Regrowth Kurri Kurri Residential and Employment Rezoning

Preliminary documentation for EPBC Act referral 2023/09572

Loxford Project Management Pty Ltd

18 April 2024

→ The Power of Commitment

Project name		Hydro biodiversity surveys and BSAR					
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1. Introduction

1.1 Proposal background

McCloy Project Management Pty Ltd (the proponent) is currently progressing the planning and approval to develop approximately 270 ha of land at Loxford, NSW which forms part of the former Hydro Aluminium Kurri Kurri smelter site (development footprint or proposed action area). The proposal would include the development of residential, business, employment, and public recreation areas as well as transport links and community infrastructure (the proposal).

A Biodiversity Certification Assessment Report (BCAR) has been prepared in accordance with the requirements of the *NSW Environment Planning and Assessment Act 1979* (EP&A Act) and *Biodiversity Conservation Act 2016* (BC Act). The BCAR addresses the potential biodiversity impacts associated with the proposed bio certification. Potential impacts to biodiversity associated with the development footprint would include the removal of up to 111 hectares (ha) of native vegetation, which provides known and potential habitat for a range of threatened biota. Two Biodiversity Stewardship Sites (BSSs) are proposed to be established adjacent to the proposed action area in accordance with Part 5 Division 2 of the BC Act (retention area or proposed BSSs). Land within these BSSs would be conserved in perpetuity to offset the impacts of the proposal on biodiversity including species and ecological communities listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The location of the proposed action area and proposed BSSs are shown on Figure 1.1.

On 5 June 2023, McCloy Project Management Pty Ltd referred the project to the Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW). The referral was re-submitted on 9 September 2023, following minor amendments. On 25 September 2023 the delegate determined that the proposed action (i.e., the proposal; EPBC Ref: 2023/09572) is a 'controlled action' under EPBC Act and the project would be assessed through preliminary documentation. The Department's advice issued on 6 October 2023 detailed the further information required for the preliminary documentation to be prepared by McCloy Project Management Pty Ltd in support of their referral (see Appendix A).

The Department's request for further information seeks further assessment of the potential impacts of the controlled action on the following Matters of National Environmental Significance (MNES), as listed under the EPBC Act:

– Kurri Sand Swamp Woodland of the Sydney Basin Bioregion, which was listed as an endangered ecological community (EEC) under the EPBC Act on 7 September 2023 (during the referral assessment period).
– Koala (*Phascolarctos cinereus*) combined populations of Queensland, New South Wales, and the Australian Capital Territory, which is listed as an endangered species under the EPBC Act.

1.2 Purpose of this report

The preliminary documentation provided in this report has been prepared to fulfil the further information requirements of the Minister for the Environment (or delegate) and provides detail on the impacts of the proposed action on the MNES listed above. Table 1.1 summarises the additional information requested by the DCCEEW and where such information has been provided in this report.

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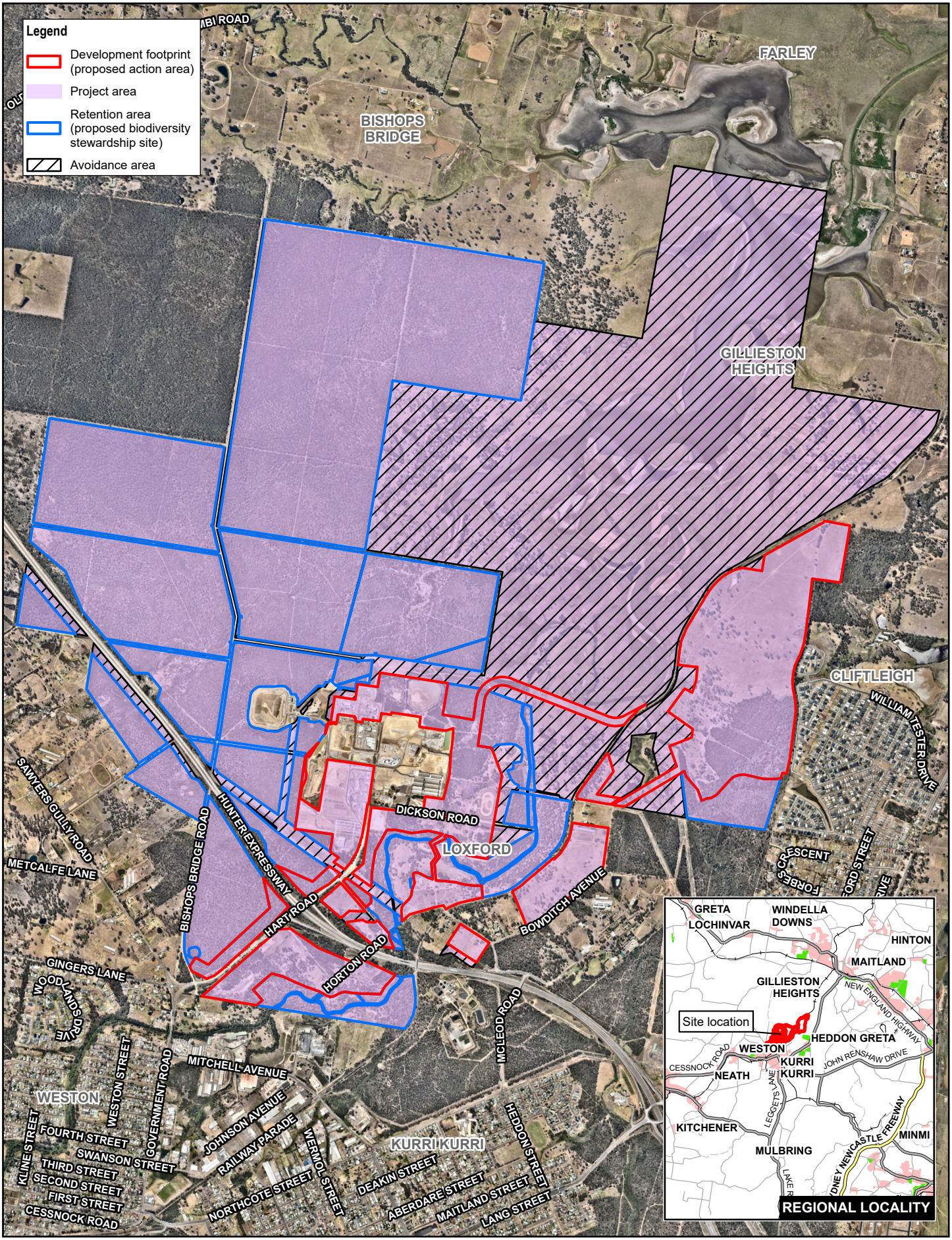
Table 1.1 Information requirements

Item	Requirements	Where addressed in this report
Listed threatened species and communities (s18 & 18A)		
1	***Phascolarctos cinereus* (Koala (combined populations of Queensland, New South Wales, and the Australian Capital Territory) – Endangered Species.** The department considers that insufficient information has been provided in the referral to determine if the proposed action will have a significant impact on *Phascolarctos cinereus* (Koala (combined populations of Queensland, New South Wales, and the Australian Capital Territory). The department requests further information on impacts, avoidance and mitigation measures as follows:	
	– How much Koala habitat occurs on the proposed action site?	Section 3.2.1
	– Where the Koala habitat is located, particularly any habitat critical to the survival of the species?	Section 3.2.1and Figure 3.1
	– How much Koala habitat would be cleared as part of the proposal, including where the clearance would occur?	Section 3.2 and Figure 3.1
	– More detail on the survey effort for locating Koalas and their habitat on the site, including the survey methods used, locations, hours spent surveying, time of day and dates.	Section 3.1
	– All NSW BioNet Atlas records for Koalas within 5km of the site, over the last 20 years.	Section 3.2.2
	– Measures that will be taken to avoid any direct or indirect impacts on the Koala?	Section 5
	– Mitigation measures including measures to reduce impacts to the Koala, such as from dogs, vehicles, habitat degradation or fragmentation, and bush fires?	Section 5
2	**Kurri Sands Swamp Woodland – Endangered Ecological Community** The department considers that further information will be required on the potential impacts of the proposed action on the Kurri sand swamp woodland. This TEC was only listed as Endangered on 7 September 2023 and consequently there has been no surveying for it on the proposed action site and no assessment of the significance of any impacts on it from the proposed action. The Approved Conservation Advice for the Kurri sand swamp woodland of the Sydney Basin bioregion states that habitat or areas most critical to the survival of this TEC are those occurrences that are in the best condition. These are those parts of the TEC that are largest and/ or have the most intact structure and ecological function, and therefore the greatest chance of persisting in the long term. However, occurrences that otherwise meet the minimum condition thresholds are also critical to the survival of the TEC, if they occur in locations or landscape positions that are particularly important for biodiversity or function and/ or that contain species or habitat features that are important in a regional or local context. The department requests further information on impacts, avoidance and mitigation measures as follows:	
	Measures that will be taken to avoid any direct or indirect impacts on this TEC	Section 5
	Mitigation measures including: – Details of any asset protection zones (such as fire management to protect housing) to be applied within patches of Kurri sand swamp woodland, and the extent to which they will impact on the retained areas of Kurri sand swamp woodland. – Measures to reduce impacts to retained Kurri sand swamp woodland during all phases of the proposed action including, but not limited to, erosion controls, fencing, waste management, signage of conservation areas, designated walking trails and weed and pest management. Map of Kurri sand swamp woodland showing: – Areas of direct impact, areas of indirect impact and areas retained. – APZ (hatching in contrasting colour). – The proposed action area boundary and development footprint boundary.	Section 5 and Figure 4.1
3	The preliminary documentation must include a clear summary of the residual impacts from the proposed action on Kurri sand swamp woodland, having regard to the avoidance and mitigation measures that will be undertaken to minimise impacts. This should be provided as a **summary table** as follows:	Section 6.2

Item	Requirements		Where addressed in this report
		Kurri sand swamp woodland	
	Proposed action area		
	Development footprint		
	Direct impact area		
	Retained area		
	Area in APZ		
	Indirect impact area		
Offsets			
4	The department is of the view that the proposal is likely to have a residual significant impact on Kurri sand swamp woodland and Koala requiring compensatory measures (e.g., environmental offsets) to be implemented under the EPBC Act. It is not yet clear what the extent of any residual impact includes. Please provide details of the direct and indirect residual impacts. Please also provide details of proposed offsets to compensate for these residual impacts including:		
	– The type of offset(s) proposed (note, the Commonwealth has endorsed the NSW BOS).		Section 7.1
	– The extent to which the proposed offset actions correlate to, and adequately compensate for, EPBC Act listed species and communities.		Section 7.2
	– The suitability of the location of any proposed offset site for EPBC Act listed species and communities, including evidence of the presence of, or usage by, relevant protected matter(s).		Section 7
	– The conservation gains to be achieved by the offset i.e., positive management strategies that improve the site or averting the future loss, degradation, or damage of the protected matter.		Section 7.3
	– The time it will take to achieve the proposed conservation gain.		Section 7.3
	– The level of certainty that the proposed offset will be successful.		Section 7.3
6	Please demonstrate that the proposal is consistent with the following conservation advice: – Department of Climate Change, Energy, the Environment and Water (2023). *Approved Conservation Advice for the Kurri sand swamp woodland of the Sydney Basin bioregion*. Canberra: Department of Climate Change, Energy, the Environment and Water.		Section 8.2
	Please demonstrate that the proposal is consistent with the following recovery plan for Koala: – Department of Climate Change, Energy, the Environment and Water (2022). National Recovery Plan for the Koala Phascolarctos cinereus (combined populations of Queensland, New South Wales, and the Australian Capital Territory). Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: • National Recovery Plan for the Koala Phascolarctos cinereus (combined populations of Queensland, New South Wales, and the Australian Capital Territory) (dcceew.gov.au). Please demonstrate how your proposal will have regard to the following conservation advice for Koala: – Department of Climate Change, Energy, the Environment and Water (2022). Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, New South Wales, and the Australian Capital Territory. Canberra: Department of Climate Change, Energy, the Environment and Water.		Section 8.1

Item	Requirements	Where addressed in this report
7	**Economic and social matters**	
	Please provide further detail on the social and economic costs and/or benefits of undertaking the proposed action, including:	
	– An estimate of any anticipated economic costs and/or benefits (in AUD), particularly with reference to the domestic market. – The basis for any estimations of costs and/or benefits. – Details of any stakeholder consultation, including First Nations consultation, and their outcomes. – Any potential employment opportunities expected to be generated at each phase of the proposed action, including any potential opportunities for First Nations people and businesses in relation to the project.	Section 9



Paper Size ISO A4

0 0.2 0.4 0.6 0.8

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Loxford Project Group Pty Ltd
Hydro biodiversity surveys and BSSAR – Response to preliminary documentation request

Project area

Project No. **12527690**
Revision No. **0**
Date **30/01/2024**

FIGURE 1

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Print date: 30 Jan 2024 - 12:06

Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; AJW: Proposed subdivision, 2023; LPI: DTDB / DCDB, 2017; Aerial Imagery: Nearmap WMS Server: . Created by: fmackay

1.1 Glossary of terms and acronyms

Term	Definition
BC Act	*Biodiversity Conservation Act 2016* (NSW).
BDAR	Biodiversity Development Assessment Report.
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the BAM. Includes ecosystem credits or species credits.
Biodiversity credit report	Specifies the number and type of biodiversity credits: required to offset the impacts of a development to obtain a Biodiversity Certification Agreement; or that would be generated through conservation and management of a Stewardship site under a Stewardship Site agreement.
Biodiversity offsets	Specific measures that are put in place to compensate for impacts on biodiversity values.
Biodiversity values	The composition, structure, and function of ecosystems, including threatened species, populations and ecological communities, and their habitats.
BOS	Biodiversity Offset Scheme.
BSA	Biodiversity Stewardship Agreement.
BSS	The area proposed to be placed under a Biodiversity Stewardship Site Agreement. The BSS would comprise the avoidance footprint for the project.
BSSAR	Biodiversity Stewardship Site Assessment Report.
CEEC	Critically endangered ecological community.
CEMP	Construction Environmental Management Plan.
DAWE	Commonwealth Department of Agriculture, Water and the Environment, now the Department of Climate Change, Energy, the Environment and Water (DCCEEW).
DBH	Diameter at breast height.
DCCEEW	Commonwealth Department of Climate Change, Energy, the Environment and Water.
Development footprint	The area shown as development footprint in Figure 7.1 and other figures throughout this report. See also definition of 'proposal'. The development footprint would be directly impacted by construction and operation of the proposal.
DPI	NSW Department of Primary Industries.
DPIE	NSW Department of Planning, Industry and Environment.
Ecosystem credit	A credit that relates to a vegetation type and the threatened species that are reliably predicted by that vegetation type (as a habitat surrogate).
EEC	Endangered ecological community.
EES	Environment, Energy and Science Group (part of NSW DPIE).
EP&A Act	NSW Environmental Planning and Assessment Act 1979.
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth).
FFMP	Flora and Fauna Management Plan.
GIS	Geographic information system.
ha	Hectare.
km	Kilometre.
KoRV	Koala Retrovirus.
LGA	Local Government Area.
Locality	The area within a 5 km radius of the development footprint.
M	Metre.
Migratory species	Species listed under listed under international agreements (i.e., Ramsar, JAMBA and CAMBA conventions) to which Australia is a party.

Term	Definition
MNES	Matters of National Environmental Significance.
NSW	New South Wales.
PCT	Plant community type.
Proposed action area	The proposed development of 270 ha of land within the former Hydro Aluminium Smelter site, located at Kurri Kurri. This term is used interchangeably with “the proposal”.
Species credit	A credit that relates to an individual threatened species that cannot be reliably predicted based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Biodiversity Data Collection.
Site	Comprises the development footprint and adjacent avoidance footprint associated with the proposed Biodiversity Stewardship Site.
Study area	The area that was subject to field survey and assessed for direct or indirect impacts arising from construction and operation of the proposal. This includes vegetation and habitat within 5km of the site.
TBDC	Threatened Biodiversity Data Collection.
TEC	Threatened ecological community.
The proposal	The proposed development of 270 ha of land within the former Hydro Aluminium Smelter site, located at Kurri Kurri. This term is used interchangeably with “the proposed action”.
Threatened biota	Threatened species, populations or ecological communities listed under the BC Act and/or the EPBC Act.

1.3 Scope and limitations

This report has been prepared based on a proposal description provided by the proponent. A ‘development footprint’ polygon (i.e., disturbance footprint) was prepared for the biodiversity assessment based on these inputs and was modified through several iterations and confirmed in consultation with the proponent and the consultant team. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the development footprint and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the proposal using Geographic Information System (GIS) software. These calculations have in turn been relied upon in the determination of key thresholds such as whether the development footprint would have a direct impact on a threatened entity, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated proposal design and/or spatial data.

This report: has been prepared by GHD for Loxford Project Management Pty Ltd and may only be used and relied on by Loxford Project Management Pty Ltd for the purpose agreed between GHD and Loxford Project Management Pty Ltd as set out in Section 1.2 of this report.

GHD otherwise disclaims responsibility to any person other than Loxford Project Management Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD and described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points and timing of surveys outlined in Table2. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

Investigations undertaken in respect of this report are constrained by the particular site conditions, such as the location of buildings, services, and vegetation. As a result, not all relevant site features and conditions may have been identified in this report.

Site conditions (including the presence of hazardous substances and/or site contamination) may change after the date of this Report. GHD does not accept responsibility arising from, or in connection with, any change to the site conditions. GHD is also not responsible for updating this report if the site conditions change.

GHD has prepared this report on the basis of information provided by Loxford Project Management Pty Ltd and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the report which were caused by errors or omissions in that information.

2. Methodology

Biodiversity impacts associated with the proposed action are being assessed by the NSW Biodiversity, Conservation and Science (BCS) division of the NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW). This required the preparation of a BCAR in line with the requirements of the Biodiversity Assessment Method 2020 (BAM) (DPIE 2020a).

The following section outlines the methods used to prepare the BCAR as well as the source of information included within this preliminary documentation package. The BCAR (GHD 2023) is included as Appendix B to this report.

Staged surveys within the proposed action area were conducted with reference to the BAM survey requirements and relevant threatened species survey guidelines for species targeted during preparation of the BCAR. This included field surveys completed between August 2019 and December 2021, as summarised in Table 2.1. In addition, several ecological surveys have been previously completed across the Hydro lands, including the proposed action area. Results of these surveys have been reviewed and referred to where relevant. Previous surveys completed within the development footprint are summarised in Table 2.2. Details regarding survey methodology are provided in Section 2 of the project BCAR.

Table 2.1 Survey techniques and timing

Stage	Date	Survey Technique
Preliminary investigation of biodiversity values and vegetation mapping	26 - 29 August 2019 08 -11 October 2019 18 June 2020	Ground-truthing of previous vegetation mapping. Random meander survey in accordance with Cropper (**1993**) to: – Document fauna habitats and features within the development area. – Assess the general condition of vegetation and habitats present. – Confirm vegetation boundaries. – Identify potential habitat for threatened biota. – Aquatic habitat assessment. – Opportunistic fauna observations.
BAM plot surveys	26 – 30 August 2019 8 -11 October 2019 24 April 2020 18 June 2020	Vegetation integrity plot/transects. Targeted threatened flora surveys, opportunistic fauna observations. Fauna habitat assessment.
Winter candidate species credit targeted fauna survey	14 - 29 August 2019	Stag watching. Owl call playback. Spotlighting. Hollow bearing tree assessments. Large forest owl tree survey. Targeted surveys for breeding habitat for Little Eagle, White-bellied Sea Eagle, and Glossy-Black Cockatoo.
Candidate species credit targeted flora survey	28 - 31 October 2019 13 - 15 November 2019 24 April 2020 06 - 08 October 2020 10 -18 October 2020 18 February 2021	Systematic parallel traverses targeting candidate threatened flora species.

Stage	Date	Survey Technique
Spring candidate species credit targeted fauna survey	25-29 November 2019	Ultrasonic call recording (Anabat). Diurnal bird survey. Pitfall trapping. Spotlighting. Call playback for threatened owls. Remote camera traps. Active searches for scats and signs.
Summer candidate species credit targeted fauna survey	24 –28 February 2020	Arboreal Elliot Traps for small mammals. Spotlighting. Call Playback for threatened owls and amphibians. Harp Trapping. Ultrasonic call recording (Anabat). Active searches for scats and signs. Remote camera traps. Habitat assessment.
Supplementary diurnal bird surveys	6-7 October 2021 15 October 2021 22 October 2021 21 November 2021 6 December 2021	At total of 74 bird surveys were undertaken across the proposed action area between Oct-Dec 2021. Repeat surveys were completed at 20 sites where blossom was present.
Swift Parrot and Regent Honeyeater habitat assessment	06 -07 October 2021 15 October 2021 22 October 2021 21 November 2021 06 December 2021	74 habitat assessment sites assessed within the proposed action area. Assessment method followed the Australian National University (ANU) and Birdlife methodology developed for the National Regent Honeyeater and Swift Parrot Monitoring Programs (Crates et al. 2017).
Supplementary surveys for *Diuris tricolor* and *Rutidosis heterogama* (Heath Wrinklewort)	05 - 06 and 19 October 2021	Systematic transects.
Supplementary surveys for Green and Golden Bell Frog	24-26 November 2021 07- 08 December 2021	Call playback. Spotlighting.

Table 2.2 Summary of previous ecological surveys completed within and adjacent to the development site

Survey	Date/s of survey	Survey techniques/effort
Biodiversity Certification Assessment Report for Hydro Lands (ELA 2016)	December 2014 February 2015 March 2014 March 2016 9 December 2014 24-19 December 2014 27 November 2014 27-29 December 2014 17-19 January 2015 and 23 February 2015	Vegetation mapping. 37 BBAM plot/transects. Threatened flora survey walking parallel transects spaces 5-10 metres apart. Plot based survey for threatened flora, including 80 20 X 50 plots. Arboreal hair tubes (1680 trap nights). Next box monitoring (70 trap nights). Camera traps (20 cameras over 10 week period). Spotlighting. Call playback for forest owls and Koala. Amphibian survey, over six nights. Echolocation call recording. Diurnal bird surveys.
Flora assessment – Hydro Aluminium Kurri Kurri (FloraSearch 2004)	29 April – 14 May 2003 8 -11 July 2003 23-15 October 2003 22-23 January 2004	Vegetation mapping. Quadrat surveys (thirty 20 X 20 plots). Spot sampling (77 survey points).
Terrestrial Vertebrate Fauna Assessment (Cenwest Environmental Services 2004)	12-24 May 2003 18-29 November 2003	Elliot A and B trapping on ground (180 trap nights). Cage traps (72 trap nights). Elliot A aboreal traps (120 trap nights). Hair tubes on ground (1200 trap nights). Aboreal Hair tubes (large and small) (560 trap nights). Pitfall traps (432 trap nights). Spotlighting. Systematic herpetological searches for 30 mins over 4 day days. Bird surveys (20 hours). Call playback (half hour at 10 sites over 4 nights). Opportunistic observations.

3. Further information regarding *Phascolarctos cinereus* (Koala)

3.1 Survey methods and effort

Based on the bioregional context for the assessment and the Plant Community Types (PCTs), patch size, vegetation cover and habitat resources present at the proposed action area, the BAM calculator generates a list of threatened fauna species that are predicted to utilise the proposal site.

The suite of predicted threatened species associated with ecosystem credits for the proposed action area, including those species recorded during field surveys and others not recorded but which could occur given the presence of relevant habitat resources on the site have been included in the project BCAR (refer to Appendix B).

Due to the presence of potential foraging habitat the BAM calculator identified the Koala as a predicted threatened species within the proposed action area. As the species is a predicted species it has been assumed present within the development footprint.

Under the BAM targeted surveys are not required for predicted species. Despite this, surveys for Koala (*Phascolarctos cinereus*) were included in the field assessments completed for the BCAR to help determine whether the site is likely to be important habitat for the species. Survey methods included spotlighting, call playback, camera trapping and active searches for Koala scats. Table 3.1 provides further detail on survey effort completed for the BCAR that was focused on locating Koalas within the development footprint. Refer to Figure 3.1 for location of Koala surveys.

No Koalas or evidence of Koalas were observed during field surveys completed for the BCAR, nor have any been recorded during previous fauna surveys that have been completed within the development footprint (ELA 2016, Cenwest Environmental Services 2004). Results of the field surveys and habitat assessment concluded that the habitat within the site was not considered important for the species as there was no evidence of occupation by Koalas and there are very few records within the local area.

Table 3.1 Survey effort for locating Koalas within the proposed action site

Survey method	Dates	Time spent surveying	Time of day
Spotlight surveys	26-28 November 2019 24-27 February 2020 7-8 December 2021	32 person hours	Post dusk
SAT test	26-27 February 2020	12 person hours	Afternoon
Camera traps	25-28 November 2019 27-29 February 2020	53 trap nights	6.00 pm-6.00 am each day

3.2 Impacts to potential Koala habitat

3.2.1 Koala habitat within the proposed action site

Although no Koalas were recorded during site surveys, the proposed action site contains potential habitat for the species within the following three PCTs:

– Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland (PCT 1633).
– Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (PCT 1600).
– Grey Gum- Routh-barked Apple grassy woodland in the Cessnock Kurri Kurri Area (PCT 1591).

Potential Koala habitat has been determined through:

– Review of the locally important Koala trees listed for the Central NSW coast (Yongentob et al 2021).
– Review of as PCTs identified as being associated with Koalas within the Threatened Biodiversity Database Collection (TBDC) (DPE 2023).

It should be noted that although PCT 1591 is not identified by the TBDC as a PCT associated with Koala it has been included as potential habitat due to the presence of *Eucalyptus punctata* (Grey Gum) and *Eucalyptus tereticornis* (Forest Redgum), both of which have been identified as important feed trees for Koala within the Central NSW coast region (Yongentob et al 2021).

The location of potential Koala habitat within the proposed action site is shown on Figure 3.1. None of this habitat is likely to be critical to the survival of the species as:

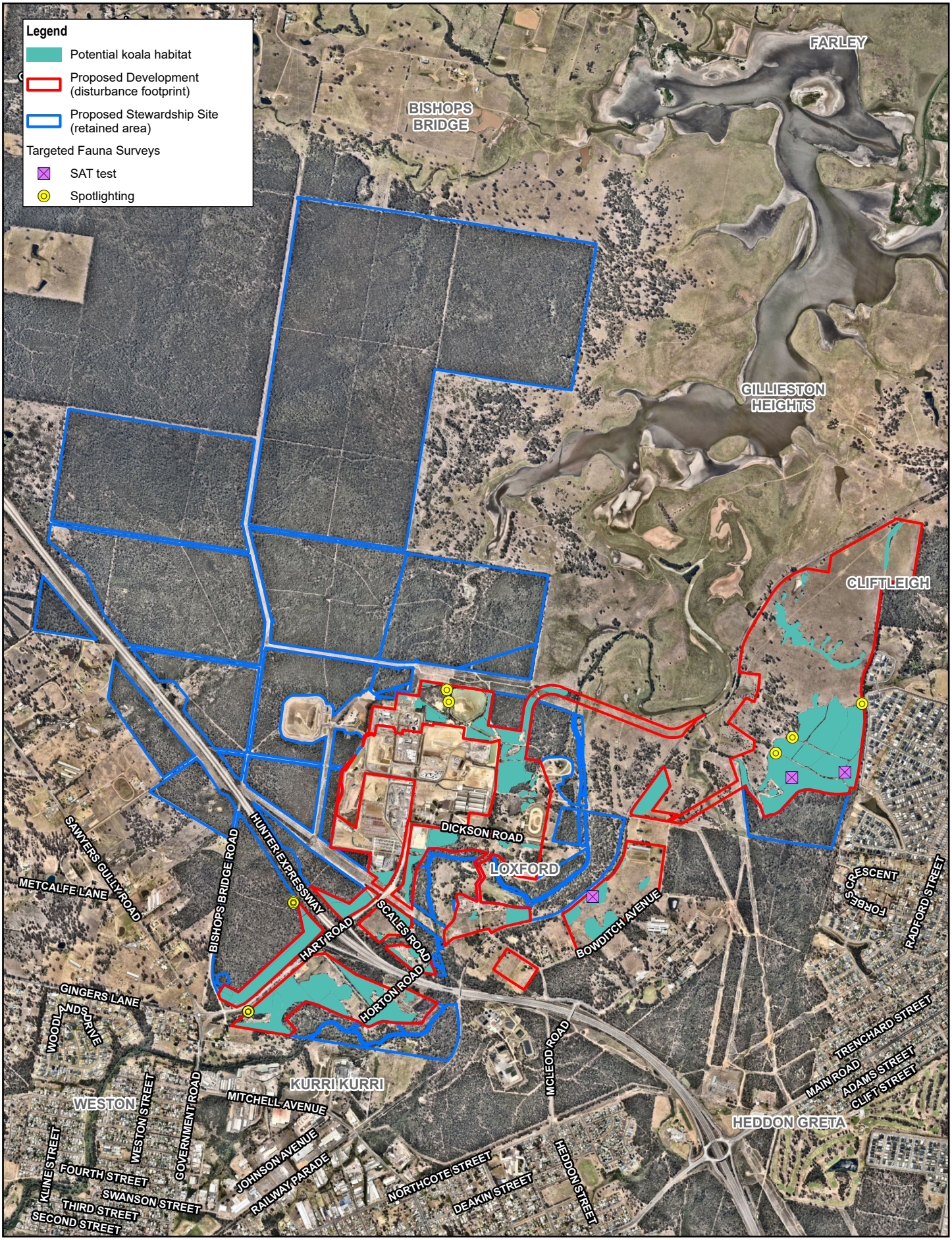
– No Koalas have been observed utilising the habitat (currently or historically).
– The habitat is not likely to be used to meet essential life cycle requirements.
– The habitat is not known to support an important population of the species.
– The habitat is not likely to be necessary to maintain genetic diversity and long-term evolutionary development of the species.
– The habitat is not necessary for use as corridors to allow the species to move freely between sites used to meet essential life cycle requirements.
– The habitat is not likely to be necessary to ensure the long-term future or the species.

Table 3.2 provides a summary of PCTs and corresponding vegetation zones within the development footprint that have the potential to provide habitat for Koalas. A total of 83.99 ha of potential Koala foraging habitat occurs within the development footprint.

Within the Sydney Basin area there is estimated to be approximately 1,605,511 ha of potential Koala habitat which accounts for 44.32 percent of the mapped vegetation within the Bioregion (Biolink 2023). Within the Cessnock LGA there is estimated to be 157,727 ha of preferred Koala habitat (80.27 percent of the mapped vegetation) (Biolink 2023). The removal of 83.99 ha represents approximately 0.005 percent of the potential Koala habitat within the Sydney Basin bioregion and 0.05 percent of the estimated Koala habitat in the Cessnock LGA.

Table 3.2 Potential Koala habitat within the proposed action site

Vegetation zone	Plant community type	PCT ID	Condition class	Area in site (ha)
1. 1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact).	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area.	1633	Intact	38.80
2. 2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed).	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area.	1633	Underscrubbed	8.04
3. 8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed).	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter.	1600	Underscrubbed	4.99
4. 10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact).	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter.	1600	Intact	17.17
5. 6 Grey Gum –Rough-barked Apple shrubby open forest of the lower Hunter (intact).	Grey Gum –Rough-barked Apple shrubby open forest of the lower Hunter.	1591	Intact	4.87
6. 7 Grey Gum –Rough-barked Apple shrubby open forest of the lower Hunter (underscrubbed).	Grey Gum –Rough-barked Apple shrubby open forest of the lower Hunter.	1591	Underscrubbed	10.12
TOTAL				**83.99**



Paper Size ISO A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Loxford Project Group Pty Ltd
Hydro biodiversity surveys and BSSAR – Response to preliminary documentation request

Potential koala habitat within development footprint

Project No. **12527690**
Revision No. **0**
Date **30/01/2024**

FIGURE 2

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Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; AJW: Proposed subdivision, 2023; LPI: DTDB / DCDB, 2017; Aerial Imagery: Nearmap WMS Server: . Created by: fmackay

3.2.2 Previous Koala records within 5 km of the proposed action site

A review of the NSW BioNet species sightings database shows that there have been seven Koalas recorded within 5km of the proposed action site within the past 20 years (DPE 2023). The most recent record was on 24 January 2023 from 526 Louth Park Road, South Maitland, approximately 2 km east of the development footprint. The closest record is from 2016 and is located within the township of Kurri Kurri. It should be noted however that precise location of this record cannot be determined, only the suburb has been provided within the BioNet data (DPE 2023).

The majority of the Koala records in the Cessnock LGA occur within the southern parts of Werakata National Park (NP) (located approximately 13 km southeast of the site) and the Sugarloaf State Conservation Area (SCA) (located approximately 13 km south of the development footprint). Significant barriers would restrict the movement of Koalas from habitat within and surrounding Werakata NP and Sugarloaf SCR into the potential Koala habitat within the development footprint (DPE 2023). These barriers to movement include large areas of urban development and major roads including the Hunter Expressway (which is fenced with six foot exclusion fencing).

A summary of the BioNet atlas records for the locality is provided in Table 3.3.

Table 3.3 NSW BioNet atlas Koala sightings

Date observed	Observation type	Location description (DPE 2023)	Accuracy (m)
2023-01-24	Seen	526 Louth Park Road, South Maitland, 2320	10
2020-12-15	Wildlife rehab	Geocoded loc: Kurri Kurri NSW 2327; Orig location provided: Kurri Kurri, 2327. Rehab provided only suburb.	1269
2020-10-28	Wildlife rehab	Geocoded loc: Abermain NSW 2326; Orig location provided: Abermain, 2326. Rehab provided only suburb.	2213
2020-12-11	Wildlife rehab	Geocoded loc: Pelaw Main NSW 2327; Orig location provided: Pelaw Main, 2327. Rehab provided only suburb.	1718
2020-12-15	Wildlife rehab	Geocoded loc: Kurri Kurri NSW 2327; Orig location provided Kurri Kurri, 2327. Rehab provided only suburb.	1269
2019-11-10	Wildlife rehab	Suburb only Provided: Kurri Kurri, NSW, 2327	1269
2016-05-07	Roadkill	Suburb only provided: Kurri Kurri, Motorway, NSW, 2327	1269

4. Further information regarding Kurri sand swamp woodland

4.1 Impacts to Kurri sand swamp woodland

Kurri sand swamp woodland was listed as an Endangered Ecological Community (EEC) under the EPBC Act on 7 September 2023. As the community was not listed on at the time of submitting the EPBC referral for the project (5 June 2023) an assessment of impacts of the proposed action on the EEC was not included in the referral.

The following section addresses the request for further information from DCCEEW regarding the impacts of the proposed action on Kurri sand swamp woodland EEC.

Vegetation within the Hydro site that is mapped as Parramatta Red-Gum-Narrow-leaved Apple- Prickly-leaved shrubby woodland in the Cessnock Kurri Kurri area (PCT 1633) corresponds with the Kurri sand swamp woodland EEC, as listed under the EPBC Act. This vegetation also represents a local occurrence of the EEC listed under the BC Act as Kurri sand swamp woodland in the Sydney Basin Bioregion.

Most of the EEC within the development footprint meets the category A1 condition threshold as defined under the approved conservation advice for this community as all patches are at least 2 ha and less than 20 percent of the total understory cover is comprised of non-native species (DCCEEW 2023). There are also two small patches of condition class A2 located south of Dickson Road and west of Hart Road.

The proposal would result in a direct impact to 47.72 ha of Kurri sands swamp woodland EEC. Including 38.80 ha in intact condition, 8.04 ha that have been under scrubbed and 0.88 of regrowth. There is also potential for indirect impacts to 2.63 ha of this community adjacent to the site. Direct and indirect impacts to Kurri sands swamp woodland are described further in Table 4.1 below. These impacts would be mitigated through measures outlined in Section 5.

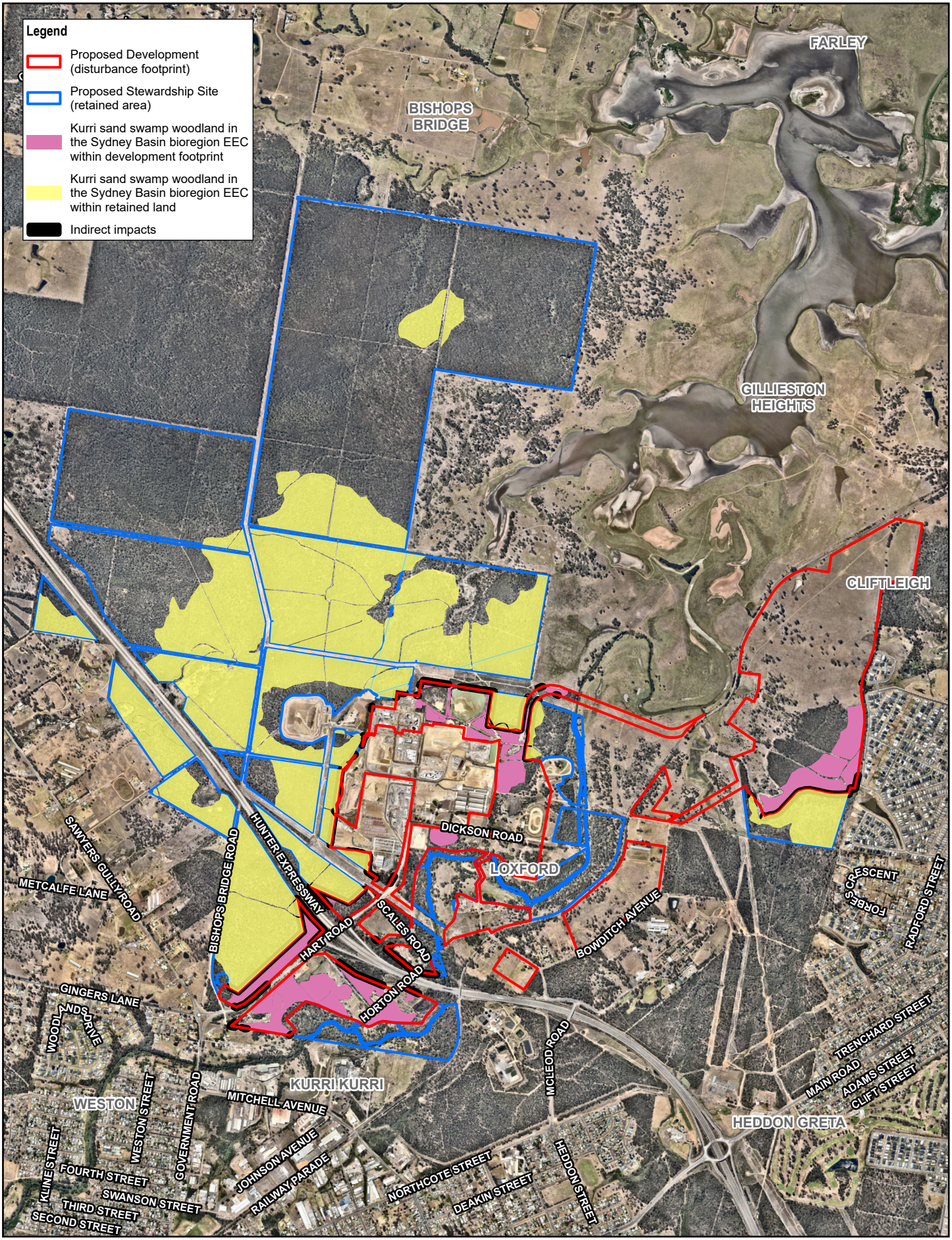
Figure 4.1 shows the areas of Kurri sand swamp woodland EEC that would be impacted by the proposed action (including direct and indirect impacts) as well as areas proposed to be retained and conserved within biodiversity offset sites.

Table 4.1 Impacts to Kurri sands swamp woodland

Impact	Description
Direct impacts	
Clearing and habitat loss	The proposal would remove 47.72 hectares of Kurri sand swamp woodland within the development footprint, made up of vegetation mapped as PCT 1633. Approximately 8.92 ha of PCT 1633 within the development footprint is in moderate condition and comprises underscrubbed or regenerating vegetation. The remaining 38.8 ha of PCT 1633 is in good condition and comprises intact vegetation. Approximately 287.5 ha of Kurri sand swamp woodland EEC is proposed to be conserved in perpetuity within two proposed biodiversity stewardship sites located adjacent to the development footprint. Areas of Kurri sand swamp woodland that meet the class A and B thresholds, are considered critical to the survival of this ecological community, some areas of class C may also be considered critical if they meet certain criteria (DCCEEW 2023). All Kurri sand swamp woodland within the site (proposed action area and proposed offset site) meet the class A conditions and therefore all of this community within the development and proposed offset sites are considered critical to the survival of the ecological community. The vegetation that would be removed from the proposed action area provides foraging, shelter, and breeding habitat resources for a range of native fauna species, including threatened species that are listed as both ecosystem and species credit species as well as for common fauna species. The proposal would remove several hollow bearing trees including trees with large hollows. Hollow-bearing trees are critical habitat components for many tree-dwelling fauna species, including arboreal mammals, microchiropteran bats and woodland birds that rely on hollows for shelter and breeding habitat. The proposal would also remove habitat resources such as leaf litter and fallen logs, which provide foraging and shelter substrate for small terrestrial animals and ground-foraging birds.

Impact	Description
Disruption of connectivity/ fragmentation	The northeast of the proposal footprint has been substantially disturbed and consists predominantly of agriculture land that in places is adjacent to remnant patches of native vegetation. A patch of PCT 1633 would be removed from the margin of a larger patch of native vegetation that extends south from the proposed action area and borders the Heddon Greta and Clift leigh residential housing estates. The removal of this vegetation would reduce connectivity to remnant vegetation that is located north of the Cliftleigh estate. This patch of vegetation is already partially fragmented and isolated as a result of previous land clearing associated with agricultural activities and urban development with only a narrow corridor of vegetation connecting this patch to remnant vegetation located to the south. Surrounding the former Hydro smelter site in the west of the proposed action area the proposed development adjoins a large tract of vegetation that extends to the north-west of the site. (refer to Figure 1.1) Near Hart Road and the Hunter Expressway the construction of an off ramp would result in the removal of vegetation from the edges or margins of this large patch. Vegetation proposed to be removed is located on the periphery of this patch and as such would not result in the further fragmentation or isolation of any areas of habitat although it would increase the distance between existing patches of native vegetation. Impacts resulting from the proposal would include an increase in gaps in habitat within the surrounding locality. Given the existing degree of fragmentation in the locality and the moderate extent of vegetation clearing proposed on the edge of a large patch of habitat, it is unlikely that the project would create significant or new barriers to the movement of pollinator and seed dispersal vectors, such as insects and birds.
Fauna injury or mortality	Construction works have the potential to result in the injury or mortality of some individuals of less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the site during clearing activities and unable to move out of the area (including Koalas in the unlikely event that they are present within the site). Fauna management measures will be implemented during construction to minimise the risk of injury to resident fauna. More mobile native fauna such as birds and large terrestrial mammals that may be sheltering in vegetation within the development footprint are likely to evade injury during works as they are likely to move away into adjoining areas.
Indirect impacts	
Edge effects	Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the development footprint. The proposal would result in an increase in the number of new edges being established within areas of relatively intact native. Vegetation adjoining the development footprint is currently in relatively good condition with few weed species present. There is therefore a high risk that construction activities and associated disturbance may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems, and flowers) into areas of native vegetation via erosion processes (wind and water) and via workers shoes and clothing and through construction vehicles. The risk of introduction of weeds would continue during operation of the proposal as members of the public may enter adjoining vegetation, and residents may illegally dump garden waste into the proposed BSS. Changes (particularly increases) in the amount of available sunlight because of vegetation clearing may also result in establishment of weed species and new infestations. Management of the proposed BSS, particularly weed and pest management, would help to mitigate the effect of these potential edge effects on retained vegetation adjoining the development site. The creation of new edges within areas of native vegetation also has the potential to introduce impacts associated with noise and light into areas of adjacent vegetation. This could in turn result in disruptions to fauna utilising vegetation adjacent to the site.
Noise and light impacts	Most of the construction works associated with the proposal would be undertaken during standard, daytime construction hours. Exemptions and approval for works outside of the above standard construction hours may be required during certain circumstances. Construction noise would be temporary and generally confined to daylight hours. It may impact on fauna at the site given that it is a ‘green field’ site. The location of the site near to the Hunter Express Way and other main roads means that noise would not be a novel impact for the site. Once the residential subdivision is in operation there would likely be ongoing indirect impacts associated with noise and light around the periphery of the development. These changes to light and noise within the local area may discourage native fauna species from using vegetation along the edges of the proposed BSS.
Introduction and spread of weeds, pests, and pathogens	Disturbance associated with vegetation clearing, vehicle traffic and general day to day operations of the proposal during construction and operation of the proposal would increase the potential for the spread, introduction, and establishment of weed and pest species, and diseases and pathogens. Weed species are effective competitors for habitat resources and have the potential to exclude native species and modify the composition and structure of vegetation communities.

Impact	Description
	Construction activities within the development footprint also have the potential to introduce or spread pathogens such as Phytophthora, Myrtle Rust and Chytrid fungus into adjacent native vegetation through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys of the study site. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus affects both tadpoles and adult frogs and can significantly affect frog populations frog populations once introduced into an area. The consequence of impacts associated with these pathogens is high, given the good condition of vegetation adjoining the development footprint. Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment, and employees. The CEMP will include measures to mitigate these risks including restriction of access to vegetation outside the development footprint, soil and surface water management measures and hygiene protocols. Such mitigation measures will reduce the risk of introduction and spread of weeds and pathogens.



Paper Size ISO A4

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Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Loxford Project Group Pty Ltd
Hydro biodiversity surveys and BSSAR – Response to preliminary documentation request

Kurri sand swamp woodland EEC within development footprint

Project No. **12527690**
Revision No. **0**
Date **30/01/2024**

FIGURE 3

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Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; AJW: Proposed subdivision, 2023; LPI: DTDB / DCDB, 2017; Aerial Imagery: Nearmap WMS Server: . Created by: fmackay

5. Measures to avoid and mitigate potential impacts of the proposed action

5.1 Koala habitat and Kurri Sand Swamp Woodland

No Koalas have been recorded within or in close proximity to the development footprint (DPE 2023). As discussed in Section 3.2.2 most of the Koala records within the Cessnock LGA are within and surrounding the Werakata NP and the Sugarloaf State SCA. There are also several records in the West of the LGA within and surrounding the Yengo NP and Watagan and Olney State Forests (DPE 2023).

The proposed rezoning masterplan footprint for the proposed action has undergone several revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value within the Hydro lands could be avoided and minimised. Various iterations of the masterplan footprint have been developed and amended in response to detailed understanding of the site's biodiversity values and offsets requirements. Hydro's intention through the rezoning process and development of the preliminary masterplan was to avoid and minimise impacts on areas of the site with high biodiversity values within the site (including potential Koala habitat and Kurri sand swamp woodland).

The Hydro lands include the 270 ha proposed action area assessed in the BCAR as well as approximately 1750 ha of adjoining land, part of which is proposed to be conserved as a stewardship site that will be used to generate credits to offset the impacts of the proposal. In 2014, an initial assessment was completed that assessed and evaluated a range of identifiable constraints within the entire Hydro land parcel. This assessment process produced a preliminary masterplan for the site. The intention of the preliminary masterplan was to identify broad characteristics and potential land uses, which was then subject to more detailed study and refinement. Regarding the native vegetation on site, the assessment considered and put forward the conservation of areas of highest biodiversity value, which are located to the north-west of the site (including substantial areas of Kurri sand swamp woodland and potential Koala habitat), and focused areas for development predominantly in previously disturbed areas and isolated patches of low and/or poor condition vegetation or at the edges of larger patches of existing vegetation.

Following the design of the preliminary masterplan, a Biodiversity Certification Assessment (BCA) of the site was prepared in accordance with the provisions in the now repealed *Threatened Species Conservation Act 1995* (ELA 2016). Based on recommendations in the BCA (ELA 2016), Hydro amended the masterplan to further avoid impacts on biodiversity values, with the footprint of the development lands reduced from 1229 ha to 657 ha, resulting in the avoidance of impacts to an additional 570 ha of vegetation including approximately 125 ha of Kurri Sand Swamp Woodland and 340 ha of potential Koala habitat.

Further refinement and updates to the rezoning masterplan were undertaken in 2019 to further reduce impacts to areas of high biodiversity value. This resulted in the area of development land being further reduced to 270 ha. These amendments resulted in the further avoidance of approximately 45 ha of Kurri sand swamp woodland EEC (also representing potential Koala habitat) located around the proposed containment cell and areas to the north-east of the former smelter site.

The reduction in the project footprint due to avoidance measures between the original 2014 Masterplan and current Masterplan for the site is provided in the project BCAR (Appendix B).

5.2 Avoidance of indirect impacts

A Construction Environmental Management Plan(s) (CEMP) will be developed and implemented for the construction phase of the proposed action to mitigate potential indirect impacts. CEMPs are required to specify environmental safeguards for the protection of biodiversity values on neighbouring properties and waterways in accordance with relevant Government policy and guidelines and development conditions. Mitigation measures will typically include, as a minimum, industry-standard measures for the management of soil, surface water, weeds, and pollutants, as well as site-specific mitigation measures and procedures to mitigate impacts to flora and fauna.

The mitigation and management measures relating to direct and indirect impacts during construction activities are summarised in Table 5.1. These mitigation measures would be implemented as part of the CEMPs for future development at the proposed action area in order to minimise the potential impacts of the proposal on biodiversity values including potential Koala habitat and Kurri sand swamp woodland EEC.

Table 5.1 Mitigation measures (construction)

Impact	Mitigation	Timing	Responsibility
General	All workers are to be provided with an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches.	Prior to clearing/construction works.	Construction contractor
	A flora and fauna management sub-plan would be prepared as part of the CEMP, incorporating recommendations below, and expanding on specific details where necessary.	Prior to clearing/construction works.	Construction contractor
	Measures to suppress dust implemented during clearing and construction.	Throughout clearing and construction phases.	Construction contractor
	Limit disturbance of vegetation to the minimum necessary to undertake the proposal.	Prior to works commencing.	Construction contractor
	Any lighting used during construction should be appropriately positioned to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats	Prior to works commencing.	Construction contractor
	Appropriate speeds are to be enforced to limit dust generation and minimise chances of fauna mortality through vehicle strike.	During construction.	Construction contractor
BSS	Identify and fence the proposed BSS as described under 'vegetation clearing' to exclude access by construction personnel and avoid indirect impacts. Ensure that construction contractors are aware of the biodiversity value and sensitivity of the BSS through site inductions and toolbox meetings.	Prior to clearing/construction works.	Construction contractor
Vegetation clearing	Prior to the commencement of any work in or adjoining areas of native vegetation, a survey would be carried out to mark the construction impact boundary. The perimeter of this area will be fenced using high visibility fencing and clearly marked as the limits of clearing. All vegetation outside this fence line will be clearly delineated as an exclusion zone to avoid unnecessary vegetation and habitat removal. Fencing and signage will be maintained for the duration of the construction period. Fencing will be designed to allow fauna (including Koalas should they occur) to exit the site during clearing activities. Clearing will be undertaken in stages to reduce immediate competition for resources in surrounding vegetation.	Prior to clearing / Daily inspections of exclusion zones during works in area.	Construction contractor and qualified ecologist
Sedimentation	Stockpiles of fill or vegetation should be placed within existing cleared areas (and not within areas of adjoining native vegetation).	Prior to clearing/ construction works.	Construction contractor
	Sediment fences should be installed to prevent transfer of sediments into adjacent vegetation.	Prior to clearing/ construction works.	Construction contractor
Introduction of Weeds and Pathogens	A weed and pest species management sub-plan would be developed and implemented as part of project CEMP to manage weeds and pathogens during the construction and operational phase of the proposal. This sub-plan would include but not be limited to the following:	Prior to clearing/ construction works.	Construction contractor

Impact	Mitigation	Timing	Responsibility
	Provisions for identify the location and extent of any priority and/or high threat environmental weeds within the site.	Prior to clearing/ construction works.	Construction contractor and qualified ecologist
	Protocols for the management of noxious and environmental weeds.	Prior to clearing/ construction works.	Construction contractor and qualified ecologist
	Protocols to prevent the introduction and/or spread of pathogens and weeds.	Prior to any plant or machinery being brought onto the site.	Construction contractor
	Protocols to limit the spread of weed propagules downstream of proposed action area.	Prior to clearing/ throughout construction works.	Construction contractor
Removal of fauna habitat	The flora and fauna management sub-plan would be developed and implemented to minimise impacts to fauna (including Koalas) during clearing works. This plan would include but not be limited to: – Provisions for preclearing surveys to identify significant habitat features such as hollow bearing trees, logs, and nests. – Protocols for the removal of hollow bearing trees and other identified significant habitat features. – Protocols to prevent introduction or spread of chytrid fungus in accordance with Office of Environment and Heritage Hygiene protocol for the control of disease in frogs (DPIE 2020). – Protocols for the salvage and relocation of fallen logs and hollows (where appropriate). – Staged removal of vegetation to minimise competition for resources within surrounding vegetation. – Provisions to have suitably qualified ecologist present during vegetation clearing. – Protocols for the appropriate handling, capture and release of fauna. – Provisions for stages vegetation removal to increase the opportunity for fauna to vacate the site and disperse into areas of adjoining habitat to evade injury. – Protocols for post clearing reporting.	Prior to clearing.	Qualified Ecologist / Construction contractor

Impact	Mitigation	Timing	Responsibility
Water Quality and aquatic habitats	Erosion and sediment control plans would be prepared in accordance with Volume 2D of Managing Urban Stormwater: Soils and Construction (DECC 2008). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase.	Prior to construction commencing.	Construction contractor
	Erosion and sediment control controls would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality.	Weekly during construction phase or after any significant rainfall event.	Construction contractor
	Stabilised surfaces should be reinstated as quickly as practicable after construction.	Immediately following clearing.	Construction contractor
	All stockpiled material should be stored in bunded areas and kept away from waterways to avoid sediment or contaminants entering the waterway.	During construction	Construction contractor
	Spill kits would be made available to construction vehicles. A management protocol for accidental spills would be put in place.	During construction	Construction contractor

5.3 Operational Phase

There are potential interface issues associated with the occupation of the proposed action area particularly in areas adjoining the proposed biodiversity stewardship site and the potential for indirect impacts on biodiversity values to be retained. The proponent would continue to explore different mechanisms to appropriately manage potential interface impacts, including plans of management and covenants on title at the proposed action area.

Environmental Management Plans (EMPs) (or similar) would be prepared for the operational life of the proposal and would be prepared prior to the issue of the subdivision certificates. Future plans would include, as a minimum, measures to appropriately manage matters such as stormwater infrastructure, open space and APZ's as well as industry-standard measures for the management of soil, surface water, weeds, and pollutants. The proposed mitigation measures would include environmental safeguards for protection of the retained areas, neighbouring properties, and waterways in accordance with relevant policy documentation and Government guidelines.

In order to appropriately address the potential impacts of the proposal on biodiversity, the mitigation and management measures outlined in Table 5.2 would be implemented as part of the EMP for the site.

Further detail regarding environmental management and mitigation measures and details of monitoring required to help identify any shortfalls in the implementation of the proposed mitigation measures and appropriate management responses would be further developed once the subdivision layout and specific uses throughout the proposed action have been confirmed.

Table 5.2 Environmental management measures (operation)

Impact	Mitigation	Timing	Responsibility	Risk	Adaptive management response
General proposed action area management	All property owners / tenants are to be provided with an environmental induction prior to occupying site. This would include information on the biodiversity values of the site and surrounding area, protection measures to be implemented to protect biodiversity and any penalties for breaches. In particular, site occupiers would be made aware of the biodiversity value and sensitivity of the BSS and any restrictions on access and activities.	Prior to occupying the site.	Contractor	Nil	N/A
General proposed action area management	Animal and speed limit signposting to raise resident, visitor and driver awareness and enforce appropriate speed limits along the proposed access road to reduce the likelihood of vehicle strike and mortality of native fauna (including Koalas in the unlikely event that they should occur within the site).	In perpetuity	Landowner	Failure to comply with speed limits resulting in fauna mortality.	Construction of speed humps or other physical speed deterrents.
Dog attacks	Strategies to prevent dog attacks on native fauna living within vegetation adjoining the site would include a public education/consultation campaign, installation of exclusion fencing, locking of all gates and appropriate signage prohibiting dogs from entering areas (no-dog area signage). The establishment of designated dog working areas would also be considered to discourage people from walking dogs within adjoining vegetation. Other strategies outlined in (DPIE 2020) would also be implemented where appropriate.	In perpetuity	BSS managers /landowner	Failure to comply with signage resulting in people exercising dogs within adjoining vegetation	Enforcement of exclusion rules by land managers, encouraging community support including means to report dog owners who are no following rules
Edge effects	APZs will be managed to act as a buffer to minimise edge effects potentially including weed, light and erosion impacts on adjacent areas of retained vegetation.	In perpetuity	Landowner/s	Increased extent or cover of exotic plants in APZs threatening adjoining areas of native vegetation.	Periodic monitoring and adaption and/or intensification of bush regeneration activities to reduce weed cover, restore native vegetation cover etc as required.
	Control of priority weeds within the proposed action area to prevent the spread of propagules into adjacent areas of native vegetation.	In perpetuity	Landowner/s	Increased extent or cover of priority weeds.	Periodic monitoring and adaption and/or intensification of weed control activities.

Impact	Mitigation	Timing	Responsibility	Risk	Adaptive management response
	Street lighting and security lighting to be designed to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats. Lighting design must identify and adopt technologies that are least likely to adversely affect fauna use of habitat through impacts such as disruption of microbat foraging. This should include consideration of light colour and intensity, provision of light shields and other measures as appropriate to the position of lighting relative to off-site habitats.	In perpetuity	Landowner	Disturbance of fauna habitat adjacent to proposed action area.	Redesign lighting to minimise impacts to adjacent habitat.
BSS management	An appropriate restriction on title be placed on lands through a Biodiversity Stewardship Agreement (BSA) The BSS will be managed to protect and enhance biodiversity values under the BSA.	As soon as practical after approval of the proposal.	Landowner	Inadequate protection of BSS.	Include as a requirement in conditions of approval for the proposal.
BSS management	Identify and fence the proposed BSS along boundaries with the proposed action area to exclude unauthorised access and avoid indirect impacts. Boundaries with other areas of native vegetation should be left unfenced to allow for fauna movement and for firefighting activities. Boundary fencing will be installed to provide a clear physical barrier to human access and incorporate appropriate signage; gates as appropriate to allow management activities. Ensure that site occupiers and visitors are aware of the biodiversity value and sensitivity of the BSS. A site management plan (SMP) will be prepared for areas of land adjacent to the development footprint that would be included in a BSS. This plan would be reviewed and approved by the NSW Department of Planning and Environment, Credit Supply Task Force and would include measures and funding for track management, erosion, weed and pest control and fire management.	Prior to occupying the site.	Landowner / contractor	Inadequate maintenance of fences. Failure of fences to mitigate impacts.	Addressed by the BSA.

6. Assessment of residual impacts

6.1 Summary of residual impacts on Koala habitat

Although there has been no Koala recorded within or near the proposed development footprint, residual impacts of the proposal would include impacts on up to 83.99 ha of potential habitat containing identified important feed trees for the species. This represents approximately 0.005 percent of the potential Koala habitat within the Sydney Basin bioregion and 0.05 percent of the estimated Koala habitat in the Cessnock LGA. The condition of this potential habitat includes approximately 60.84 ha that is relatively intact and 15.11 ha of disturbed vegetation.

6.2 Summary of residual impacts to Kurri sand swamp woodland EEC

Residual impacts of the proposed action on Kurri sand swamp woodland EEC would include the removal of up to 47.72 ha of the community and potential indirect impacts on an estimated 2.62 ha. Table 6.1 provides a summary of residual impacts of the proposed action on Kurri sand swamp woodland EEC.

Areas within the proposed development that will contain APZs have not been defined to date. All APZs however would be confined to within the proposed development footprint (proposed action area) and have been accounted for in disturbance calculations. For this reason, the area of Kurri sand swamp woodland within APZs has not been calculated separately.

Table 6.1 Residual impacts of proposed action on Kurri sand swamp woodland

Impacts	Area of Kurri sand swamp woodland (ha)
Proposed action area	47.72
Development footprint	47.72
Direct impact area	47.72
Indirect impact area	2.62
Total impact area	50.34
Retained area	287.52

7. Offsets

7.1 Type of offsets proposed

The department has noted in its request for preliminary documentation that it is of the view that the proposal is likely to have a residual significant impact on Kurri Sand Swamp Woodland and Koala requiring compensatory measures (e.g., environmental offsets) to be implemented under the EPBC Act. This section provides a summary of the residual impacts of the proposal in the Koala and Kurri sand swamp woodland and the offsets that are proposed to compensate for these residual impacts.

As described above, the proposal would impact up to 83.99 ha of potential Koala habitat and 50.34 ha of Kurri sand swamp woodland EEC (including direct and indirect impacts).

These impacts would be offset through the Biodiversity Offsets Scheme (BOS), which is the NSW Government framework for assessing and offsetting the impacts of development on biodiversity in NSW. The NSW BOS, BAM and the offset rules set out in the Biodiversity Conservation (BC) Act Regulation have been formally endorsed in the assessment bilateral agreement between Commonwealth and NSW governments under Section 45 of the EPBC Act.

The quantum of biodiversity credits required to offset the proposed residual impacts on Koala and Kurri sand swamp woodland EEC have been calculated in the project BCAR using the BAM. Biodiversity offsets for the proposal would be secured according to the BOS through the purchase and retirement of biodiversity credits generated at two Biodiversity Stewardship Sites (BBSs) that will be established adjacent to the proposed action area. The location of the proposed BSSs in relation to the development footprint is shown on Figure 7.1 and Figure 7.2.

The two BSSs would include a total of approximately 770 ha of land comprising native vegetation. These BSSs would be conserved under Biodiversity Stewardship Agreements (BSAs) and would generate appropriate like for like credits to offset the residual impacts of the proposed development on Koala and Kurri sand swamp woodland.

The proposed BSSs would be the subject of a Biodiversity Stewardship Site Assessment Report (BSSAR) and BSA application in accordance with the BAM and associated regulations and policy documents. The draft BSSAR, Site management plans (SMPs) and total fund deposit (TFD) calculations have been submitted to the NSW credit supply task force for assessment and approval.

A SMP has been prepared for each of the BSSs. These SMPs present the detailed management actions that will be undertaken for each management zone. Cost estimates for proposed management and rehabilitation works over the life of the stewardship sites has been prepared and are included in the BSA applications.

Across the two BSSs there is approximately 683.95 ha of potential habitat for Koalas and 287.5 ha of Kurri sand swamp woodland EEC. It is estimated that the BSAs would generate approximately 4494 ecosystem credits that could be used to offset residual impacts to potential Koala habitat and approximately 1622 ecosystem credits that would offset impacts to Kurri sand swamp woodland EEC.

These credits would be more than sufficient to offset the credits required to be retired. If for some reason there were any shortfall in credits, these would be sourced from the ‘open market’ or via a payment into the BCF in accordance with the trading rules associated with the NSW BOS and the requirements for offsetting impacts to protected matters under the Amended Bilateral Agreement. The application to the BCT for a payment to the BCF would include notification that the proposal is a controlled action to ensure that like-for-like offsets are secured for the protected matters listed above.

Table 7.1 and presents the biodiversity credits required to offset residual impacts of the proposal on Koala and Kurri sand swamp woodland. Table 7.3 provides a summary of the estimated credit that are likely to be generated for these MNES at the BSSs.

The NSW Conditions of Consent and EPBC Act approval conditions are likely to require that offsets are secured prior to each stage of the development impacts.

Table 7.1 Offsets (ecosystem credits) required to compensate for impacts on potential Koala habitat

Plant community type	PCT ID	Direct impact area (ha)	EPBC Status	BC Act status[1]	Ecosystem credits required to offset residual impacts
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	1633	38.80	Kurri Sand Swamp Woodland EEC	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	1235
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	1633	8.04	Kurri Sand Swamp Woodland EEC	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	182
6 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact)	1591	4.87	Not listed	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	111
7 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (underscrubbed)	1591	10.12	Not listed	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	152
8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	1600	4.99	Not listed	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	65
10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)	1600	17.17	Not listed	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC	560
TOTAL		**83.99**			**2305**

Table 7.2 Ecosystem credits required to offset residual impacts to Kurri Sands Swamp Woodland EEC

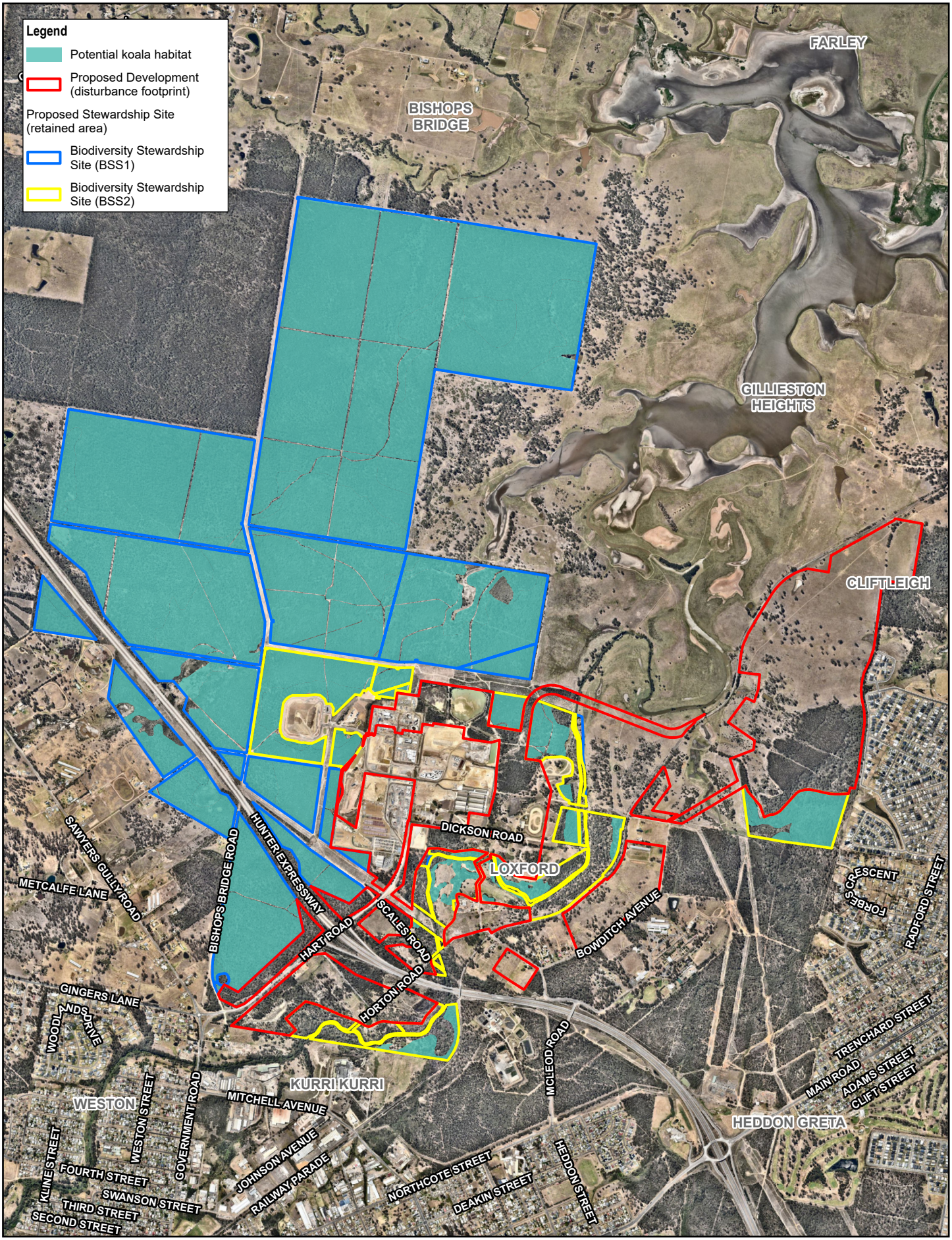
Plant community type	PCT ID	Direct impact area (ha)	Indirect impact area (ha)	Ecosystem credits required to offset direct impacts	Ecosystem credits required to offset indirect impacts	Total ecosystem credits required
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	1633	38.80	2.36	1235	75	1310
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	1633	8.04	0.2	182	5	187

Plant community type	PCT ID	Direct impact area (ha)	Indirect impact area (ha)	Ecosystem credits required to offset direct impacts	Ecosystem credits required to offset indirect impacts	Total ecosystem credits required
3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)	1633	0.88	0.06	15	2	17
TOTAL		**47.72**	**2.62**	**1432**	**82**	**1514**

Table 7.3 Estimated credits likely to be generated at Biodiversity Stewardship Sites

Plant community type	PCT ID	Credit type	Area within BSS1	Area within BSS2	Credits generated BSS1	Credits generated BSS2	Total credits generated
Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter – good (PCT 1592_good).	1592	Ecosystem (Koala)	33.18	0	270	0	270
Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter (PCT 1593_good).	1593	Ecosystem (Koala)	309.30	11.18	2320	81	2401
Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter (PCT 1593_low).	1593	Ecosystem (Koala)	3.04	0	5	0	5
Forest Red Gum grassy open forest on floodplains of the lower Hunter (PCT 1598_good).	1598	Ecosystem (Koala)	11.71	4.44	47	4	51
Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter (PCT 1600_good).	1600	Ecosystem (Koala)	9.14	0.16	66	1	67
Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter (PCT 1591_ good).	1591	Ecosystem (Koala)	0	9.01	0	63	63
Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter (PCT 1591_ weedy).	1591	Ecosystem (Koala)	0	5.27	0	15	15

Plant community type	PCT ID	Credit type	Area within BSS1	Area within BSS2	Credits generated BSS1	Credits generated BSS2	Total credits generated
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633_good).	1633	Ecosystem (Koala and Kurri sand swamp woodland EEC)	241.14	39.83	1,368	225	1593
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633_low).	1633	Ecosystem Koala and Kurri sand swamp woodland EEC)	2.25	0	6	0	6
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633_regrowth).	1633	Ecosystem Koala and Kurri sand swamp woodland EEC)	4.30	0	23	23	23
TOTAL		**Koala**	**614.06**	**69.89**	**4105**	**349**	**4494**
TOTAL		**Kurri sand swamp woodland**	**247.69**	**39.83**	**1397**	**248**	**1622**



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Loxford Project Group Pty Ltd
Hydro biodiversity surveys and BSSAR – Response to preliminary documentation request

Potential koala habitat within stewardship sites

Project No. **12527690**
Revision No. **0**
Date **30/01/2024**

FIGURE 4

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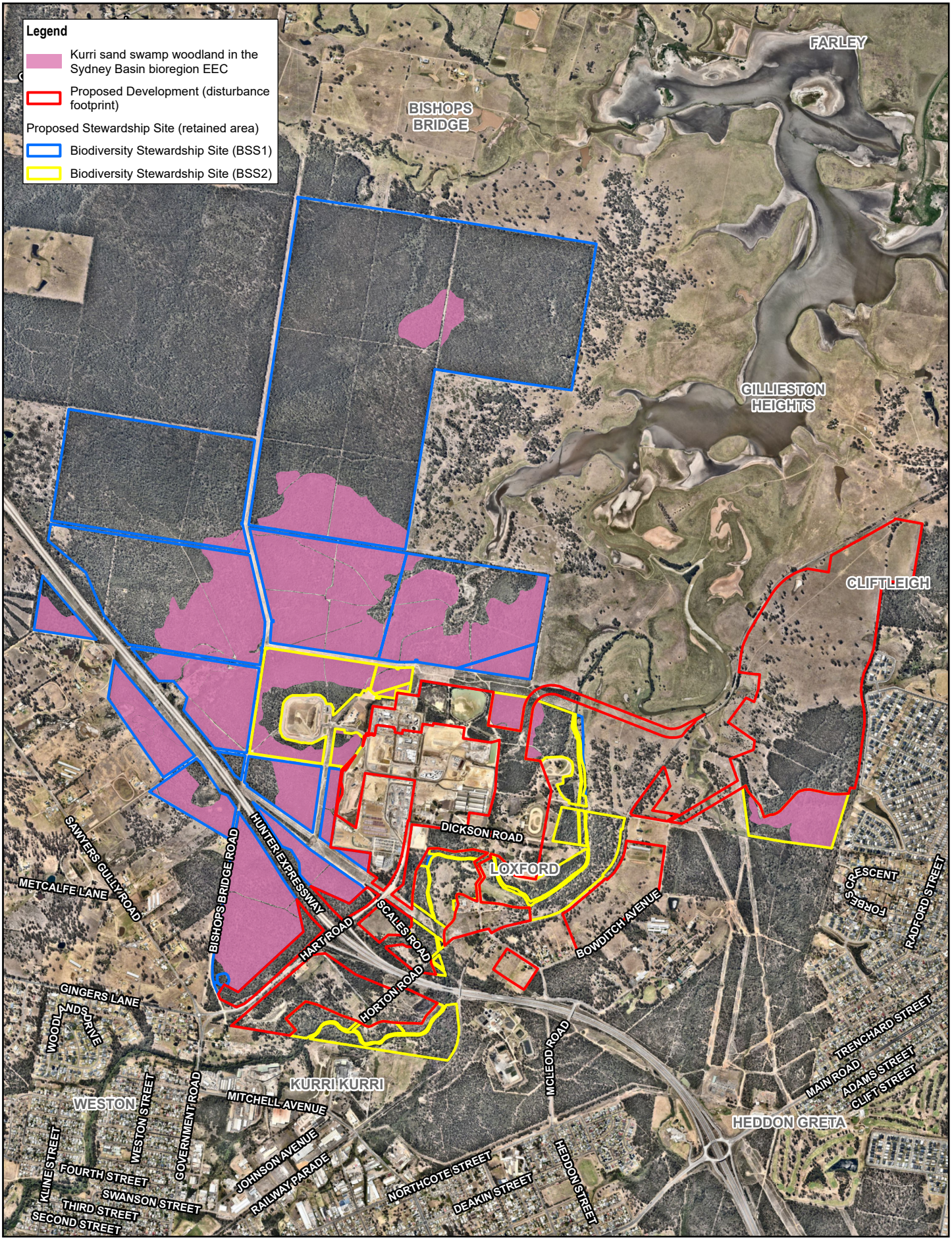
Print date: 30 Jan 2024 - 12:06

Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; AJW: Proposed subdivision, 2023; LPI: DTDB / DCDB, 2017; Aerial Imagery: Nearmap WMS Server: . Created by: fmackay



Paper Size ISO A4

0 250 500 750 1,000

Metres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Loxford Project Group Pty Ltd
Hydro biodiversity surveys and BSSAR – Response to preliminary documentation request

Kurri sand swamp woodland EEC within stewardship site

Project No. **12527690**
Revision No. **0**
Date **30/01/2024**

FIGURE 5

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Print date: 30 Jan 2024 - 12:06

Data source: Geoscience Australia: 250k Topographic Data Series 3, 2006; AJW: Proposed subdivision, 2023; LPI: DTDB / DCDB, 2017; Aerial Imagery: Nearmap WMS Server: . Created by: fmackay

7.2 Achieving conservation gains

Improvement in biodiversity values through management actions at a BSS is the basis for creation of ecosystem credits and species credits. The following sections provide an outline of the actions that would be undertaken for ongoing management of the proposed BSSs which will result in conservation gains across the BSSs.

Required management actions are those actions required on all BSSs to improve vegetation integrity when entering into a BSA. A detailed description of these actions and their relevance to the BSS is provided in the SMP that has been prepared for each BSS. The default list of required management actions for all BSS are shown in Table 7.4, with those actions relevant to each of the proposed BSSs indicated in the right-hand column.

Table 7.4 Required management actions at the proposed BSS (all management zones) (BAM 2020)

Required management action	Types of management activities that may be undertaken as part of the required management action for ecosystem credits and species credits	To be planned and delivered at the proposed BSS1 and BSS2
Preparation of a management plan	Preparation of a management plan for the biodiversity stewardship agreement for the site.	Yes
Fire management	Undertake ecological burning activities.	Yes
	Prevention of fire.	Yes
Grazing management	Fencing to exclude stock.	Yes
	Strategic grazing of stock.	No
Native vegetation management	Restore/rehabilitate native vegetation.	Yes
	Retain and manage regrowth.	Yes
	Prevent/restrict non-natural nutrient inputs.	N/A
	Threatened species habitat management activities related to native vegetation.	Yes
Threatened species habitat management	Protection of breeding habitat features or sites.	Yes
	Undertake any other required management action identified in the Save our Species database Threatened Biodiversity Data Collection to create species credits or ecosystem credits required for that threatened species.	Yes
Integrated pest animal control	Undertake feral pest management including control of foxes, cats, pigs, goats, avian pests, horses, and any other miscellaneous species as required.	Yes
Integrated weed management and control of high threat weeds	Undertake weed management and activities to control high threat exotic and other exotic vegetation.	Yes
	Fine-scale intensive removal of high threat weeds	Yes
Management of human disturbance	Exclude development and clearing activities except those listed as permissible in the biodiversity stewardship agreement.	Yes
	Identify sensitive locations and protect from disturbance.	Yes
	Undertake rubbish removal.	Yes
	Implement measures to restrict access to the site where necessary (vehicles, etc.).	Yes
Monitoring	Monitoring to adequately assess outcomes against all performance measures. Measures should be described for monitoring outcomes in relation to threat control as well as biodiversity response	Yes
	Establishment of permanent plots to provide a baseline for assessing biodiversity outcomes.	Yes
	Establishment of 360° photo points.	Yes
	Monitoring of indicators to specifically assess change in threatened species abundance, occupancy, or habitat.	Yes
	Review of the management plan and management activities.	Yes

Required management action	Types of management activities that may be undertaken as part of the required management action for ecosystem credits and species credits	To be planned and delivered at the proposed BSS1 and BSS2
	Monitoring must be designed and implemented in accordance with Biodiversity Conservation Trust guidance documents.	yes

7.3 Timing of conservation gains and level of certainty

As discussed above, conservation gains at a BSS are achieved through management of the site to increase condition, function and structural attributes of vegetation and habitat within the site (calculated through the BAM as an increase in vegetation integrity (VI) score).

The terms of the BSA are agreed between the landholder and the BCT before it is signed. The BSA clearly states the obligations and entitlements in relation to the land, including: the management actions required to be undertake at the site to improve its biodiversity values, the number and class of biodiversity credits created by the BSA, annual reporting requirements to demonstrate compliance with the BSA, and the amount required to be deposited in the Biodiversity Stewardship Payment Fund (the total fund deposit), along with the payment schedule and conditions for annual payments from this fund. The BSA includes provisions for ongoing monitoring at the site and the BCT can withhold payments if management obligations are not being met.

Management actions within the BSS occur over an initial twenty-year period, over which time calculated gains would be achieved (improvement in VI scores). These management actions are set out in the SMP and funded through the TFD that is held in trust in the Biodiversity Stewardship Payments Fund (BSPF). The BSPF then is used to make annual payments made to the landowner to fund scheduled management actions within the site as set out in the SMP. Conservation gains within the site would begin following the first annual payment from the TFD and would continue over the twenty-year management period of the site.

The TFD also includes recurring costs to manage the site in perpetuity (for example ongoing weed and pest management) to ensure that conservation gains are not diminished over time.

Offsets achieved through the BOS have a high level of certainty as they are legally binding and in perpetuity. A BSA that is made under Part 5 Division 2 of the BC Act. Once signed if forms a legal agreement between a landowner and the Minister administering the BC Act, to establish a BSS for the purpose of generating biodiversity credits under the BOS (i.e., to establish an offset site). The Agreement is registered on the land title and is binding on subsequent owners of the land in perpetuity.

7.4 Current land tenure of proposed offset and method of securing and managing offset

The proposed BSSs that would be used to offset impacts of the proposed action on Koala and Kurri sand swamp woodland EEC are held under private land titles. As discussed above offsets would be secured through a BSA that is made under Part 5 Division 2 of the BC Act. This agreement would be registered on the land title and is binding on subsequent owners of the land in perpetuity.

The BSSs would be managed in accordance with the site-specific management actions detailed within the SMPs for each of the sites. The SMPs would form part of the BSAs and would include obligations for ongoing monitoring and reporting to demonstrate compliance.

8. Approved conservation advice and recovery plans

8.1 Koala (*Phascolarctos cinereus*) combined populations of Queensland, NSW, and the ACT

As described above impacts to potential Koala habitat have been considered in the project BCAR and by the Biodiversity and Conservation Division (BCD) of the NSW Department of Planning and Environment (DPE) during their assessment process.

Key threats that have been identified to Koala populations in the approved conservation advice are climate change, land-use change, natural system modification as well as other threats such as disease, dogs, and vehicle strike (DAWE 2022a).

Table 8.1 outlines the potential threats impacting the Koala combined populations of Queensland, NSW and the ACT as outlined in the approved conservation advice that are relevant to the proposal.

Table 8.1 Key identified threats impacting the Koala population of Queensland, NSW and the ACT

Identified threats (DAWE 2022a)	Relevance to proposal
Climate change driven processes and drivers	
Loss of climatically suitable habitat	The proposal would not substantially contribute to climate change or increase the predicted effects of climate change on the Koala population. Development adjacent to potential Koala habitat may increase the risk of bushfire ignition. This threat would be managed through bushfire management plans for the area and establishment of asset protection zones along the margins of the proposed development site.
Increased intensity / frequency of drought	
Increased intensity / frequency of heatwaves	
Increased intensity / frequency of bushfire	
Declining nutritional value of foliage	
Human related activities	
Clearing and degradation of Koala habitat	The proposal would contribute to this threat by clearing 83.99 ha of potential habitat for Koalas. This represents approximately 0.005 percent of the potential Koala habitat within the Sydney Basin bioregion and 0.05 percent of the estimated Koala habitat in the Cessnock LGA. Due to the reasons outlined in section 3.2.1 this habitat is not considered to be critical habitat for Koalas.
Encounter mortality with vehicles and dogs	The proposal is likely to result in an increase in vehicle movement within the local area as well as an increase in dogs in parts of the site that would be developed for residential housing. This may result in an increased potential for vehicle strike and dog attacks leading to Koala mortality. This threat would be mitigated through the enforcement of speed limits and restrictions on dog access to adjacent vegetation.
Disease and health	
Koala retrovirus (KoRV) and Chlamydia *(Chlamydia percorum*)	Many Koalas carry Chlamydia, but do not always show clinical symptoms (known as chlamydiosis). The symptoms include eye, urinary tract, respiratory tract and reproductive tract infections, and the latter can lead to infertility in female Koalas (NRMMC 2010). There is circumstantial evidence that chlamydiosis might increase in response to environmental stresses such as overcrowding and poor nutrition (Melzer et al. 2000), although the epidemiology of chlamydiosis is not well understood.

Identified threats (DAWE 2022a)	Relevance to proposal
	Reduced female fertility caused by Chlamydia infection may limit the reproductive potential of Koala populations (DAWE 2022). Chlamydiosis may contribute to local declines or extinctions in small, isolated Koala sub-population fragments, where recruitment rates between Koala groups are low and mortalities from other threats are high (DECC 2008). However, through reducing female fertility, chlamydiosis may also prevent some Koala sub-populations from reaching very high densities and over-browsing their food trees (DECC 2008). Koala Retrovirus (KoRV) was recently identified and is thought to be responsible for a range of conditions, including leukaemia (Tarlinton et al. 2005) and an immunodeficiency syndrome. Up to 100 percent of Koalas in Queensland and NSW have KoRV, but the proportions are lower in southern populations (Hanger & Loader 2009; Lee 2010; Tarlinton et al. 2006). There is some evidence that chlamydiosis may be exacerbated by KoRV (Tarlinton et al. 2005). There has been no Koala's recorded within the proposed action area and very few records within the locality. This would indicate that in the unlikely event that Koala's were present within the site they would be present in very low numbers. The proposed action is not expected to exacerbate either chlamydiosis or KoRV in the local Koala population, as it would not result in overcrowding or reduced nutrition within the population.

8.2 Kurri sand swamp woodland EEC

Kurri sand swamp woodland of the Sydney Basin Bioregion was listed as an EEC under the EPBC Act on 7 September 2023.

The approved conservation advice for this EEC describes habitat critical to the survival of the ecological community to be occurrences that that are in the best condition. Such areas may include those parts of the TEC that are largest and/ or have the most intact structure and ecological function, and therefore the greatest chance of persisting in the long term.

All patches of Kurri sand swamp woodland EEC within the proposed action site and the proposed offset site are in relatively good condition (class A1 and A2) and are therefore considered to be habitat critical to the survival of the ecological community. Within the proposed action area patch size is typically smaller than those within the proposed BSSs, with most of the patches mapped within the proposed action area being currently impacted by existing edge impacts. Patches of the EEC within the development footprint also occur adjacent to industrial and urban development and consequently, condition of these patches is generally poorer than patches of the EEC that occur within the proposed BSSs. The proposal is therefore consistent with conservation advice in that the highest quality vegetation would be retained and conserved within the proposed offsets sites.

The primary conservation objective described in the conservation advice for Kurri sand swamp woodland is to "prevent the extinction of the Kurri sand swamp woodland in the near future and promote recovery of its biodiversity and ecological function". This would be done by protecting it from significant impacts and by guiding management and recovery consisted with the recommended priority conservation actions set out in the advice. This includes retaining and protecting all moderate to very high condition woodland patches (condition class A, B and C) from key identified threats and restoring majority of patches to a higher condition class (DCCEEW 2023).

The conservation advice for this EEC describes priority actions to meet the conservation objective with the primary principle being to maintain existing occurrences of the ecological community that are relatively intact and of high quality. This principle aims to prevent the offset of intact remnants with lower quality sites (DCCEEW 2023). The proposal is consistent with this principle as it would offset removal of the EEC with vegetation that is of similar or higher quality (VI scores). Vegetation within the proposed BSSs would also be actively managed with the aim of increasing VI scores (vegetation condition, structure, and function) overtime (future VI Score).

Table 8.2 and Table 8.3 below illustrates the comparison of condition of the EEC within the proposed action area and offset sites.

Table 8.2 Vegetation quality development site

Vegetation zone	Area (Ha)	Current VI score	Future VI score
– 1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact).	38.80	63.6	0
– 2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed).	8.04	45.2	0
– 3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth).	0.88	34.3	0
TOTAL	**47.72**		

Table 8.3 Vegetation quality proposed offset area

Vegetation zone	Area (Ha)	Current VI score	Future VI score with management
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633_good).	241.14	66.6	94.1
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633_regrowth).	4.30	47.2	26
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633_low).	2.25	17.3	83
TOTAL	**247.69**		

8.2.1 Threats to Kurri sand swamp woodland EEC

The approved conservation advice for Kurri sand swamp woodland EEC describes the primary impacts to the community as habitat loss and fragmentation mainly associated with urban and industrial infrastructure development. Key threats are due to indiscriminate clearing or logging, unauthorised access of recreational and other vehicles, dumping of rubbish and other contaminants, weed invasion, and high frequency fire over an extended period (DCCEEW 2023). Table 8.4 below discussed key threats identified in the conservation advice for the community in relation to the proposed action.

Table 8.4 Key threats to Kurri sand swamp woodland

Key threats identified for the EEC (DCCEEW 2023)	Relevance to proposed action
Clearing and fragmentation	The proposed action would contribute to this threat to the EEC as it would result in the clearing of 47.7 ha of Kurri sand swamp woodland EEC. It is estimated that across NSW there is approximately 3686 ha of Kurri sand swamp woodland (indicative of the relatively localised occurrence of the community) (DCCEEW). The proposal would therefore result in the removal of approximately 1.2 percent of the mapped occurrence of the community. Areas proposed to be cleared typically occur as discrete patches and as such the proposal would not result in fragmentation of the community.

Key threats identified for the EEC (DCCEEW 2023)	Relevance to proposed action
Timber and firewood collection	The proposal is unlikely to result in an increase in timber and/or firewood collection within the EEC. The SMP for the proposed offset site prohibits the collection of firewood and timber within the BSSs within land currently zoned RU2. Establishment of offset sites would therefore result in the prevention of timber and firewood collection across approximately 247 ha of Kurri sand swamp woodland EEC.
Fire regimes that cause declines in biodiversity	There is potential that the development of residential housing adjacent to areas of Kurri sand swamp woodland EEC may result in an increased risk of bushfire within adjoining vegetation. These risks would be managed through the establishment of APZs within the development boundary. The SMPs associated with the BSSs include fire for conservation management plan which prescribes ecological burns in accordance with recommended burning frequencies identified for the community (RFS 2013).
Disturbances due to recreational activities (particularly track creation and waste dumping)	There is a risk that the development of residential housing and the industrial precinct may result in dumping of fill, rubbish and or garden waste. Recreational activities would be excluded from vegetation adjoining areas of Kurri sand swamp woodland EEC that would be conserved within the BSS sites. Any potential waste dumping would be managed on an ongoing basis as part of the SMP for the BSSs surrounding the site.
Introduced species - weeds	There is a risk that the construction of the proposed action could result in the introduction and spread of weeds into adjacent retained areas of Kurri sand swamp woodland EEC. A weed and pest species management sub-plan would be developed and implemented as part of project CEMP to manage weeds and pathogens during the construction l phase of the proposal. This sub-plan would include but not be limited to the following: – Provisions for identify the location and extent of any priority and/or high threat environmental weeds within the site. – Protocols for the management of noxious and environmental weeds. – Protocols to prevent the introduction and/or spread of pathogens and weeds. – Protocols to limit the spread of weed propagules downstream of subject site. The risk of introduction of weeds into surrounding areas of Kurri sand swamp woodland EEC would continue during the operation of the proposal as members of the public may enter adjoining vegetation. This would be mitigated by the integrated weed management plan that would be developed and implemented as part of the SMP for the BSSs surrounding the site. This plan will include provisions and funding for ongoing weed control and monitoring.
Introduced species- animals including domestic stock	The proposal is not likely to result in the introduction and/or spread of introduced fauna species into surrounding areas of Kurri sand swamp woodland. The BSSs are already impacted by introduced species including, deer, pig, foxes, noisy miners, and wild dogs. These pests would be managed through the protocols outlined in the integrated pest management plan that forms part of the SMPs for the BSSs. In addition, all grazing would be excluded from the BSSs and the sites would be completed fenced around all boundaries to prevent stock entering the site.

Key threats identified for the EEC (DCCEEW 2023)	Relevance to proposed action
Other pests and diseases	Construction activities within the proposed action area may, in general, have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent habitat through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus may harm frog populations once introduced into an area. To help mitigate the risk of pathogens and diseases being brought onto and/or spread through the site all machinery brought to site will be washed down and inspected to be free of soils, seeds, and other organic material in accordance with the mitigation measures outlined in Section 5.

8.2.2 Key threatening processes

The proposal would contribute to one of the key threatening processes (KTP) identified in the conservation advice (land clearance) in that it proposes to remove 47.6 ha of Kurri sand swamp woodland in very high condition (condition class A1 and A2) (DCCEEW 2023). It will however result in the protection, ongoing management, and restoration of approximately 247 ha of this EEC which is also in very high condition (class A1).

Vegetation within the proposed BSSs would be protected and actively managed to prevent KTP that have been identified as relevant to Kurri sand swamp woodland EEC.

The proposal would not contribute to other KPTs identified in the conservation advice for Kurri sand swamp woodland EEC after mitigation measures are implemented. Such KPTs include:

- Aggressive exclusion of birds from potential woodland and forest habitat by over abundant noisy miners (*Manorina melanocephala*).
- Biological effects, including lethal toxic ingestion, caused by Cane Toads (*Bufo marinus*).
- Competition and land degradation by unmanaged goats.
- Competition and land degradation by rabbits.
- Fire regimes that cause declines in biodiversity.
- Land clearing.
- Infection of amphibians with chytrid fungus resulting in chytridiomycosis.
- Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants.
- Novel biota and their impact on biodiversity (includes feral deer).
- Predation, habitat degradation, competition, and disease transmission by feral pigs.
- Predation by European red fox.
- Predation by feral cats.

The above threats would be managed by actions prescribed in the BSS SMPs which include the following:

- Fire for conservation management plan.
- Native vegetation management plan.
- Threatened species habitat management plan.
- Integrated feral pest management plan.
- Integrated weed and pathogen management plan.
- Monitoring plan.

9. Social and economic costs and/or benefits of undertaking the proposed action

9.1 Estimate of anticipated economic costs and/or benefits

An Economic Assessment Report was completed for the planning proposal for the proposed action (Urbis 2015). This assessment determined there will be economic benefits associated with the site's redevelopment, including:

– Ongoing jobs expansion of approximately 6,900 jobs, with 3,840 blue collar jobs and 3,060 white collar jobs (full-time, part-time, and casual direct jobs).
– 13,160 direct construction jobs and 20,710 indirect supplier jobs, for a total construction phase employment benefit of 33,870 jobs (full-time, part-time, and casual jobs).
– Expansion of ongoing jobs will result in an additional $448.6 million worker income per annum.
– The expansion in population from the delivery of new housing and subsequent population growth is expected to expand local retail spend by $58.4 million at full development.
– Ongoing management of the proposed BSSs which would provide multiple jobs and input to the local economy.

Refer to Appendix C for copy of the Economic Assessment Report.

The planning proposal considered the social impact upon the it is considered that there will be a positive net community benefit as a result of the planning proposal. Identified benefits of the proposal for the local community include:

– Enabling the provision of new housing stock (an anticipated lot yield of 1435 is proposed) in a range of sizes, styles, and price points, which will directly contribute to the NSW Government target for new housing, as well as State Government and Council policies for new housing.
– A subdivision layout that extends, consolidates, and links into, existing communities rather than creating new, stand-alone, isolated residential areas.
– Provision of new community infrastructure and open space which will support an active community and encourage healthy lifestyles.
– The potential for much needed local employment opportunities and economic growth through the inclusion of areas zoned as Business Park, General Industry and Heavy Industry, and through the subsequent construction of the proposed developments.
– Planning will support a community with a unique sense of place.
– Permeability between these new communities and surrounding areas.
– A Site layout that will be accessible to people of all ages and abilities and a range of income groups.
– Road layout that will be accessible for buses.
– Design principles that support creation of a socially sustainable community.

9.2 Details of any stakeholder consultation including First Nations consultation, and their outcomes

9.2.1 Engagement and consultation with public

Keeping the community informed about activities at the former Aluminium smelter and the future of the Hydro Land has been an integral activity in the development of the Project area. Several community engagement activities have been undertaken to inform the community about the proposed action and to identify the community's concerns and issues.

These include:

Information and Feedback Mechanisms

A community website and means of contact have been established to provide the community with a range of ways to contact the Project team, gain access to information and provide comment on various aspects of the project. Information about the proposed action continues to be uploaded onto the project website to provide the community ready access to information about the Project.

Community Reference Group

A Community Reference Group was established in 2014. The group is comprised of local community representatives with the following aims:

– Create a forum for discussion and exchange of information on topics related to the Project.
– Assist Hydro to understand the values, aspirations, and preferences that the community has for the project area and identify related local issues that will need to be taken into consideration in the development, environmental assessment and management, construction/demolition and rezoning/divestment phases of the project.
– Act as a communication link between Hydro, the community, and other stakeholders. The first meeting of the Community Reference Group was held in July 2014, and it continues to meet on a bi-monthly basis. Minutes of the Community Reference Group meetings are posted on the Regrowth Kurri Kurri website (**https://regrowthkurrikurri.com.au/**).

Community Drop-In Sessions

Community drop in sessions were held on 23 April 2015 (the former Smelter Site), 28 May 2015 (Weston), 2 June 2015 (Gillieston Heights) and 10 June 2015 (Kurri Kurri). The drop-in sessions were held to allow interested parties to ask questions about the Project and raise any concerns.

Community Information Notices and Fact Sheets

Several Community Information Notices and Information Newsletters have been developed on the various aspects of the future of the Hydro Land, including the proposed action. This has included:

– Information Notices in the Cessnock Advertiser and Maitland Mercury providing information on the future land uses at the Smelter and the Hydro Land.
– Information Newsletters were placed on the Regrowth Kurri Kurri website.

9.2.2 Engagement and Consultation with Indigenous stakeholders

Aboriginal community consultation for the project's planning proposal was undertaken in accordance with OEH's Aboriginal Cultural Heritage Consultation Requirements for Proponents (DECCW, 2010b) (the Consultation Requirements).

This extensive consultation process included several stages (described below). The results of the consultation process undertaken are summarised below, with further detail provided in Chapter 3 of the Aboriginal Cultural Heritage Assessment (AECOM 2014).

Stage 1 Notification and Registration:

The aim of Stage 1 of the Consultation Requirements was to identify, notify and register Aboriginal people who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the Project area. This involved detailed consultation with Regulatory Agencies including:

– OEH - Hunter Central Coast Region Office.
– Mindaribba Local Aboriginal Land Council (Mindaribba LALC).
– Office of the Registrar, Aboriginal Land Rights Act 1983 (NSW).
– The National Native Title Tribunal (NNTT).
– NTSCORP Limited.
– Maitland Shire Council.
– Cessnock Shire Council.
– Hunter-Central Rivers Catchment Management Authority (HCR CMA).

A public notice was also placed in the Maitland Mercury on 11 March 2014. The closing date for registration via this notice was 25 March 2014, which provided the necessary minimum 14 day period for expressions of interest. No responses to the notice were received prior to or after this date.

On 11 March 2014, a letter inviting expressions of interest and containing summary information on the project was sent to all Aboriginal persons and organisations identified by the regulatory agencies. A total of 75 Aboriginal stakeholders were invited to register an interest in being consulted. This resulted in a total of 27 parties registering an interest in the assessment. An additional five parties registered an interest after this date and were included in the consultation process. Summary information on all RAPs, including registration dates, is provided in Table 2 of the Aboriginal Cultural Heritage Assessment (Appendix B).

Stage 2 - Presentation of Information about Project:

The aim of Stage 2 of the Consultation Requirements was to provide RAPs with information about the scope of the proposed project and the proposed cultural heritage assessment process. Presentation of information about the Project area and Hydro's planning proposal was provided to RAPs as part of the registration of interest process detailed above. Basic information on the proponent and planning proposal was included in the EOI letter mailed on 11 March 2014.

Stage 3 Gathering Information about Cultural Significance:

Stage 3 of the Consultation process involved consultation with RAPs regarding the cultural heritage values of the Project area including:

A request with the draft assessment methodology for any initial comments regarding the Aboriginal cultural heritage values of the Project area.

Discussion of cultural heritage values during fieldwork.

The provision of a draft report to all RAPs for comment prior to finalisation.

Stage 4 - Review of Draft Assessment Report:

The aim of Stage 4 of the Consultation Requirements is to prepare and finalise an Aboriginal cultural heritage assessment report with input from RAPs. In accordance with Section 4.4.2 of the Consultation Requirements, on 7 November 2014, all RAPs were sent a draft of the Aboriginal cultural heritage assessment for review and comment. The specified closing date for comments was 8 December 2014, which provided the necessary minimum 28 day review period. Two responses to the draft report were received from RAPs: one written and one verbal. Both responses are summarised in Table 5. Written RAP responses to the draft report are attached as Appendix F. Consultation and corresponding outcomes are further described in the Aboriginal Cultural Heritage Assessment (AECOM 2014, Appendix B).

9.2.3 Community consultation on BCAR

The project BCAR was placed on public exhibition from Monday 12 September 2022 to Friday 14 October 2022. The public consultation included advertisements placed in the Sydney Morning Herald on the 12 September 2022 and the Cessnock Advertiser on 14 September 2022. The BCAR document was available for public viewing through the Regrowth Kurri Kurri website (regrowthkurri.com.au/statutory-information) as well as the BCD have your say page (environment.nsw.gov.au/get-involved/have-your-say). A total of four public submissions were received through the BCD have your say page. No submissions were lodged through the Regrowth Kurri Kurri submissions website, these submissions are included in the response to consultation document provided to BCD on 21 October 2022.

9.2.4 Potential employment opportunities expected to be generated at each phase of the proposed action

As discussed in section 9.1 the proposed action would generate employment opportunities including 6,900 new jobs, representing 10.5% of the Lower Hunter Regional Strategy jobs target. Of the 45,459 new jobs expected to be created in the Lower Hunter between 2011 and 2031, approximately 3,528 of these are expected to be in industrial based sectors, with 902 of these jobs forecast for Cessnock LGA. This will result in the take up of 176 ha (8.8 ha per annum) of additional industrial land in the Lower Hunter Region, 45 ha (2.25 ha per annum) of which are expected to be located in the Cessnock LGA by 2031.

The 198 hectares of industrial zoned land within the proposed action area exceeds the Cessnock LGA's demand for industrial stock by 2031. Despite this, Urbis' analysis indicates that given the site's location adjacent to the Hunter Expressway, ability to offer flexible lot sizes (due to its consolidated land ownership) and the expected growth in the freight and logistics and construction sectors, that the site would cater to larger warehouse and distribution operators while also providing smaller sized options. As such it would be expected to draw on Lower Hunter Region's demand for employment land, as it would offer employment opportunities for residents in the whole of the Lower Hunter Region. While the development of the site will be staged, this will likely occur over a period of time longer than the official employment forecasts. Urbis expects this to occur at a 5.3 - 8.4 hectare per annum rate, resulting in a 24-37 year development timeframe.

At full development the proposal is expected to deliver ongoing jobs expansion of approximately 6,900 jobs (Urbis 2015).

10. References

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- GHD (2022), Biodiversity Certification Assessment Report, report prepared for Hydro Aluminium Kurri Kurri.
- Melzer A, Carrick F, Menkhorst P, Lunney D & John BS, (2000). Overview, critical assessment, and conservation implications of Koala distribution and abundance. Conservation Biology 14,619-628.
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- NSW Rural Fire Service, (2023), Threatened Species Hazard Reduction List – Part 3 – Endangered Ecological Communities.
- Urbis (2015), Economic Assessment – Hydro Aluminium, Kurri Kurri, unpublished report prepared as part of the Masterplan for the Hydro Aluminium Kurri Kurri redevelopment.
- Youngentob, K.N, Marsh, K.F., Skewes, J., (2021), A review of Koala habitat assessment criteria and methods, report prepared for the Department of Agriculture, Water and the Environment, Canberra.
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Appendices

Appendix A

DCCEEW preliminary documentation request

Attachment A – Preliminary Documentation Requirements

This document sets out the general and specified information required by the Minister under section 95A of the EPBC Act for the assessment of the impacts of your proposed action ('the preliminary documentation').

Based on the information provided in your referral, and other available information, the department requires the additional information tabulated below.

Listed threatened species and communities (s18 & 18A)	
1.	The department considers that insufficient information has been provided in the referral to determine if the proposed action will have a significant impact on the following EPBC listed threatened species: ***Phascolarctos cinereus*** **(Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory))**. The department requests further information on impacts, avoidance and mitigation measures as follows: • How much Koala habitat occurs on the proposed action site? • Where the Koala habitat is located, particularly any habitat critical to the survival of the species? • How much Koala habitat would be cleared as part of the proposal, including where the clearance would occur? • More detail on the survey effort for locating Koalas and their habitat on the site, including the survey methods used, locations, hours spent surveying, time of day and dates. • All NSW BioNet Atlas records for Koalas within 5km of the site, over the last 20 years. • Measures that will be taken to avoid any direct or indirect impacts on the Koala? • Mitigation measures including measures to reduce impacts to the Koala, such as from dogs, vehicles, habitat degradation or fragmentation, and bush fires? • A clear summary of the residual impacts from the proposed action on Koala, having regard to the avoidance and mitigation measures that will be undertaken to minimise impacts.

2.	The department considers that further information will be required on the potential impacts of the proposed action on the **Kurri sand swamp woodland.** This TEC was only listed as Endangered on 7 September 2023 and consequently there has been no surveying for it on the proposed action site and no assessment of the significance of any impacts on it from the proposed action. The Approved Conservation Advice for the Kurri sand swamp woodland of the Sydney Basin bioregion states that habitat or areas most critical to the survival of this TEC are those occurrences that are in the best condition. These are those parts of the TEC that are largest and/ or have the most intact structure and ecological function, and therefore the greatest chance of persisting in the long term. However, occurrences that otherwise meet the minimum condition thresholds are also critical to the survival of the TEC, if they occur in locations or landscape positions that are particularly important for biodiversity or function and/ or that contain species or habitat features that are important in a regional or local context. The department requests further information on impacts, avoidance and mitigation measures as follows: • Measures that will be taken to avoid any direct or indirect impacts on this TEC • Mitigation measures including: o details of any asset protection zones (such as fire management to protect housing) to be applied within patches of Kurri sand swamp woodland, and the extent to which they will impact on the retained areas of Kurri sand swamp woodland o measures to reduce impacts to retained Kurri sand swamp woodland during all phases of the proposed action including, but not limited to, erosion controls, fencing, waste management, signage of conservation areas, designated walking trails and weed and pest management. o Map of Kurri sand swamp woodland showing: ▪ areas of direct impact, areas of indirect impact and areas retained ▪ APZ (hatching in contrasting colour) ▪ the proposed action area boundary and development footprint boundary.

3. The preliminary documentation must include a clear summary of the residual impacts from the proposed action on Kurri sand swamp woodland, having regard to the avoidance and mitigation measures that will be undertaken to minimise impacts. This should be provided as a **summary table** as follows:

	Kurri sand swamp woodland
Proposed action area	
Development footprint	
Direct impact area	
Retained area	
Area in APZ	
Indirect impact area	

Offsets

4. The department is of the view that the proposal is likely to have a residual significant impact on Kurri sand swamp woodland and Koala requiring compensatory measures (e.g., environmental offsets) to be implemented under the EPBC Act.

It is not yet clear what the extent of any residual impact includes. Please provide details of the direct and indirect residual impacts.

Please also provide details of proposed offsets to compensate for these residual impacts including:

- The type of offset(s) proposed (note, the Commonwealth has endorsed the NSW BOS).
- The extent to which the proposed offset actions correlate to, and adequately compensate for, EPBC Act listed species and communities.
- The suitability of the location of any proposed offset site for EPBC Act listed species and communities, including evidence of the presence of, or usage by, relevant protected matter(s).
- The conservation gains to be achieved by the offset i.e., positive management strategies that improve the site or averting the future loss, degradation, or damage of the protected matter.
- The time it will take to achieve the proposed conservation gain.
- The level of certainty that the proposed offset will be successful.
- The current land tenure of any proposed land-based offset and the method of securing and managing that offset.

5.	Please demonstrate how the proposed offset meets the requirements of the department's EPBC Act Environmental Offsets Policy (October 2012) and provide a completed offsets assessment guide(s), including justifications for figures used to complete the offsets assessment guide(s).
6.	Please demonstrate that the proposal is consistent with the following conservation advice: • Department of Climate Change, Energy, the Environment and Water (2023). *Approved Conservation Advice for the Kurri sand swamp woodland of the Sydney Basin bioregion*. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: http://www.environment.gov.au/biodiversity/threatened/communities/pubs/183-conservation-advice.pdf The department notes that there are no recovery plans or threat abatement plans relevant to this community. Please demonstrate that the proposal is consistent with the following recovery plan for Koala: • Department of Climate Change, Energy, the Environment and Water (2022). *National Recovery Plan for the Koala Phascolarctos cinereus (combined populations of Queensland, New South Wales and the Australian Capital Territory)*. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: • National Recovery Plan for the Koala Phascolarctos cinereus (combined populations of Queensland, New South Wales and the Australian Capital Territory) (dcceew.gov.au) Please demonstrate how your proposal will have regard to the following conservation advice for Koala: • Department of Climate Change, Energy, the Environment and Water (2022). *Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory*. Canberra: Department of Climate Change, Energy, the Environment and Water. Available from: • Conservation Advice for Phascolarctos cinereus (Koala) combined populations of Queensland, New South Wales and the Australian Capital Territory (environment.gov.au) The department notes that there is no threat abatement plan for Koala.
Economic and social matters	
7.	Please provide further detail on the social and economic costs and/or benefits of undertaking the proposed action, including: • An estimate of any anticipated economic costs and/or benefits (in AUD), particularly with reference to the domestic market. • The basis for any estimations of costs and/or benefits.

	• Details of any stakeholder consultation, including First Nations consultation, and their outcomes. • Any potential employment opportunities expected to be generated at each phase of the proposed action, including any potential opportunities for First Nations people and businesses in relation to the project.

Appendix B

Project Biodiversity Certification Assessment Report

Hydro Aluminium Kurri Kurri Pty Ltd

Biodiversity Certification Assessment Report

August 2022

19 August 2022

Our ref: 2220284-99356-125
Your ref:

Dear Approver

Certification under Section 6.15 of the Biodiversity Conservation Act 2016

I, Arien Quin (accredited assessor number BAAS 17098), certify that this Biodiversity Certification Assessment Report and the accompanying finalised credit report dated 06 June 2022 has been prepared in accordance with the requirements of (and information provided under) the Biodiversity Assessment Method 2020.

Sincerely
GHD

Arien Quin
Senior Ecologist
+61 2 4979 9959
arien.quin@ghd.com

Executive summary

Hydro Aluminium Kurri Kurri Pty Ltd (Hydro) owns and manages approximately 1,400 ha of land at Loxford, NSW (referred to herein as the Hydro Land).

Council is proposing to rezone a portion of the Hydro Land primarily for employment and residential purposes with a large proportion of the site being retained for future conservation. Given the scale and strategic location of the Hydro land, the proposal has the potential to play a key role in achieving the economic, employment and environmental objectives for the Hunter Region identified in the NSW State Plan 2021, Hunter Regional Plan 2036 and the Greater Newcastle Metropolitan Plan 2036. The rezoning would facilitate a mixed used development that includes areas for residential, business, employment, public recreation and special purpose infrastructure.

The north-eastern portion of the subject site comprises large areas that have been historically cleared and utilised for cattle grazing. It also contains scattered remnants of disturbed woodland as well as several patches of intact or relatively intact woodland. There are a small number of farm dams within the cleared agricultural lands as well as a number of constructed waterbodies associated with stormwater collection surrounding the former smelter site.

This Biodiversity Certification Assessment Report (BCAR) has been prepared by GHD to identify the potential impacts on biodiversity associated with conferring biodiversity certification over the subject site. This assessment has been completed in accordance with the Biodiversity Assessment Method (BAM 2020) and includes:

- Desktop assessment to describe the existing environment and landscape features of the subject site and to identify the suite of threatened biota potentially affected by the conferral of biodiversity certification.
- Field survey in accordance with the BAM to describe the biodiversity values of the subject site and determine the likelihood of threatened biota and their habitats occurring in the proposal footprint.
- Discussion of measures to avoid and minimise impacts to biodiversity values.
- BAM calculations using the credit calculator version 1.4.0.00 to quantify the biodiversity impacts of the proposal following implementation of measures to avoid and minimise impacts and to determine the biodiversity credits that would be required to be secured and retired to offset the residual impacts associate with the proposed conferral of biodiversity certification.

The proposed development site rezoning masterplan footprint has undergone a number of revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value within the Hydro lands could be avoided and minimised. Various iterations of the masterplan footprint have been developed and amended in response to detailed understanding of the site's biodiversity values and offsets requirements.

The conferral of biodiversity certification would result in impacts to approximately 110.84 ha of native vegetation comprised of five plant community types (PCTs). The vegetation proposed to be impacted provides known and potential habitat for a range of threatened biota. Of the native vegetation proposed to be impacted, approximately 109 ha is commensurate with endangered ecological communities (EECs) listed under the *Biodiversity Conservation Act 2016 (BC Act).* Native vegetation within the subject site ranges in condition and quality from highly degraded patches to large intact remnants. Approximately 64.7 ha of the subject site is comprised of relatively intact vegetation, 40.6 ha of moderate condition vegetation that is either regrowth or disturbed and 5.0 ha of poor condition vegetation that comprises sparsely scattered canopy trees over a predominantly exotic understorey.

Impacts to PCTs present within the subject site include:

- The removal of 47.2 ha of Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633). This community is listed under the BC Act as Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC.
- The removal of 10.8 ha of Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (PCT 1594). This community is listed under the BC Act as River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions EEC and 7.6 ha is also commensurate with the related critically endangered ecological community (CEEC) listed under the EPBC Act as River-Flat Eucalypt Forest on Coastal Floodplains of Southern NSW and Eastern Victoria.
- The removal of 14.7 ha of Grey-Gum –Rough-barked Apple shrubby open forest of the lower Hunter (PCT 1591). This community is listed under the BC Act as Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC.
- The removal of 36.38 ha of Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (PCT 1600).
- The removal of 0.9 ha of Typha rushland (PCT 1737).

Two entities at risk of Serious and Irreversible Impacts (SAII), the Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*) would be impacted by the proposal.

The area of important habitat for Swift Parrot and Regent Honeyeater within the subject site has been identified based on the BAM Important Area Map contained within the BAM-C (DPIE 2022f). Based on this mapping, the Swift Parrot and the Regent Honeyeater are both assumed to potentially utilise part of the subject site for foraging.

In accordance with the requirements of the BAM species credits required to offset impacts on these species have been calculated based on the area identified on the Important Area Map.

The Important Areas Map for Swift Parrot has been developed based on applying a buffer area of 2 km to areas where there have been five or more birds recorded over any two or more years, or single sightings of more than 40 birds (DPIE 2022e). The NSW State Vegetation Type Map (including draft East Coast classification) was then used to select Plant Community Types associated with the swift parrot within the buffers. Any areas of vegetation less than one hectare were excluded.

Throughout the Hydro site the important habitat mapping appears to be somewhat arbitrary with the boundary of the mapped important habitat being located through the middle of a large patch of contiguous vegetation that extends to the north-west of the site that is known to contain similar vegetation types as the subject site. As noted above the mapping has been developed using NSW State Vegetation Type Mapping, with mapped PCTs associated with the Swift Parrot within the buffer area selected as important habitat. This vegetation mapping has been completed at a broad scale and contains numerous inaccuracies. For example, areas of cleared land, exotic grassland and Typha wetland that would not provide any foraging habitat for this species have been mapped as important habitat.

To determine more accurately the extent and quality of important habitat for the Swift Parrot and Regent Honeyeater within the site a species expert was engaged to undertake a detailed assessment of habitat for these two SAII entities across the Hydro site (including the subject site and proposed adjacent BSS). The purpose of the expert assessment was to determine whether vegetation within the site is likely to be important for these two species and to also quantify the quality of habitat throughout the site.

The expert report determined that a large extent of the mapped important habitat within the site is not likely to comprise important habitat for either of these species and recommended the important habitat mapped within the site for Swift Parrot should be reduced to 47.55 ha and the important habitat mapped for the Regent Honeyeater should be reduced 34.63 ha (Appendix F).

The expert report states that the Regent Honeyeater and Swift Parrot habitat within the subject site is of low to moderate quality, relative to other areas of mapped important habitat within the lower Hunter Valley, such as parts of Werakata National Park and the Hunter Economic Zone (Roderick et al. 2014). The species expert determined that the site was not likely to provide any breeding habitat for the Regent Honeyeater and considered it unlikely that Swift Parrots or Regent Honeyeaters would utilise mapped habitats within the subject site. The expert report also concludes that none of the mapped important habitat within the site is likely to be critical habitat for either species (Crates 2022).

The expert report is included as Appendix F of this BCAR.

Assessments of impacts on these two SAII entities as well as Assessments of Significant (AoS) under the EPBC Act Guidelines have been completed based on Dr Crates assessment of the subject site and are included in Appendix G and H.

Impacts to SAII entities include:

- Removal of up to 84.1 ha of potential foraging habitat for the Swift Parrot (of which 68.2 ha is mapped on the Swift Parrot Important Area map and 47.55 has been identified as important by a species expert).
- Removal of up to 50.3 ha of land mapped as important habitat for the Regent Honeyeater (foraging habitat only) of which 34.63 has been identified as important by a species expert.

Three threatened flora species were identified within the subject site during site surveys:

- Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*), which is listed as a vulnerable species under the BC Act and EPBC Act.
- Netted Bottle Brush (*Callistemon linearifolius*) which is listed as a vulnerable species under the BC Act.
- Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*) which is listed as a vulnerable species under the BC Act and EPBC Act.

One additional threatened flora species (Bynoe's Wattle (*Acacia bynoeana*), which is listed as an endangered species under the BC Act and a vulnerable species under the EPBC Act, has previously been recorded within the subject site (ELA 2016).

Eight threatened fauna species classified as predicted (ecosystem credit) species were recorded during field survey:

- Grey-crowned babbler (*Pomatostomus temporalis*).
- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*).
- Grey-headed flying fox (*Pteropus poliocephalus*)(non-roosting habitat).
- Little Bent-wing Bat (*Miniopterus australis*)(foraging habitat).
- Large Bent-wing Bat (probable) (*Miniopterus orianae oceanensis*)(foraging habitat).
- Varied Sittella (*Daphoenositta chrysoptera*).
- Little Lorikeet (*Glossopsitta pusilla*).
- White-bellied Sea-eagle (*Haliaeetus leucogaster*) (foraging habitat).

Each of these species area is listed as vulnerable under the BC Act. The Grey-headed Flying-fox is also listed as a vulnerable species under the EPBC Act.

Two threatened species that are associated with species credits were identified within or adjacent to the subject site during field surveys:

- Southern Myotis (*Myotis macropus*) (listed as a vulnerable species under the BC Act).
- Large-eared-Pied Bat (*Chalinolobus dwyeri*) (listed as a vulnerable species under the BC Act and EPBC Act).

Although not recorded during recent surveys of the site, the Squirrel Glider (*Petaurus norfolcensis*) has been previously recorded utilising the site. As the site contains suitable habitat for this species it has been assumed present and species credits calculated.

The proposal would result in impacts to up to 110.84 ha of habitat resources for local populations of threatened biota known and predicted to occur within the subject site including:

- Removal of approximately 10.9 ha of occupied habitat for the Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*).
- Removal of approximately 2.7 ha of habitat for Byone's Wattle.
- Removal of approximately 400 Netted Bottle Brush individuals.
- Removal of approximately 3224 Parramatta Red Gum (including 1069 adults, 1604 juveniles and 548 seedlings).
- Removal of up to 26.97 ha of potential Southern Myotis habitat.
- Removal of up to 84.49 ha of potential Squirrel Glider habitat.
- Removal of up to 109 ha of foraging and roosting habitat for the threatened woodland bird species Grey-crowned babbler and Varied Sitella.
- Removal of up to 84.1 ha of foraging and breeding habitat for the Little Lorikeet.
- Removal of up to 84.1 ha of foraging habitat for the threatened bat species: Large Bent-winged Bat; Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Coastal Free-tailed Bat and Little Bentwing-bat.
- Removal of up to 84.1 ha of foraging habitat for the Grey Headed Flying Fox and White-bellied Sea-eagle .
- Removal of up to 110.84 ha of potential foraging and breeding habitat for a range of threatened fauna species that although not recorded during field assessments are predicted to occur by the BAM credit calculator within the above mentioned PCTs.

The proposal may also result in potential indirect impacts to adjoining vegetation associated with sediment and erosion, pollution, weed invasion and edge effects, noise, vibration and light impacts, and the introduction and spread of weeds, pests and pathogens. Mitigation measures to avoid and minimise these impacts would be incorporated into Environmental Management Plans that would be developed for the proposal.

The proposal would not impact any threatened biota listed under the *Fisheries Management Act 1994* (FM Act).

A BAM assessment and credit calculations have been performed in accordance with the methodology and using credit calculator version 1.4.0.00. Ecosystem credits required to be secured and retired to offset the impacts of the proposal include:

- 1416 ecosystem credits of PCT 1633 – Parramatta Red Gum-Narrow-leaved Apple – Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri Area.
- 383 ecosystem credits of PCT 1594 – Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter.
- 263 ecosystem credits of PCT 1591 – Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter.
- 926 ecosystem credits of PCT 1600 – Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter.
- 35 ecosystem credits of PCT 1737 – Typha rushland.

Additional ecosystem credits are also proposed to be retired to offset potential indirect and prescribed impacts associated with the proposal.

Impacts on candidate threatened species will be offset by securing the number and type of species listed below in accordance with the BAM and BOS.

- 87 Bynoe's Wattle species credits.
- 601 Netted Bottle Brush species credits.
- 348 Small-flower Grevillea species credits.
- 6448 Parramatta Red Gum species credits.
- 852 Southern Myotis species credits.
- 2594 Squirrel Glider species credits.
- 2953 Swift Parrot species credits.
- 2399 Regent Honeyeater species credits.

Other threatened species identified as potentially being impacted by the conferral of biodiversity certification are ecosystem credit species which would be offset through the retirement of the above listed ecosystem credits.

To avoid and minimise potential impacts of the proposal on biodiversity, the proposed development site rezoning masterplan footprint has undergone a number of revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value within the Hydro lands could be avoided as far as is practical. Various iterations of the masterplan footprint have been developed and amended in response to studies that have provided information regarding the site's biodiversity values.

To further mitigate potential impacts of the proposal a series of mitigation and management measures have been identified, which would be implemented as part of the construction environmental management plan for the site. These include measures relating to:

- Standard Construction Environmental Management Plan protocols– including site inductions and dust suppression measures.
- Vegetation protection – including protective fencing to prevent impacts to surrounding vegetation, vehicle washing to avoid spread of pathogens/weeds, situating stockpiles in appropriate locations during construction and installation of sediment fences.
- Weeds – including weed management actions/planning, weed propagule spread control measures and sediment control.
- Fauna habitat management – including hygiene protocol implementation, presence of an ecologist during clearing, staged vegetation clearing, protocols for the removal of hollow-bearing trees and other habitat features.
- Water quality and aquatic habitats – including erosion and sediment control measures, plans and surface stabilisation, dust control, spill kits and protocols.

During operation there is potential for the proposal to impact surrounding vegetation and habitat values through:

- Generation of additional light and noise.
- Erosion and sedimentation as a result of runoff from hard stand areas.
- Introduction of weed propagules by vehicle and/or residents.
- Fauna mortality as a result of collision with vehicles.
- Fauna mortality as a result of domesticated animals.
- Increased risk of fire.
- Rubbish dumping.

Mitigation measures would be implemented to minimise potential operational impacts. These would include:

- Ongoing management of priority weeds according to statutory requirements.
- Management of feral animals including noisy miners in areas of adjoining vegetation.
- Ongoing water quality management.
- Measures to reduce the increased risk of fire.
- Prescribed fencing requirements.
- Ecologically sensitive street lighting design.
- Domestic animal restrictions.

The preferred approach to offset the residual impacts of the proposed development is to secure and retire appropriate credits from a proposed onsite Biodiversity Stewardship Site (BSS), located adjacent to the subject site. Any residual credit shortfalls would be secured from additional stewardship sites that provide biodiversity credits that comply with the trading rules of the NSW Biodiversity Offsets Scheme (BOS). A payment to the Biodiversity Conservation Fund (BC Fund) would only be considered if a suitable number and type of biodiversity credits cannot be secured from stewardship sites.

The proposed development has been determined to require a referral to the Commonwealth Department of Agriculture, Water and the Environment (DAWE) in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Determination of the referral by the Department of Climate Change, Energy, the Environment and Water (DCCEEW) would confirm if impacts associated with any listed Matters of National Environmental Significance (MNES) are considered significant and whether biodiversity offsets are required. Offsets required would be delivered in accordance with the recently endorsed bilateral agreement. Under the Amendments to the existing Assessment Bilateral Agreement between the Commonwealth of Australia and the State of New South Wales, offsetting can be undertaken in accordance with the NSW Biodiversity Offsets Scheme's like-for-like credit trading rules and may also include a payment into the BC Fund. Use of the variation to trading rules is not permitted under the bilateral agreement.

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Glossary of terms and abbreviations

Term	Definition
AOBV	Areas of Outstanding Biodiversity Value
BC Act	*Biodiversity Conservation Act 2016* (NSW)
BCAR	Biodiversity Certification Assessment Report
BSSAR	Biodiversity Stewardship Site Assessment Report
BCD	Biodiversity Conservation Division (formally OEH)
BCT	Biodiversity Conservation Trust
BAM	Biodiversity Assessment Method published by the Office of Environment and Heritage for the NSW Government dated August 2017. The rules for biodiversity assessment established under the BC Act that determine credits created, credits required and the circumstances that improve or maintain biodiversity values.
BAM-C	Biodiversity Assessment Method Calculator. Online application of the BAM. The calculator uses the rules and data collected in accordance with the BAM to calculate the biodiversity credits required to offset a development or the biodiversity credits generated at a stewardship site.
Biodiversity credit	A unit of biodiversity value to measure specific development impacts or conservation gains in accordance with the BAM. Includes ecosystem credits and species credits.
Biodiversity credit report	Specifies the number and type of biodiversity credits: required to offset the impacts of a development to obtain a Biodiversity Certification Agreement; or that would be generated through conservation and management of a Stewardship site under a Biodiversity Stewardship site agreement.
Biodiversity offsets	Specific measures that are put in place to compensate for impacts on biodiversity values.
Biodiversity values	The composition, structure and function of ecosystems, including threatened species, populations and ecological communities, and their habitats.
BOS	Biodiversity Offset Scheme
CEEC	Critically endangered ecological community
CEMP	Construction Environmental Management Plan
DAWE	Department of Agriculture, Water and the Environment (formally Department of the Environment and Energy)
DPIE	Department of Planning Industry and Environment
Ecosystem credit	A credit that relates to a vegetation type and the threatened species that are reliably predicted by that vegetation type (as a habitat surrogate)
EEC	Endangered ecological community
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FFMP	Flora and Fauna Management Plan
IBRA	Interim Biogeographic Regionalisation for Australia
LEP	Local Environment Plan
LGA	Local Government Area
Locality	The area within a 10 km radius of the subject site.
Migratory species	Species listed under listed under international agreements (i.e. Ramsar, JAMBA and CAMBA conventions) to which Australia is a party
MNES	Matters of National Environmental Significance
OEH	Office of Environment and Heritage (now the BCD)
PCT	Plant community type

Term	Definition
SAII	Serious and irreversible impacts
SAII entity	Species and ecological communities that are likely to be the subject of serious and irreversible impacts (SAIIs)
SEPP	State Environment Planning Policy
Species credit	A credit that relates to an individual threatened species that cannot be reliably predicted based on habitat surrogates. Threatened species that require species credits are identified in the Threatened Biodiversity Data Collection (TBDC).
Subject site	The area that would be directly impacted by development on the land proposed for biodiversity certification.
TEC	Threatened ecological community.
TBDC	Threatened Biodiversity Data Collection
Threatened biota	Threatened species, populations or ecological communities listed under the BC Act and/or the EPBC Act.

1. Introduction

1.1 Overview

Hydro Aluminium Kurri Kurri Pty Ltd (Hydro) owns and manages approximately 1,390 ha of land at Loxford, NSW (referred to herein as the Hydro Land). The site was used for the former Hydro Aluminium Kurri Kurri Smelter (the smelter site) and adjacent buffer lands (buffer land). The Smelter ceased operations in September 2012, with Hydro formally announcing its closure in May 2014. The Hydro Land is strategically situated in close proximity to the centres of Cessnock, Kurri Kurri and Maitland with access to existing significant infrastructure, including the South Maitland Railway, Hunter Expressway and Kurri Kurri Wastewater Treatment Works.

Council is proposing to rezone a portion of the Hydro Land primarily for employment and residential purposes with a large proportion of the site being retained for future conservation. Given the scale and strategic location of the Hydro land, the proposal has the potential to play a key role in achieving the economic, employment and environmental objectives for the Hunter Region identified in the NSW State Plan 2021, Hunter Regional Plan 2036 and the Greater Newcastle metropolitan Plan 2036. The rezoning would facilitate a mixed used development that includes areas for residential, business, employment, public recreation and special purpose infrastructure.

GHD Pty Ltd (GHD) has been engaged by Hydro to prepare a Biodiversity Certification Assessment Report (BCAR) to address the potential biodiversity impacts associated with the proposed biocertification of approximately 243 ha of Hydro land (the proposal).

This BCAR has been prepared as a supporting document to the two Planning Proposals which have been prepared in accordance with section 3.33 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the NSW Department of Planning and Environment's *A Guide to Preparing Local Environmental Plans and A Guide to Preparing Planning Proposals*. The BCAR has been prepared on behalf of Hydro for submission to the Biodiversity Conservation Division (BCD) of the Department of Planning Industry and Environment (DPIE) and for consideration by Cessnock and Maitland City Councils.

The Planning Proposals seek to rezone approximately 332 ha of Hydro Land within the Cessnock Local Government Area (LGA). This includes approximately 270 ha proposed for biodiversity certification and future development within the ‘subject site’ for this BCAR. The remaining land would be assessed under a State Significant Development (SSD) approval associated with the remediation of the former Hydro smelter site

The location of the area proposed to be bio-certified is shown on Figure 1-1 and the masterplan for the proposed rezoning is shown in Figure 1-2.

Potential impacts to biodiversity associated with biodiversity certification of the subject site would include the removal of up to 110.84 ha of native vegetation, which provides known and potential habitat for a range of threatened biota. Native vegetation within the site ranges in condition and quality, with approximately 65.11 ha comprised of intact vegetation and 45.71 ha of moderate condition vegetation that is either regrowth, planted or has been previously disturbed. The remaining 158.72 ha of land proposed for biodiversity certification comprises exotic grassland, cleared land/hardstand and/or open water.

This report describes the biodiversity values at the site, with emphasis on identification of native Plant Community Types (PCTs) and threatened ecological communities (TECs), populations, species and their habitats. It assesses the impact of the proposal, identifies measures to avoid and minimise impacts and describes and quantifies the biodiversity credits required to offset the residual impacts of the proposal on biodiversity values according to the Biodiversity Assessment Methodology 2020 (BAM) (DPIE 2020a).

Proposed conservation measures to offset the impacts of the development and to demonstrate that biodiversity values are being improved and maintained are discussed in Section 8. Biodiversity offsets would include conservation of approximately 770 ha of land outside the subject site via a stewardship agreement. Biodiversity values and credits generated from proposed conservation areas adjacent to the site and in the locality and would be described in detail in a separate Biodiversity Stewardship Site Assessment Report (BSSAR).

1.2 Definitions

The following terms are used in this report:

- The '**proposal**' refers to the proposed biocertification of 270 ha of land that that would facilitate development for residential, business, employment and special purpose infrastructure.
- The '**subject site**' refers to the 270 ha of land that is proposed for biodiversity certification within the former Hydro lands (shown as 'biocertification area' on each of the figures included in this BCAR).
- The '**locality**' refers to the area within a 10 km radius of the subject site.

1.3 Biodiversity Offset Scheme

The BC Act, together with the *Biodiversity Conservation Regulations 2017***,** provides a mechanism to address impacts on biodiversity from land clearing associated with development. Under this legislation, there are provisions for a Biodiversity Offsets Scheme (BOS), which includes a framework to avoid, minimise and offset impacts of development on biodiversity.

The purpose of the BOS is to provide a transparent, consistent and scientifically based approach to biodiversity assessment and offsetting, to ensure that the impacts of development, clearing or biodiversity certification will result in no net loss of biodiversity.

The scheme creates a market framework for the conservation of biodiversity values and the offsetting of development impacts, by establishing the mechanisms to offset impacts of development, clearing or biodiversity certification through biodiversity credit trading such that there is no net loss of biodiversity values. The scheme also allows for the establishment of Biodiversity Stewardship Agreements (BSAs), which are in-perpetuity agreements entered into by landholders, to secure offset sites and generate biodiversity credits, which can be used to offset impacts of development.

The Biodiversity Conservation Fund (BCF) ensures that landowners have the funds needed to carry out the management actions required each year and provides a financial incentive to landowners to carry out those actions. The scheme is administered by the Biodiversity and Conservation Division (BCD, formerly the Office of Environment and Heritage, or OEH) and ensures accountability and compliance through legislation, regular reporting requirements and financial measures.

1.4 Biodiversity Assessment Methodology

The BAM was established by the former New South Wales (NSW) Office of Environment and Heritage (OEH). The BAM underpins the BOS and establishes as a standard method to address the loss of biodiversity and threatened species. The BAM (2020) sets out how biodiversity values will be assessed, prescribes requirements to avoid and minimise impacts, establishes rules for calculating the number and class of credits required for unavoidable impacts, and determines the trading rules that will apply.

The methodology includes a software package known as the Biodiversity Assessment Method Calculator (BAM-C) which processes site survey and assessment data. The credit calculator specifies the type and extent of surveys required for a biodiversity assessment and then processes survey data to calculate the number and type of biodiversity credits that are either required at a development site or will be generated at a stewardship site. The BAM must be applied by a person accredited under the BC Act.

The requirement for a BAM assessment is triggered if:

- The amount of native vegetation being cleared exceeds the BOS clearing threshold.
- The impacts occur on an area mapped on the Biodiversity Values map published by the Minister for the Environment.
- The results of an assessment of significance (the 5-part test contained in section 7.3 of the BC Act) indicates the project could have a significant impact on threatened biota.

The proposal will trigger the BOS as native vegetation proposed for clearing will be ≥1 ha in a minimum lot size between 40-1000 ha and parts of the subject site are mapped on the biodiversity values map (refer to Figure 1-1). Therefore, the proposal requires a BCAR to be prepared in accordance with the BAM to accompany the Planning Proposals.

This BCAR has been prepared to assess the impacts of the conferral of biodiversity certification on biodiversity values using the BAM 2020 and to determine the quantum of biodiversity offset required for residual impacts.

1.5 Biodiversity certification

Biodiversity certification provides for a streamlined biodiversity assessment process for strategic or large developments.

Provisions to apply for biodiversity certification are contained within Section 8 of the BC Act.

Steps involved in biodiversity certification include:

- Planning and design of the development, including identifying the specific area that will be subject to the biodiversity certification application.
- Consultation with BCD and relevant local council/s.
- Preparation of a formal application. This involves an accredited assessor applying the BAM to the area subject to the biodiversity certification proposal and preparation of a BCAR (this report) to assess the impacts on biodiversity values of conferring biodiversity certification on the subject site and to quantify and describe the biodiversity credits required to offset the impacts of conferral of biodiversity certification on biodiversity values.
- Public consultation and notification of the proposal and response to any submissions.
- Determination of the application by the Minister for the Environment.
- Ongoing review and auditing of compliance activities.

After biodiversity certification is conferred on an area of land, development may proceed without the usual requirement under the *Environmental Planning and Assessment Act 1979* (EP&A Act) for site-by-site threatened species assessment and no further assessments of threatened biota listed under the BC Act are required to accompany future Development Applications.

Biodiversity certification may only be conferred by the Minister if they are satisfied that the approved conservation measures adequately address the likely impacts of the proposal.

Parties to biodiversity certification are responsible for the implementation of the proposed conservation measures for the duration of the certification. Formal approval of the Proposal cannot be granted until the approved conservation measures and required offsets have been secured (i.e. the approval of future Development Applications (DA's) and Construction Certificates (CC's) can't be issued until approval conditions associated with the BCAR are met).

1.6 Purpose of this report

This BCAR has been prepared to assess the potential impacts of the conferral of biodiversity certification on biodiversity values using the BAM and to determine the quantum of biodiversity offset required for residual impacts. Specifically, the objectives of this assessment are to:

- Outline the methods used in the biodiversity assessment.
- Describe the existing environment of the proposed biodiversity certification area in terms of its biodiversity values, including type and condition of PCTs and terrestrial and aquatic habitats.
- Identify flora and fauna species and PCTs within the subject site that have the potential to be impacted by the proposed conferral of biodiversity certification.
- Describe the conservation significance of the subject site in terms of threatened biota known or predicted to occur within the subject site.
- Provide a description of the proposal, including potential direct and indirect impacts on biodiversity values.
- Identify measures undertaken to avoid and minimise impact to biodiversity values.
- Present the data used to perform the BAM assessment and credit calculations for the proposal.
- Calculate the number and type of biodiversity credits using the BAM that would be required to offset impacts of the proposal.
- Discuss conservation measures proposed to offset the residual impact of the proposal.

1.7 Assumption and limitations

This report has been prepared by GHD for Hydro Aluminium Kurri Kurri Pty Ltd and may only be used and relied on by Hydro Aluminium Kurri Kurri Pty Ltd for the purpose agreed between GHD and the Hydro Aluminium Kurri Kurri Pty Ltd as set out in Section 1.6 of this report.

GHD otherwise disclaims responsibility to any person other than Hydro Aluminium Kurri Kurri Pty Ltd arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible.

The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report.

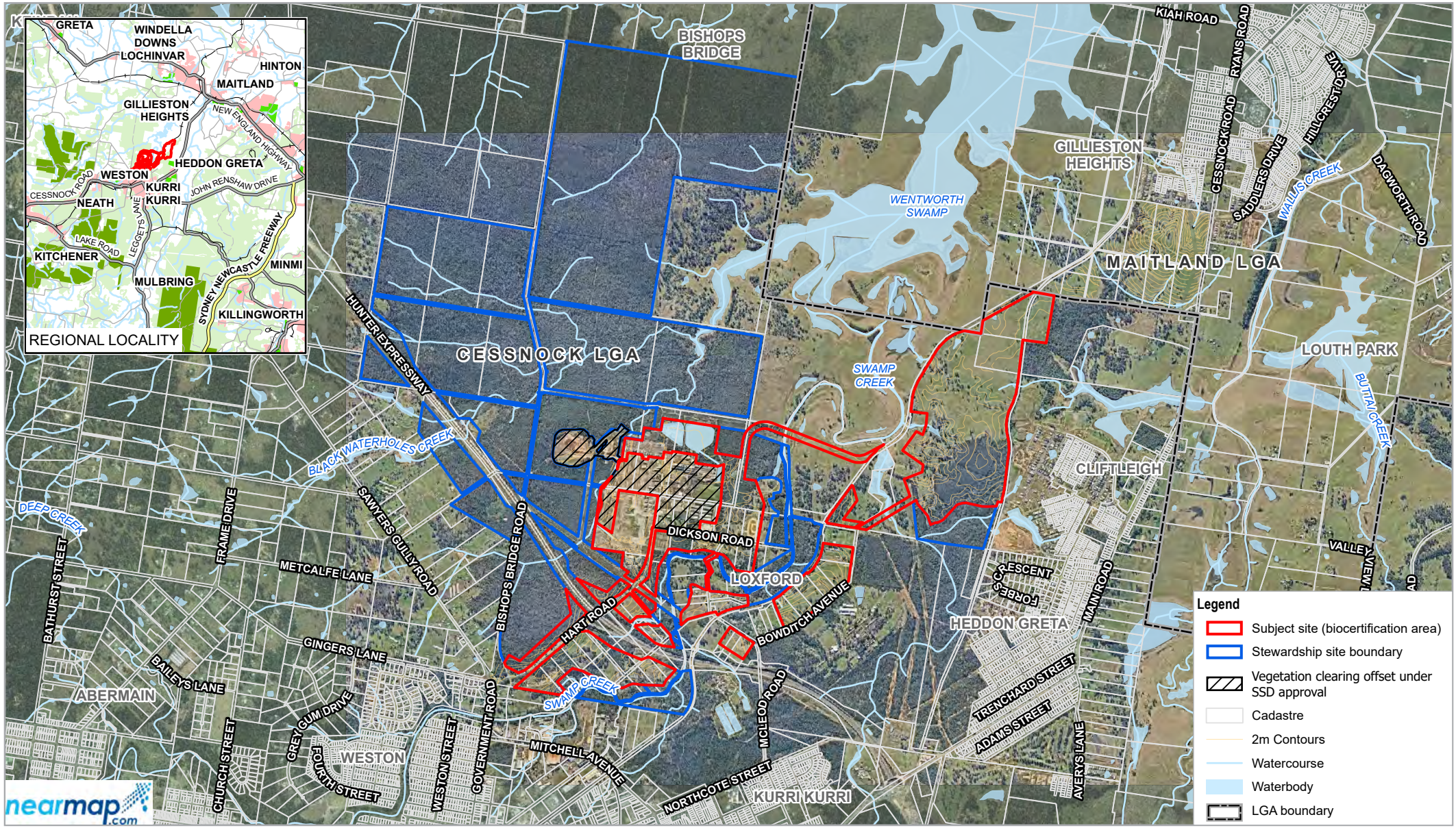
The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared.

The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD described in this report (refer Section 1.7 of this report as well as general assumptions quoted throughout). GHD disclaims liability arising from any of the assumptions being incorrect.

GHD has prepared this BCAR on the basis of information provided by Hydro and others who provided information to GHD (including Government authorities), which GHD has not independently verified or checked beyond the agreed scope of work. GHD does not accept liability in connection with such unverified information, including errors and omissions in the BCAR which were caused by errors or omissions in that information. Specifically, this report has been prepared based on the proposal description and maps and plans provided by the proponent. A 'proposal footprint' polygon (i.e. disturbance footprint) was prepared for the biodiversity assessment based on these inputs and confirmed in consultation with the proponent. It is assumed that the description and spatial data accurately represent the extent of direct impacts arising from the proposal and so these data have been used to calculate the extent of removal of vegetation and habitat arising from the proposal using GIS. These calculations have in turn been relied upon in the BAM calculations and the determination of key thresholds such as whether the proposal would have a direct impact on a threatened species, whether biodiversity offsets are required for a particular impact and whether a particular impact is likely to be significant. The assessment conclusions may change as a result of the provision of an updated proposal design and/or spatial data.

The opinions, conclusions and any recommendations in this report are based on information obtained from, and testing undertaken at or in connection with, specific sample points. Site conditions at other parts of the site may be different from the site conditions found at the specific sample points.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared. Where this Report is relied on or used without obtaining this further advice from GHD, to the maximum extent permitted by law, GHD disclaims all liability and responsibility to any person in connection with, arising from or in respect of this Report whether such liability arises in contract, tort (including negligence) or under statute.



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Site map

Figure 1-1

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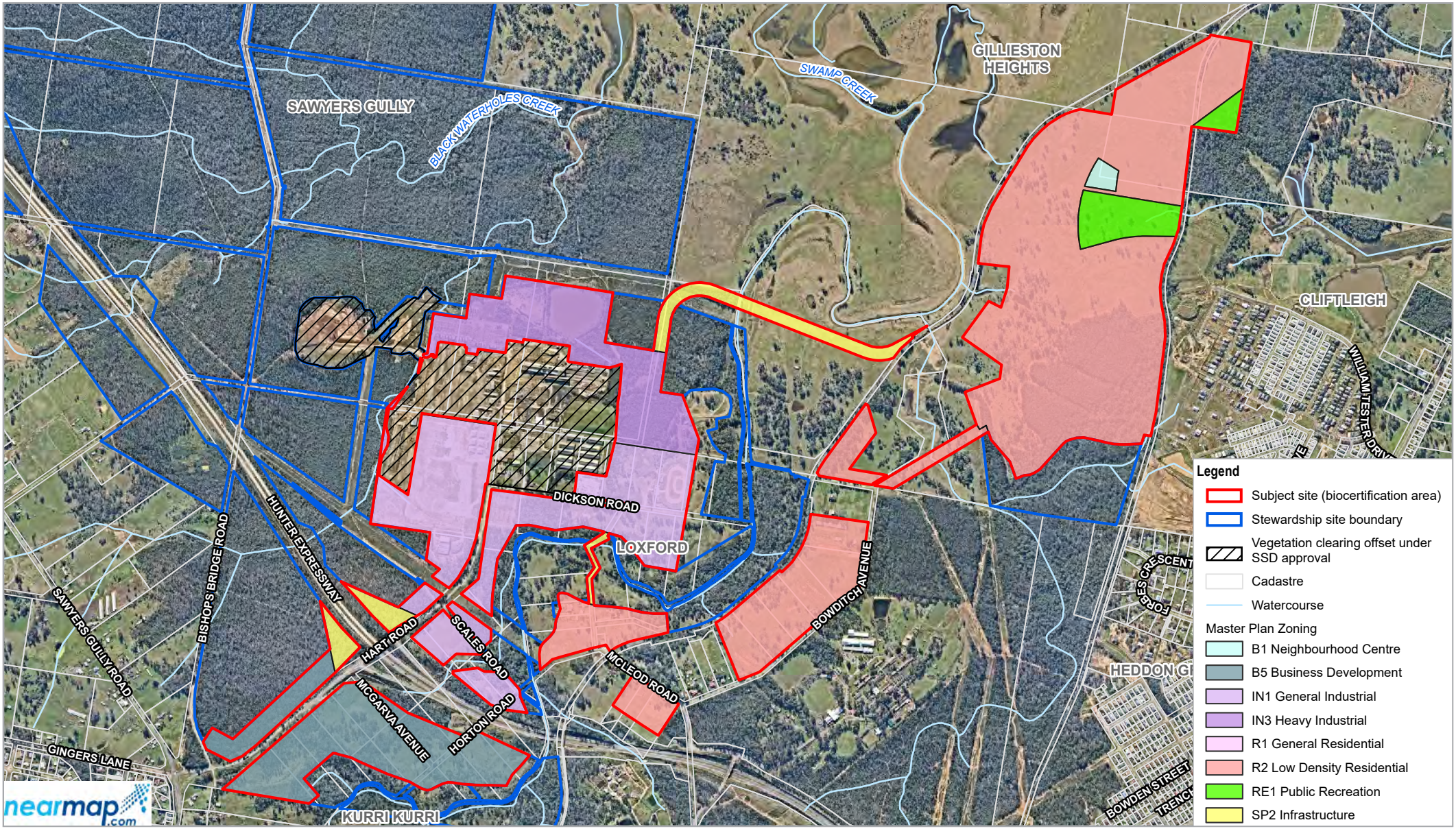
Print date: 01 Jun 2022 - 14:30

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Geoscience Australia: 250k Topographic Data Series 3, 2006; Hydro Aluminium: Subject Site, 2019; LPI: DTDB / DCDB, 2017public_NSW_Imagery: © Department of Customer Service 2020. Created by: fmackay



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Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

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Revision No. **1**
Date **01/06/2022**

Proposal site layout

Figure 1-2

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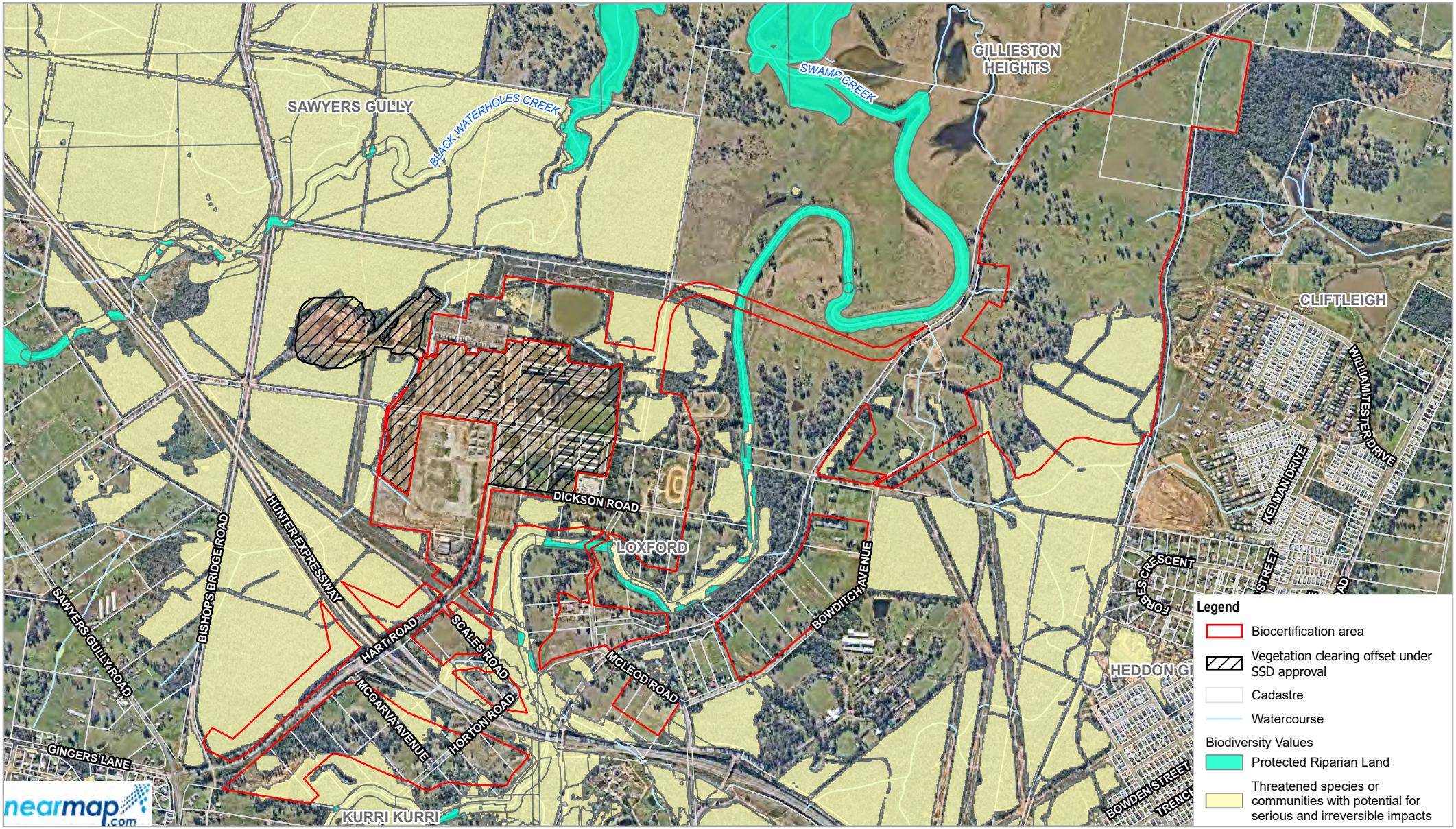
Print date: 01 Jun 2022 - 14:30

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Hydro Aluminium Kurri Kurri Pty Ltd
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Revision No. **1**
Date **01/06/2022**

OEH biodiversity values mapping

Figure 1-3

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Print date: 01 Jun 2022 - 14:31

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; OEH: Biodiversity values mapping; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

2. Methodology

2.1 Approach

This BCAR has been prepared to describe the impacts of the conferral of biodiversity certification on biodiversity values using the BAM (DPIE 2020a).

The main components of the methodology for the biodiversity assessment include:

- Desktop assessment to describe the existing environment and landscape features of the Subject site and to identify the suite of threatened biota potentially affected by the proposal.
- Field survey in accordance with the BAM to describe the biodiversity values within development footprint and surrounding subject site and determine the likelihood of threatened biota and their habitats occurring in the subject site or being affected by the proposal.
- Determining reasonable actions to avoid and minimise impacts to biodiversity values.
- Completing calculations using the BAM calculator version 1.24.0.00 to quantify the residual biodiversity impacts of the proposed conferral of biodiversity certification and to determine the ecosystem and species credits that would require retirement to offset these impacts.

The biodiversity assessment and biodiversity credit calculations were performed by Arien Quin in accordance with the BAM (BAAS17098). A technical review of the BCAR was completed by Ben Harrington (BAAS17023).

2.2 Desktop assessment

2.2.1 Information sources

A desktop assessment was undertaken to gather information relating to the existing environment and landscape features of the subject site and to identify the suite of threatened biota potentially affected by the proposal. Biodiversity resources pertaining to the subject site and locality (i.e. within a 10 km radius of the site) that were used in the preparation of this BCAR include:

- NSW BioNet data including NSW Wildlife Atlas database records and Threatened Species Profile Data Collection (TSPDC) profiles of threatened species listed under the BC Act (DPIE 2022a).
- *Threatened biodiversity profile search* online database for threatened ecological communities listed under the BC Act (DPIE 2022b).
- Department of Agriculture, Water and the Environment (DAWE) *Protected Matters Online Search Tool* for MNES listed under the EPBC Act and predicted to occur in the locality (DAWE 2020a).
- DAWE online *Species profiles and threats database* (SPRAT) (DAWE 2020b).
- DPI maps of Key Fish Habitat (DPI 2007).
- NSW *BioNet Vegetation Classification database* to identify plant community types (PCTs) that occur within the subject site (DPIE 2022c).

- Aerial photographs and satellite imagery, 2 m contour data, and creek line data of the subject site.
- DPIE eSpade V.2 online soil landscape mapping (DPIE 2022d).
- Soil Landscapes of Central and Eastern NSW V2 (OEH 2019).
- Available regional-scale vegetation mapping of the site (NPWS 2000, Bell and Driscoll 2007).
- Previous ecological studies and reports relevant to the site and data and references including ELA, 2016, Cenwest Environmental Servcies, 2004, FloraSearch 2004 and 2008.

2.2.2 Database review and likelihood of occurrence assessment

A desktop database review was undertaken to identify threatened flora and fauna species, populations and ecological communities (biota) listed under the BC Act, FM Act, and EPBC Act, which could be expected to occur in the locality, based on previous records, known distribution ranges, and habitats present. These were also used to obtain the necessary site data to perform BAM calculations.

The threatened biota and migratory species identified in the desktop assessment are presented in Appendix A. Following collation of database records and threatened species and community profiles, a list of threatened species requiring assessment was compiled according to the 'steps for identifying habitat suitability for threatened species' presented in Section 6.4 of the BAM. This was further refined following field surveys and identification and assessment of habitat present within the subject site. A likelihood of occurrence ranking was attributed to these biota based on this information and used to compile lists of 'predicted threatened species' (i.e. ecosystem credit species) and 'candidate threatened species' (i.e. species credit entities requiring targeted survey) according to Step 2 'assessment of habitat constraints' of Section 6.4 of the BAM.

2.3 Site survey

2.3.1 Previous surveys completed within the subject site

A number of ecological surveys have been previously completed across the Hydro lands, including the subject site. Results of these surveys have been reviewed and referred to where relevant. Previous surveys completed within the subject site are summarised in Table 2-1.

Table 2-1 Summary of previous ecological surveys completed within and adjacent to the subject site

Survey	Date/s of survey	Survey techniques/effort
Biodiversity Certification Assessment Report for Hydro Lands (ELA 2016)	December 2014 February 2015 March 2014 March 2016 9 December 2014 24-19 December 2014 27 November 2014 27-29 December 2014 17-19 January 2015 and 23 February	Vegetation mapping 37 BBAM plot/transects Threatened flora survey walking parallel transects spaces 5-10 metres apart Plot based survey for threatened flora, including 80 20 X 50 plots Arboreal hair tubes (1680 trap nights) Next box monitoring (70 trap nights) Camera traps (20 cameras over 10 week period) Spotlighting Call playback for forest owls and Koala Amphibian survey, over six nights

Survey	Date/s of survey	Survey techniques/effort
	2015	Echolocation call recording Diurnal bird surveys
Flora assessment – Hydro Aluminium Kurri Kurri (FloraSeach 2004)	29 April – 14 May 2003 8-11 July 2003 23-15 October 2003 22-23 January 2004	Vegetation mapping Quadrat surveys (thirty 20 X 20 plots) Spot sampling (77 survey points)
Terrestrial Vertebrate Fauna Assessment (Cenwest Environmental Services 2004)	12-24 May 2003 18-29 November 2003	Elliot A and B trapping on ground (180 trap nights) Cage traps (72 trap nights) Elliot A aboreal traps (120 trap nights) Hair tubes on ground (1200 trap nights) Aboreal Hair tubes (large and small) (560 trap nights) Pitfall traps (432 trap nights) Spotlighting Systematic herpetological searches for 30 mins over 4 day days Bird surveys (20 hours) Call playback (half hour at 10 sites over 4 nights) Opportunistic observations

2.3.2 Survey overview

Staged surveys of the subject site were conducted for this BCAR with reference to the BAM and appropriate threatened species survey guidelines for targeted species. Site surveys have included:

- Initial site stratification, preliminary investigation of biodiversity values and vegetation mapping
- Vegetation integrity plots
- Incidental threatened flora surveys
- Opportunistic fauna surveys
- Habitat assessments
- Targeted surveys for threatened flora
- Targeted surveys for threatened fauna

Survey effort that has directly contributed to this BCAR is summarised in Table 2-2 and is described in detail below.

Table 2-2 Survey techniques and timing

Stage	Date	Survey Technique
Preliminary investigation of biodiversity values and vegetation mapping	26-29 August 2019 8-11 October 2019 18 June 2020	Ground-truthing of previous vegetation mapping. Random meander in accordance with Cropper (1993) to: -Document fauna habitats and features within the development area -Assess the general condition of vegetation and habitats present -Confirm vegetation boundaries -Identify potential habitat for threatened biota -Aquatic habitat assessment -Opportunistic fauna observations
BAM plot surveys	26-30 August 2019 8-11 October 2019 24 April 2020 18 June 2020	Vegetation integrity plot/transects Targeted threatened flora surveys, opportunistic fauna observations Fauna habitat assessment.
Winter candidate species credit targeted fauna survey	14-29 August 2019	Stag watching Owl call playback Spotlighting Hollow bearing tree assessments Large forest owl tree survey Targeted surveys for breeding habitat for Little Eagle, White-bellied Sea Eagle and Glossy-Black Cockatoo
Candidate species credit targeted flora survey	28-31 October 2019 13-15 November 2019 24 April 2020 6-8 October 2020 10-18 October 2020 18 February 2021	Systematic parallel traverses targeting candidate threatened flora species
Spring candidate species credit targeted fauna survey	25-29 November 2019	Ultrasonic call recording (Anabat) Diurnal bird survey Pitfall trapping Spotlighting Call playback for threatened owls Remote camera traps Active searches for scats and signs
Summer candidate species credit targeted fauna survey	24 –28 February 2020	Arboreal Elliot Traps for small mammals Spotlighting Call Playback for threatened owls and amphibians Harp Trapping Ultrasonic call recording (Anabat) Active searches for scats and signs Remote camera traps Habitat assessment

Stage	Date	Survey Technique
Supplementary diurnal bird surveys	6-7 October 2021 15 October 2021 22 October 2021 21 November 2021 6 December 2021	At total of 74 bird surveys were undertaken across the subject site between Oct-Dec 2021. Repeat surveys were completed at 20 sites where blossom was present.
Swift Parrot and Regent Honeyeater habitat assessment	6-7 October 2021 15 October 2021 22 October 2021 21 November 2021 6 December 2021	74 habitat assessment sites assessed within the subject site, Assessment method followed the Australian National University (ANU) and Birdlife methodology developed for the National Regent Honeyeater and Swift Parrot Monitoring Programs (Crates et al. 2017)
Supplementary surveys for *Diuris tricolor* and *Rutidosis heterogama* (Heath Wrinklewort)	5-6 and 19 October 2021	Systematic transects
Supplementary surveys for Green and Golden Bell Frog	24-26 November 2021 7- 8 December 2021	Call playback Spotlighting

2.3.3 Vegetation mapping

Existing vegetation mapping of the site completed by Bell and Driscoll (2007) and EcoLogical (ELA) (2016) was ground-truthed in the field by driving and/or walking the boundaries of vegetation types. Necessary adjustments were made by hand on aerial photographs of the subject site with reference to a handheld Global Positioning System (GPS) unit. Other information recorded included observed vegetation structure, soil type, landscape position and condition. The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health. This data in combination with plot survey data (Appendix C) was then used to map the vegetation across the site. PCTs were identified based on vegetation structure, species composition, soil type and landscape position and with reference to the BioNet Vegetation Classification database (DPIE 2022c). The site was subsequently divided into relatively homogenous or discrete zones for assessment (i.e. vegetation zones). These vegetation zones represent a distinct PCT and broad condition state.

2.3.4 Vegetation integrity survey plots (assessment of site condition)

Following the stratification of the subject site into vegetation zones, plot surveys were conducted in accordance with Section 4.3.3 and Section 4.3.4 the BAM (DPIE 2020a) to obtain vegetation integrity data for the calculation of biodiversity credits.

Plots were located to comply with the minimum number of plots required by Table 3 in the BAM (DPIE 2020a). In total, 28 plots were sampled within the subject site. Plots were located randomly within each of the vegetation zones by walking a random distance into the vegetation zone and then locating the plot on a randomly generated compass bearing; this was then repeated for subsequent plots within the vegetation zone. Plots were located away from ecotones, tracks and track edges or other disturbed areas where practicable.

The location of survey plots is shown on Figure 2-1 and Figure 4-1. The minimum plot survey requirements are summarised in Table 2-3.

The site value was determined by assessing ten attributes used to assess function, composition and structure of vegetation within a 50 metre by 20 metre plot. These attributes were then assessed against benchmark values. Benchmarks are quantitative measures of the range of variability in condition in vegetation with relatively little evidence of alteration, disturbance or modification by humans since European settlement.

Attributes assessed within each plot are listed in Table 2-4. All flora species within a 20 metre by 20 metre quadrat nestled within the 50 metre by 20 metre plot were identified according to the nomenclature of the Royal Botanic Gardens and Domain Trust (RBGT 2021). Each species identified was allocated a growth form group1 and designated as either native, exotic or high threat exotic in accordance with the lists accessed by assessors via the BAM calculator.

The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health.

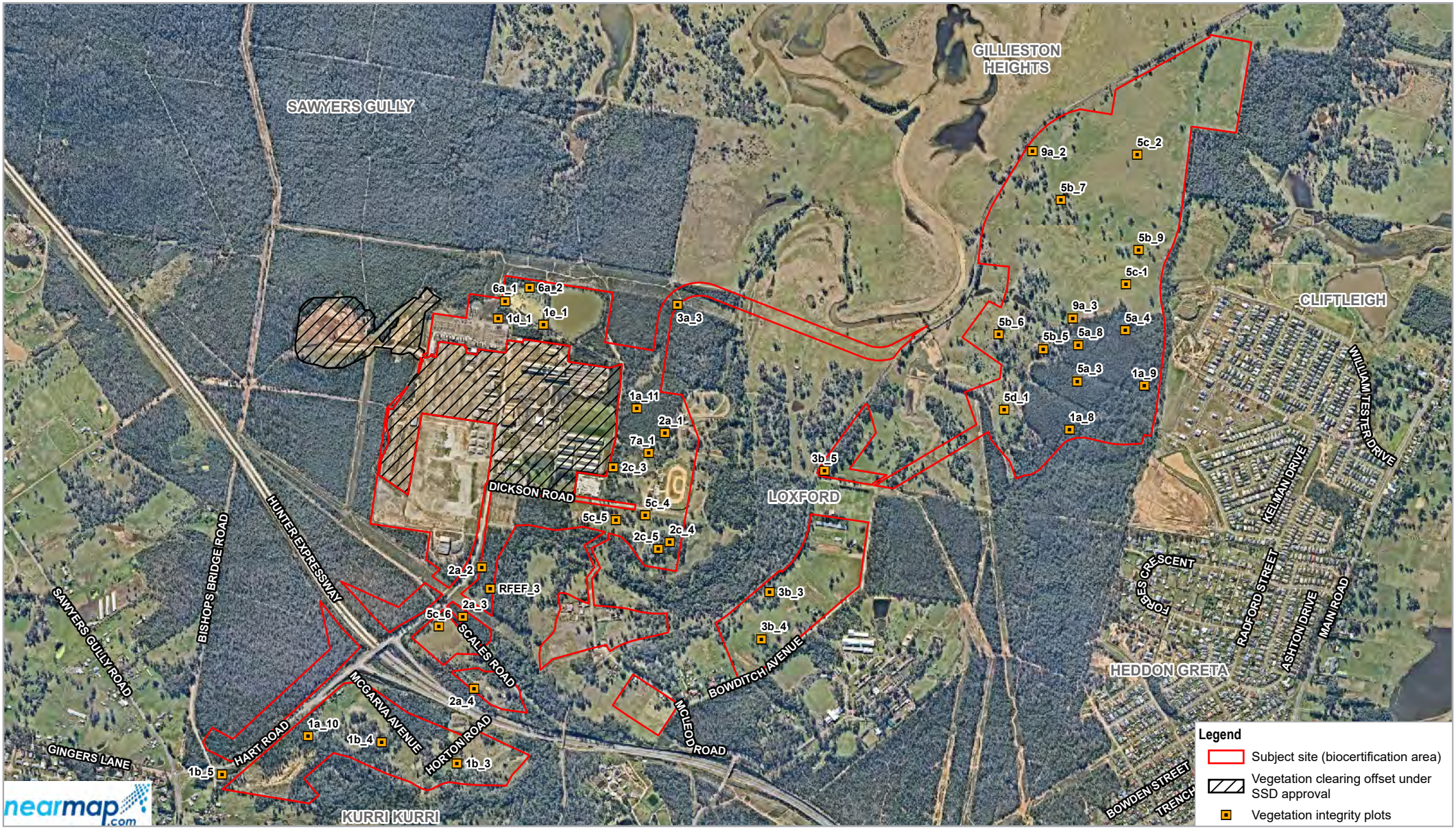
[1] TG – tree, SG – shrub, GG – grass/grasslike, FG – forb, EG – fern, OG – other (Table 2 of the BAM, DPIE 2020)

Table 2-3 Minimum plot survey requirements within the subject site

Veg Zone	PCT Number	PCT Name	PCT condition	Area (ha)	Minimum Plots	Number of plots sampled
1	1633	Parramatta Red Gum-Narrow-Leaved Apple- Prickly leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Good	38.80	4	4
2	1633	Parramatta Red Gum-Narrow-Leaved Apple- Prickly leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Poor	8.04	3	3
3	1633	Parramatta Red Gum-Narrow-Leaved Apple- Prickly leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Regrowth	0.88	1	1
4	1594	Cabbage Gum – Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	Good	4.28	2	2
5	1594	Cabbage Gum – Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	Poor	6.56	3	3
6	1591	Grey Gum – Rough-barked Apple shrubby open forest of the lower hunter	Good	4.87	2	3
7	1591	Grey Gum – Rough-barked Apple shrubby open forest of the lower hunter	Poor	10.12	3	3
8	1600	Spotted Gum – Red Ironbark – narrow-leaved Ironbark – Grey Box shrub –grass open forest of the lower Hunter	Poor	4.99	2	2
9	1600	Spotted Gum – Red Ironbark – narrow-leaved Ironbark – Grey Box shrub –grass open forest of the lower Hunter	Regenerating	14.23	3	3
10	1600	Spotted Gum – Red Ironbark – narrow-leaved Ironbark – Grey Box shrub –grass open forest of the lower Hunter	Good	17.17	3	3
11	1737	Typha rushland	Good	0.9	1	1
Total				**110.84**	**27**	**28**

Table 2-4 Site data collected within each BAM plot

Attribute	Sample area
Composition	
Native plant species richness, total species richness of each growth form group	20 x 20 metre plot
Structure	
Percentage foliage cover for each species, total cover of each growth form group	20 x 20 metre plot
Estimated number of individuals for each species	20 x 20 metre plot
Function	
Number of large trees	20 x 50 metre plot
Tree regeneration (presence/absence)	50 x 20 metre plot
Tree stem size class	50 x 20 metre plot
Total length of fallen logs	50 x 20 metre plot
Litter cover	5 times 1 x 1 metre plot
High threat exotic vegetation cover	20 x 20 metre plot
Hollow bearing trees	50 x 20 metre plot



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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Vegetation integrity plots

Figure 2-1

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Print date: 01 Jun 2022 - 14:33

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

2.3.5 Targeted flora surveys

Potential candidate species credit entities for the subject site were identified and assessed in accordance with Section 5.2 and Section 5.3 of the BAM (DPIE 2020a). All threatened plants are classified under the BAM as species credit entities as their occurrence cannot be reliably predicted based on vegetation type.

The suite of threatened plants with potential to occur in the subject site was identified based on the desktop assessment results and the species credit entities identified by preliminary BAM Calculations (see Appendix A) Habitat for these species was identified and assessed based on threatened species profiles and the experience and judgement of GHD ecologists. A large area of the subject site is highly modified and is dominated by exotic species, heavily grazed and can be readily discounted as supporting populations of threatened plant species.

Candidate threatened flora species that were targeted during these surveys and the appropriate survey period specified in the BAM calculator are listed in Table 2-5. Surveys focused on areas of suitable habitat for candidate species within the subject site.

Targeted searches were completed by experienced botanists systematically walking parallel traverses within areas of suitable habitat, with reference to the threatened plant survey guidelines (DPIE 2020b). Targeted threatened flora surveys were undertaken between:

- 28-30 October 2019
- 13-15 November 2019
- 5-7 October 2020
- 9-17 November 2020
- 18 February 2021
- 5-6 October 2021
- 19 October 2021
- 3 November 2021
- 16-17 Nov 2021

The location of threatened flora traverses is shown on Figure 2-2, Figure 2-3 and Figure 2-4. Further detail regarding candidate threatened flora species is provided in Section 5.1.

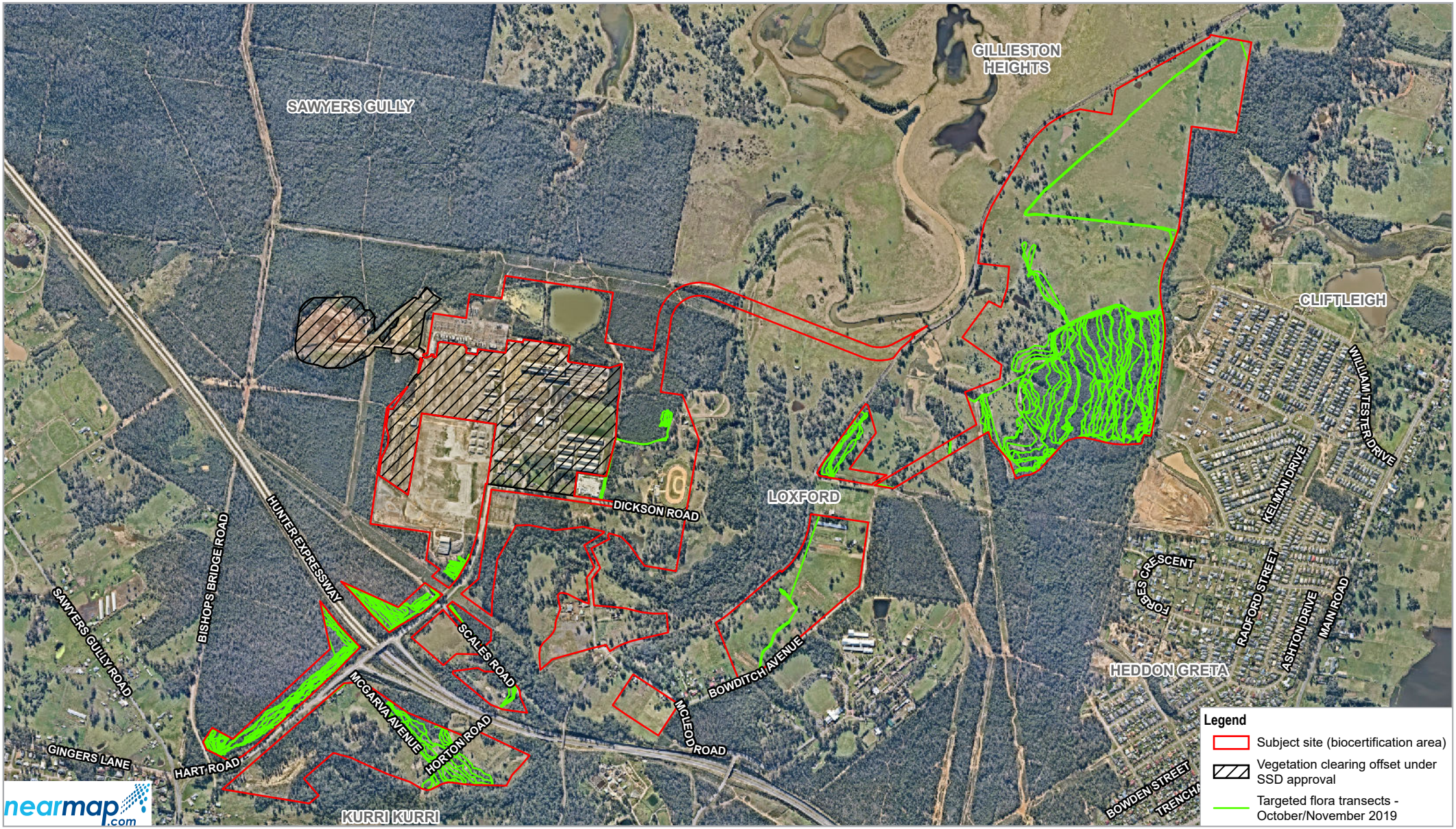
Table 2-5 Candidate threatened flora species targeted during surveys

Common name	Scientific name	Appropriate survey period (TBDC)	Specific survey requirements (DPIE 2022e)	Survey effort	Comment
Bynoe's Wattle	*Acacia bynoeana*	All year	Use reference population to identify vegetative state, which will assist in positive identification during survey	54 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019. An additional 12 person hours of targeted searches were completed in October and November 2020 targeting area where previous records were located.	Species identified within the subject site by ELA in 2015. None of the six individuals recorded by ELA were relocated during targeted surveys completed in October/November 2019 and October/November 2020. Species however has been assumed present due to the known records on the site.
Netted Bottle Brush	*Callistemon linearifolius*	October - January	Use flowers to identify. Survey Oct-Jan. If not observed in flower, return to site for resurvey-later in survey period.	54 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019. 208 person hours systematic transverses in October/November 2020	Species observed flowering within subject site at time of survey
Slaty Red Gum	*Eucalyptus glaucina*	All year	Use buds/or juvenile growth to detect and identify	54 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019. 208 person hours systematic transverses in October/November 2020	-

Common name	Scientific name	Appropriate survey period (TBDC)	Specific survey requirements (DPIE 2022e)	Survey effort	Comment
Parramatta Red Gum	*Eucalyptus parramattensis* subsp. *decadens*	All year	Nil	54 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019. 208 person hours systematic transverses in October/November 2020	-
Pokolbin Mallee	*Eucalyptus pumila*	All year	Nil	54 person hours of systematic traverses in October 2019 and 36 days a systematic traverse in November 2019. 208 person hours systematic transverses in October/November 2020	Marginal habitat present (refer to Appendix A)
Leafless Tongue Orchid	*Cryptostylis hunteriana*	November - January	Survey northern populations Nov-Dec. Survey southern populations Dec - Jan	54 person hours of systematic traverses 28-30 October 2019 and 36 hours systematic traverses in November 2019. 208 person hours systematic transverses in October/November 2020	Survey completed when species was known to start in flower at reference population on central coast (21 October 2019). Advice received from Saving our Species officer Anthony Von Chrismar was this was also an appropriate time to survey for the species in the Kurri Kurri area.
White-flowered Wax Plant	*Cynanchum elegans*	All year	Nil	56 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019. 208 person hours systematic transverses in October/November 2020	No suitable habitat present (refer to Appendix A)

Common name	Scientific name	Appropriate survey period (TBDC)	Specific survey requirements (DPIE 2022e)	Survey effort	Comment
Pine Donkey Orchid	*Diuris tricolor*	September-October	Nil	56 person hours of systematic traverses in October 2019 and further 21 hours of systematic traverses completed in October 2021	
Small-flower Grevillea	*Grevillea parviflora* subsp. *parviflora*	All year	Use flowers to identify, as easily confused with *G. humilis*	54 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019. 208 person hours systematic transverses in October/November 2020	Species recorded flowering in subject site at time of survey
Maundia triglochinoides	*Maundia triglochinoides*	November-March	Use fruits to identify, as easily confused with *Triglochin* genus or *Phlidrum*.	Systematic traverses over 4 person hours on 18 February 2021.	
Ozothamnus tesselatus	*Ozothamnus tesselatus*	September-October	Nil	56 person hours of systematic traverses in October 2019.	-
Tall Knotweed	*Persicaria elatior*	December-May	May die off above ground in winter. Can be identified from its leaves without flowers by a skilled botanist	Systematic traverses over 4 person hours in April 2019 and 4 person hours in February 2021.	Marginal habitat present (refer to Appendix A)
Scant Pomaderris	*Pomaderris queenslandica*	All year	Nil	54 person hours of systematic traverses in October 2019 and 36 hours systematic traverses in November 2019.	Marginal habitat present (refer to Appendix A)

Common name	Scientific name	Appropriate survey period (TBDC)	Specific survey requirements (DPIE 2022e)	Survey effort	Comment
Singleton Mint Bush	*Prostanthera cineolifera*	September-October	Nil	54 person hours of systematic traverses in October 2019	No suitable habitat present (refer to Appendix A)
Heath Wrinklewort	*Rutidosis heterogama*	All year	Species flowers opportunistically depending on temperature and rainfall. Use a reference population to identify likely flowering period.	54 person hours of systematic traverses in October 2019 36 hours systematic traverses in November 2019 and 21 hours of systematic traverses completed in October 2021.	Reference population confirmed to be in flower prior to survey
Pterostylis chaetophora	*Pterostylis chaetophora*	September-November	Use flowering material to identify this species	76 person hours of systematic traverses in October/ November 2019. And further 16 hours of systematic traverses completed in October/November 2021	Reference population in North Rothbury known to be in flower on 21 October 2019 also confirmed suitable time for survey in October/November 2021 (pers com BCD). Marginal habitat present within development site.
Zanichellia palustrus	*Zanichellia palustrus*	October- January	Nil	3 hours targeted survey through areas of suitable habitat in October 2019.	Areas of potential habitat substantially degraded.



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Kilometres

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Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Targeted flora surveys
October / November 2019

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Figure 2-2

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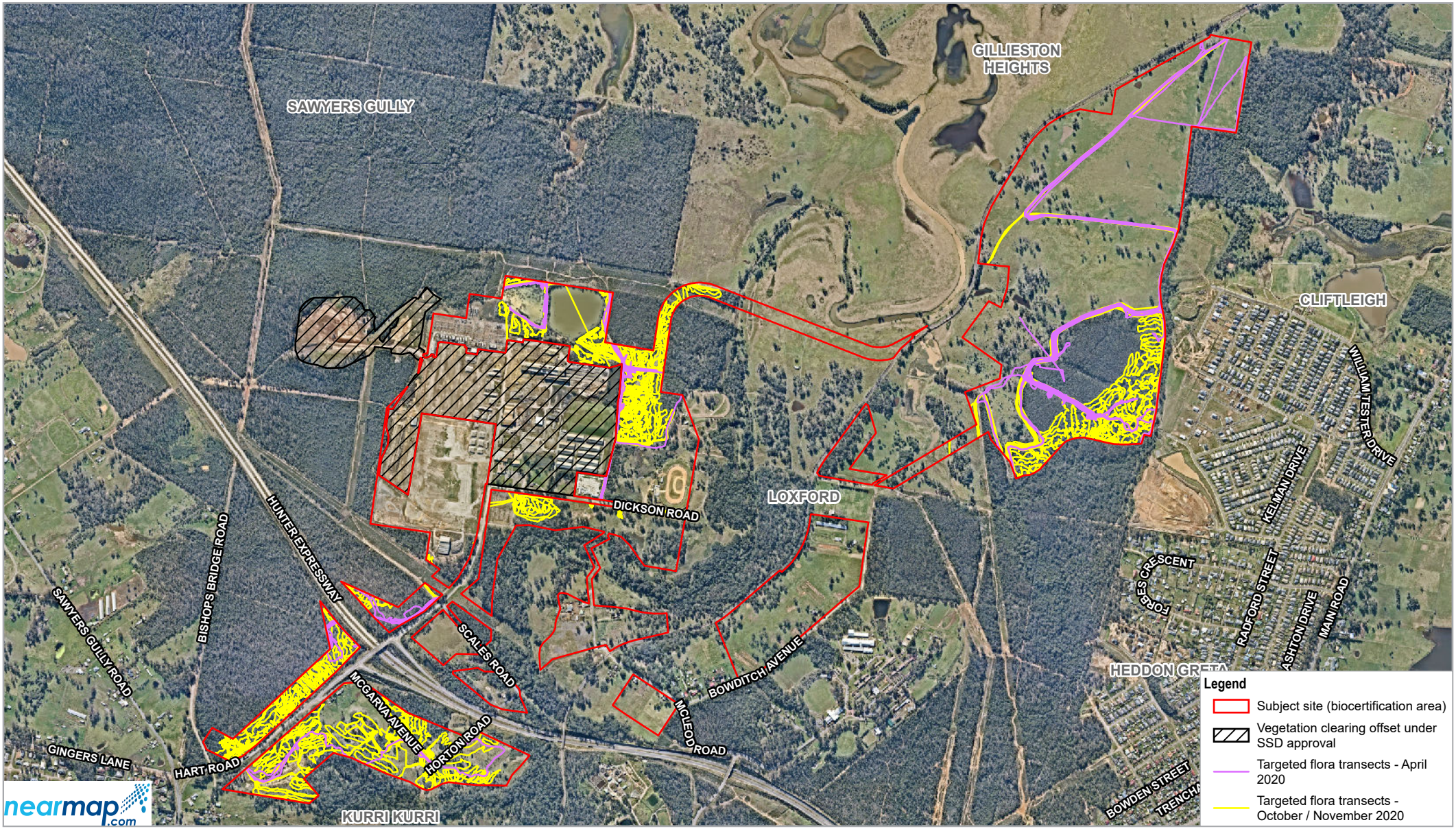

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Targeted flora surveys April / October / November 2020

Figure 2-3

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Kilometres

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Targeted flora surveys February / October / November / December 2021

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Figure 2-4

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Print date: 01 Jun 2022 - 14:32

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

2.3.6 Terrestrial fauna surveys

Fauna habitat assessment

Fauna habitat assessments were undertaken throughout the subject site during all survey periods, including observation of potential shelter, basking, roosting, nesting and/or foraging sites. Specific habitat features and resources such as water bodies, food trees, the density of understorey vegetation, the composition of ground cover, the soil type, presence of hollow-bearing trees, leaf litter and ground debris were noted.

Indicative habitat criteria for targeted threatened species (i.e. those determined as having the potential to occur within the subject site following the desktop review) were identified prior to fieldwork. Habitat criteria were based on information provided in DPIE and DAWE threatened species profiles, field guides, and the knowledge and experience of GHD field ecologists.

Habitat assessments included searches for resources of potential value to threatened fauna including:

- Hollow bearing trees.
- Trees with bird nests or other potential fauna roosts.
- Rock outcrops or overhangs providing potential shelter sites for fauna.
- Burrows, dens and warrens.
- Distinctive scats or latrine sites, owl white-wash and regurgitated pellets under roost sites.
- Tracks or animal remains.
- Waterbodies.
- Evidence of activity such as feeding scars, scratches and diggings.
- Specific food trees and evidence of foraging (chewed *Allocasuarina* cones indicative of Glossy Black-cockatoos).

The locations and qualitative descriptions of significant habitat features were captured using the collector for ArcGIS mapping application.

Opportunistic and incidental observations of fauna species were recorded at all times during field surveys. This included a conscious focus on suitable areas of habitat during flora surveys, for instance fallen timber was scanned and/or turned for reptiles and mature trees and stags were scanned for roosting birds.

Targeted surveys

Under the BAM, targeted surveys are not required for threatened fauna species that can be reliably predicted to occur at the subject site based on habitat surrogates (predicted / ecosystem credit species). These species are assumed to be present within certain PCTs, given a certain patch size and condition. Nonetheless these species and their habitats were recorded along with fauna that are not listed as threatened, as a general guide to the condition and biodiversity value of the subject site.

Targeted, seasonal surveys are required for candidate threatened species entities i.e. species credit species and specific habitat resources such as nesting or roosting habitat for dual credit species. Candidate species credit entities that have a moderate potential to occur at the subject site) and that were targeted during these surveys are listed in refer to Appendix A.

Targeted threatened fauna surveys were conducted between:

- 26-31 August 2019
- 25-28 November 2020
- 24-28 February 2020
- 6-7 October 2021
- 15 October 2021
- 22 October 2021
- 24-15 November 2021
- 21 November 2021
- 6-8 December 2021.

According to the TBDC, these are suitable times of the year to survey all identified candidate threatened fauna species. Further detail regarding candidate fauna species targeted during surveys is provided in Section 5.1.

Targeted fauna survey techniques and effort conducted in the subject site are summarised in Table 2-7. Survey effort was stratified across the entire subject site, noting that fauna species are mobile and may rely upon habitat resources in the subject site even if not directly observed at the subject site. Survey locations are shown on Figure 2-5. All fauna observations were recorded on pro forma field data sheets.

Table 2-6 Candidate species credit entities targeted during surveys

Common name	Scientific name	Appropriate survey period	Survey Timing	Survey Method/s
Bush Stone-curlew	*Burhinus grallarius*	All year	November 2019	Spotlighting
Glossy Black-Cockatoo (breeding)	*Calyptorhynchus lathami*	January - September	August 2019 February 2020	Daytime traverse Diurnal bird surveys
Gang-gang Cockatoo	*Callocephalon fimbriatum*	October - January	November 2019	Diurnal bird surveys Nest surveys Opportunistic observations
Eastern Pygmy-possum	*Cercartetus nanus*	October-March	November 2019	Elliot trapping Remote Cameras Spotlighting
Large-eared Pied Bat	*Chalinolobus dwyeri*	November - January	November 2019	Anabat detectors Harp Traps Searches for breeding habitat
Striped Legless Lizard	*Delma impar*	September-December	November 2019	Pit-fall traps
Little Eagle	*Hieraaetus morphnoides*	August-October	August 2019	Diurnal bird surveys Opportunistic observations Active searches for scats and signs
Pale-headed Snake	*Hoplocephalus bitorquatus*	November - March	November 2019, February 2020	Spotlighting
Green and Golden Bell Frog	*Litoria aurea*	November - March	February 2020 November 2021 December 2021	Spotlighting Call playback Active amphibian searches

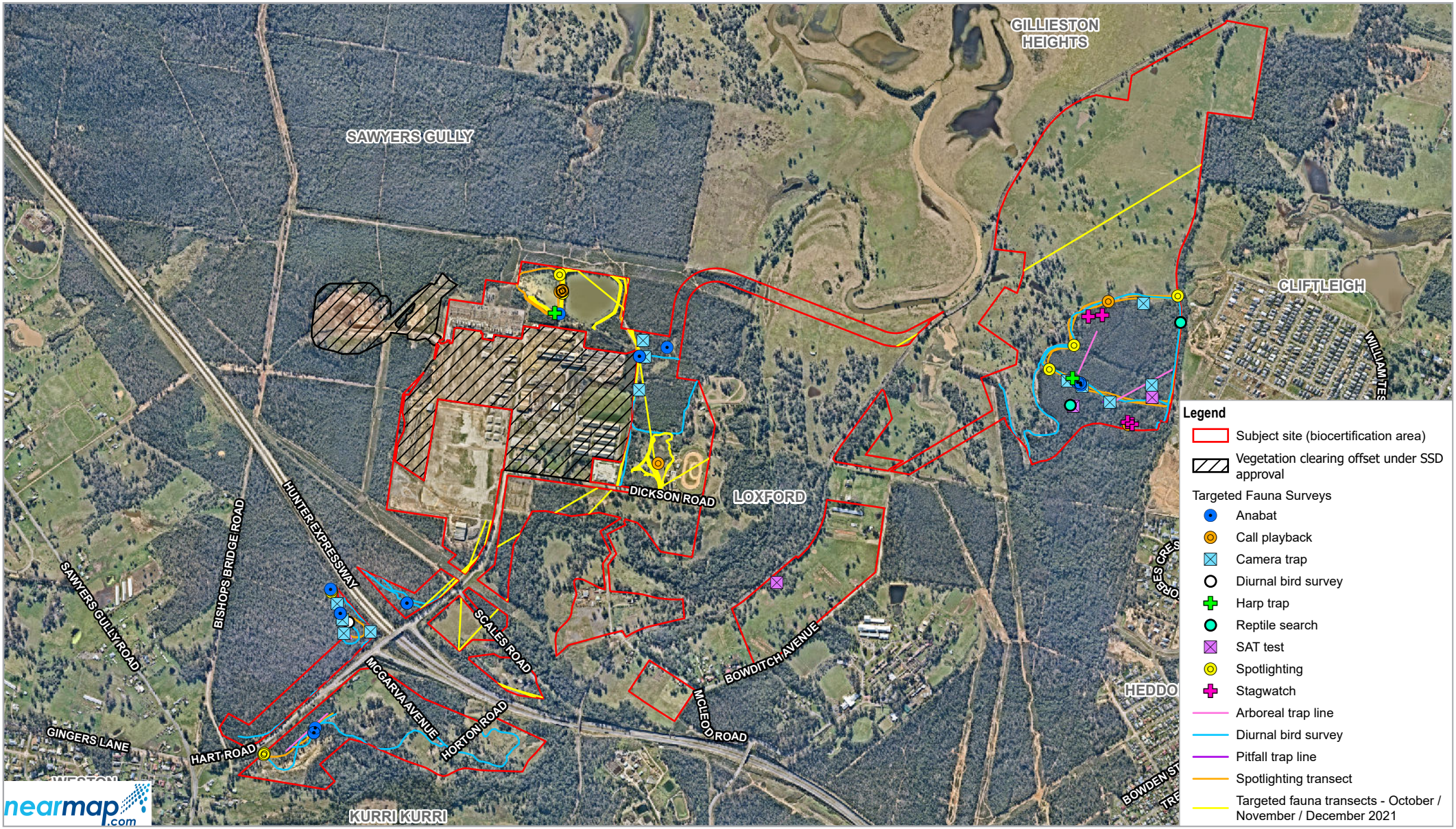
Common name	Scientific name	Appropriate survey period	Survey Timing	Survey Method/s
Square-tailed Kite (breeding)	*Lophoictinia isura*	September-January	November 2019 Oct 2021 Nov 2021 Dec 2021	Active searches for scats and signs Active searches for nests Diurnal bird surveys
Little Bentwing-bat (breeding)	*Miniopterus australis*	December to February	February 2020	Anabat detectors Harp Traps Searches for breeding habitat
Large Bent-winged Bat (breeding)	*Miniopterus orianae oceanensis*	December to February	February 2020	Anabat detectors Harp Traps Searches for breeding habitat
Southern Myotis	*Myotis macropus*	October - March	February 2020	Anabat detectors Harp Traps
White-bellied Sea-Eagle (breeding)	*Haliaeetus leucogaster*	July - December	August 2019	Active searches for scats and signs Diurnal bird surveys
Barking Owl (breeding)	*Ninox connivens*	May - December	August 2019	Spotlighting Stag- watching of potential hollows Call playback Active searches for whitewash and pellets Hollow bearing tree assessment
Powerful Owl (breeding)	*Ninox strenua*	May – August	August 2019	Spotlighting Stag- watching of potential hollows Call playback Active searches for whitewash and pellets Hollow bearing tree assessment
Greater Glider	*Petauroides volans*	All year	February 2020	Elliot trapping Spotlighting
Squirrel Glider	*Petaurus norfolcensis*	All year	February 2020	Elliot trapping Spotlighting Call playback
Brush-tailed Phascogale	*Phascogale tapoatafa*	December - June	February 2020	Elliot trapping Spotlighting
Koala (important habitat)	*Phascolarctos cinereus*	All year	November 2019 February 2020	Spotlighting Call playback Active searches for scats
Common Planigale	*Planigale maculata*	All year	November 2020	Spotlighting Camera Traps Pit Fall Traps
Masked Owl (breeding)	*Tyto novaehollandiae*	May – August	August 2019	Spotlighting Stag- watching of potential hollows Call playback Active searches for whitewash and pellets Hollow bearing tree assessment

Common name	Scientific name	Appropriate survey period	Survey Timing	Survey Method/s
Mahony's Toadlet	*Uperoleia mahonyi*	October-March	February 2020 November 2021 December 2021	Spotlighting Active searches for amphibians

Table 2-7 Targeted fauna survey techniques and effort

Survey technique	Survey effort
Arboreal trapping	Arboreal trapping was conducted between 24 and 28 February 2020. A total of five transects were established. Transects were spread throughout the subject site to sample the various vegetation communities. Transects consisted of 10 arboreal Elliot B sized traps over 4 day/nights, totalling 200 trap nights. Arboreal traps were used to target Squirrel Glider, Greater Glider, Brushed-tailed Phascogale and Eastern-Pygmy Possum.
Pitfall trapping	Four pitfall trapping transects were installed on the 25-29 November 2019. Each transect contained 6 traps that were open for 4 nights totalling 96 trap nights. Pitfall traps were used to target Common planigale and Striped legless lizard.
Camera trapping	Ten baited motion activated camera traps were set between 25-28 November 2019 and three camera traps were set up between 24-28 February 2020, totalling 52 trap nights. These surveys targeted Brush-tailed Phascogale, Squirrel Glider, Pygmy Possum and Brush-tailed Rock-wallaby.
Call playback	Owl call playback was conducted at five locations for: Barking Owl, Powerful Owl and Masked Owl over three consecutive nights between 27 and 29 August 2019. A total of five person hours of owl call playback was completed. In addition call playback surveys targeting Green and Golden Bell Frog were conducted on 26 November 2019, between 24 and 28 February 2020, between 24-26 November 2021 and 7-8 December 2021. A total of seven hours of amphibian call playback was undertaken.
Spotlight survey	Spotlighting surveys were conducted between 26 and 27 November 2019 along two walked transects. The November surveys totalled four person hours. Additional spotlight surveys were completed at seven locations between 24 and 27 February 2020, 24-25 November 2021 and 7-8 December 2021. These spotlight surveys were conducted over six nights With total survey effort of 28 person hours.
Diurnal bird survey	Diurnal bird surveys conducted over three days between 25 -28 November 2020 for a total of three person hours. A list of opportunistic bird sightings was recorded during the November 2019 and February 2020 fauna surveys while undertaking other fieldwork components. An additional five days of diurnal bird surveys and habitat assessments were completed on 6, 15 and 22 October 2021, 21 November, and 6 Dec 2021 by Dr Ross Crates. These surveys included 74 bird surveys and habitat assessments across the development footprint. Repeat surveys were conducted at 20 sites within the subject site where blossom was found to be present. Survey followed the methodology of the National Regent Honeyeater and Swift Parrot Monitoring Programs (NRHMP and NSPMP (Crates et al. 2017)
Hollow-bearing tree and nest surveys	Systematic surveys for hollow bearing trees suitable for forest owls and glossy black cockatoos were conducted on 14, 15 and 20 August 2019.
Stag watching	Stag watching was conducted between 26-29 August 2019. Ten stags were watched in total over of a period of 20 person hours.
Ultrasonic recording	A total of two Anabat express detectors were placed in flyways and set to record whole nights of data between 25-28 November 2019 and 24-28 February 2020. Eight sites were surveyed totalling 18 nights of Anabat recording.
Harp trapping	Two harp traps were placed in flyways, one near a large water body and the other along a track in dry Sclerophyll forests. Harp traps were in place between 24-28 February 2020, totalling eight trap nights.

Survey technique	Survey effort
Daytime traverses Active reptile/amphibian searches Active searches for scats and other signs	Active searches of woody debris, loose bark and other ground litter were conducted throughout the subject site targeting threatened frogs and reptiles a total of 9 person hours was completed undertaking these searches.



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Kilometres

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Grid: GDA 1994 MGA Zone 56

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Fauna survey effort

Figure 2-5

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Print date: 01 Jun 2022 - 14:32

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

2.2.6 Aquatic habitat assessment

A rapid aquatic habitat assessment was undertaken along Swamp Creek, a small section of which exists in the subject site. The character and condition of this area was noted.

An assessment of potential habitat for threatened aquatic species was based on the habitat assessments undertaken during the field survey and published habitat preferences of threatened biota. Key fish habitat maps for the area (DPI 2007) were reviewed and key fish habitat was identified according to the following classifications as detailed in (DPI 2013):

- Type 1 – highly sensitive fish habitat (includes freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or three metres in length, or native aquatic plants; known or expected protected or threatened fish habitat; and areas of critical habitat).
- Type 2 – moderately sensitive key fish habitat (freshwater habitats other than those defined in Type 1).
- Type 3 – minimally sensitive key fish habitat (ephemeral aquatic habitat not supporting native aquatic or wetland vegetation).
- Not key fish habitat (includes first and second order streams on gaining streams).

2.3.7 Assessment of River-flat Eucalypt Forest on coastal floodplains of southern NSW and eastern Victoria CEEC

Initial vegetation assessments completed for the subject site indicated that several the PCTs present within the site had potential to align with the threatened community listed under the EPBC Act as River-flat Eucalypt Forest on coastal floodplains of southern NSW and eastern Victoria. An assessment was therefore completed to determine the extent of this critically endangered vegetation community within the site.

This assessment included a review of floristic data for all plots collected as part of the vegetation integrity surveys of the site followed by survey of an additional 18 20 X 20-meter quadrats within areas that contained canopy species characteristic of this community. This assessment was completed over two days from the 17-18 November 2021.

The following data was reviewed and collected for each quadrat to assist with determining whether the key diagnostic characteristics and minimum condition thresholds set out in the conservation advice for this community were present within any vegetation patches within the site:

- Floristic composition including species richness and perennial understory cover
- Number of large trees
- Review of flooding and topographic data
- Assessment of soil type
- Assessment of crown cover
- Assessment of patch size

2.4 Survey conditions

The majority of field surveys completed for this BCAR were undertaken in August, November and December 2019 and February 2020. The Kurri Kurri region experienced drought conditions during the August and November 2019 surveys which likely impacted on the presence and detection of flora and fauna species at the subject site. It is possible that many populations are likely to have been suffering drought stress and that population numbers are likely to have reduced. This limitation was addressed through the review of numerous other detailed surveys that have been completed across the site during more favourable conditions as well as through undertaking supplementary surveys in October November and December 2021 following extended periods of rain.

Other than dry conditions during the 2019/2020 survey periods, weather conditions were otherwise generally good for the detection of the species targeted. The wind conditions during diurnal bird surveys and call playback surveys were low to none and so would not have hampered the detection of bird species or impacted Anabat recordings.

The Kurri Kurri area received approximately 47 mm of rainfall the week prior to the 24 – 28 February 2020 fauna surveys. In addition, there was a further 9 mm of rain recorded during the February surveys. Although the site was still considerably dry as a result of long-term drought, these rainfall events resulted in water pooling across the site making conditions suitable to complete frog surveys within the site. As confirmed by presence of active calling frog species frog.

Supplementary frog surveys were also completed on 24-25 November 2021 and 7 and 8 December 2021. These surveys were proceeded with 43.4 mm of rainfall in the three days prior to the November surveys and 7 mm prior and during the December surveys. Numerous species of frog were calling within the subject site at the time of these surveys and Green and Golden Bell Frogs were also confirmed to be calling at Kooragang Island (nearest known reference population) during the survey period (pers com Allen Cullen, Newcastle University).

Bureau of Meteorology (BOM) records for the survey periods are outlined in Table 2-8. These records were taken at Maitland Airport weather station (station 061428) located approximately 10 kilometres east of the subject site (BOM 2020b).

Table 2-8 Daily weather observations during the survey period (BOM, 2020b)

Date	Min temp (Deg Celsius)	Max temp (Deg Celsius)	Rainfall (mm)	Onsite weather observations
26-31 August 2019 (fauna surveys)				
26/8/2019	10.7	21.4	0	Light wind
27/8/2019	6.5	21.2	0.2	Clear, cool
28/8/2019	6.9	23.0	0.2	Clear, cool
29/8/2019	5.5	18.9	0	Clear, cool
30/8/2019	10.0	14.9	2.2	Clear, cool
31/8/2019	9.9	16.3	43.8	Moderate rain
28-31 October 2019 (targeted flora surveys),				
28/10/2019	8.4	25.5	0	Warm, clear
29/10/2019	10.3	29.4	0	Warm, clear
30/10/2019	12.1	32.3	0	Warm, clear
31/10/2019	11.9	32.7	0	Warm, clear
13-14 November 2019 (targeted flora surveys),				
13/11/2019	11.2	27.4	0	Warm, clear
14/11/2019	6.6	29.9	0	Warm, clear
25-29 November 2019 (fauna surveys)				
25/11/2019	17.8	35.4	0	Hot, dry
26/11/2019	14.0	37.5	0.2	Hot, dry
27/11/2019	10.0	27.1	0	Hot, dry
28/11/2019	8.8	32.0	0	Hot, dry
29/11/2019	16.7	36.4	0	Hot, dry
24- 28 February 2020 (fauna surveys)				
24/2/2020	18.8	26.4	0	Clear, Warm
25/2/2020	17.9	30.2	8.2	Light rain
26/2/2020	18.6	32.5	0.2	Warm, light wind
27/2/2020	19.3	26.3	0.2	Calm
28/2/2020	16.3	27.8	0.2	Calm
5-7 October 2020 (targeted flora surveys)				
5/10/2020	11.1	30.8	0.2	Light winds, warm
6/10/2020	13.5	23.6	0	Warm, calm
7/10/2020	16.5	24.9	0	Warm, calm
9-17 November 2020 (targeted flora surveys)				
9/11/2020	No temperature data available	No temperature data available	0	Walm, calm
10/11/2020	7.8	24.6	0	Walm, calm
11/11/2020	9.7	29.1	0	Walm, calm
12/11/2020	12.6	32.0	2.4	Hot, windy
13/11/2020	18.0	28.9	9.2	Walm, showers
16/11/2020	14.3	37.6	0	Hot, windy
17/11/2020	19.0	24.2	15.6	Walm, calm
18 February 2021 (targeted flora survey)				
18/2/2021	16.8	26.0	0.6	Walm, light wind
24-25 November 2021(frog surveys)				
24/11/2021	16.0	23.5	6.4	Light wind
25/11/2021	17.6	29.8	2.0	Calm
7-8 December 2021 (frog surveys)				
07/12/2021	16.7	29.1	5.2	Warm, light wind
08/12/2021	17.0	25.7	1.2	Warm, light wind

2.5 BAM calculations

The proposal was assessed according to the methodology presented in the BAM (DPIE 2020a). The BAM calculator is a software application that is used to apply the BAM. Data is entered into the BAM calculator based on information collected in the desktop assessment, site surveys and from using GIS mapping software.

The BAM calculations were performed by Arien Quin (accredited BAM assessor number BAAS 17098). Using calculator version 1.4.0.00 (DPIE 2021) and reviewed by Ben Harrington (BAAS 17023). The data and assumptions used to perform the BAM credit calculations are summarised in Section 8.

2.6 Geographical Information System (GIS) analysis

GIS was used to:

- Plot the subject site on a high-resolution aerial photo base and to map vegetation zones, survey effort, habitat resources and biodiversity values across the subject site.
- Plot a 1500 metre buffer area surrounding subject site.
- Calculate the extent of native vegetation to be impacted, patch size and cover in the buffer area.
- Confirm the relevant IBRA bioregion, IBRA subregion and Mitchell Landscape for the site.

Native vegetation cover, extent and connectivity were assessed using aerial photography. Aerial photo interpretation was used to identify and record distinct vegetation patches, determine the broad condition state of vegetation types and the location and extent of vegetated habitat corridors.

3. Landscape Context

The BAM requires the assessment of landscape features to help describe the biodiversity values of the subject site and assess the impacts of the proposal. Landscape features are discussed in relation to a buffer area of 1,500 metres surrounding the boundary of the subject site. Further details regarding landscape features are provided below.

3.1 Location

The subject site is located off Hart Road, Cessnock Road and Bowdich Avenue in the suburb of Loxford, NSW It lies approximately 30 km northwest of Newcastle Central Business District within the Cessnock City Council LGA. The Hunter Expressway runs beneath Hart Road and is located adjacent to the south-western extent of the site (refer to Figure 1-1). The site is currently zoned RU2 Rural Landscape and E2 Environmental Conservation and is dispersed across 82 Lots and a total of 35 DP allotments (refer to Appendix B for list of Lots included within the proposed biocertification area).

Swamp Creek is located adjacent to the subject site where it drains in a northerly direction into a large wetland waterbody known as Wentworth Swamp (refer to Figure 1-1) A small section of the creek also intersects with the subject site near the proposed rail spur. Additional drainage lines flow into this wetland area, including Black Waterholes Creek to the north-west of the subject site and Bishops Creek to the north.

Much of the land to the northeast and south of the subject site has been cleared for agricultural and residential development. To the northwest, the site adjoins a large vegetation corridor that extends through to Werakata National Park to the west of the subject site. Connectivity to this park has been impacted by the construction of the Hunter Expressway

3.2 Existing land use

The north-eastern portion of the subject site comprises large areas that have been historically cleared and utilised for cattle grazing. This land forms part of an agricultural property called Wangara that has been predominantly cleared and subject to long term cattle grazing. The north-eastern portion of the site contains scattered remnants of disturbed woodland as well as several patches of intact or relatively intact woodland. There are a small number of farm dams within the cleared agricultural lands as well as a number of constructed waterbodies associated with stormwater collection surrounding the former smelter site.

The current land uses across the site include administration activities associated with the smelter site and cattle grazing across a large portion of the buffer land located in the northeast of the subject site. There is also a number of tracks and trails with evidence of informal recreational use including motorbike riding and walking. In the north, within patches of native vegetation, a network of overgrown and unmaintained access trails occur.

3.3 Climate

The site has a warm temperate climate. Based on data from the Maitland Airport weather station (station 061428) located approximately 10 kilometres north of the subject site, the site has a mean annual rainfall of 720 mm, falling predominantly in late summer to early autumn. The site can reach up to mean monthly maximum temperatures of 30.5 degrees and down to mean monthly minimum temperature of 4 degrees Celsius (BOM 2020a).

3.4 Landscape features

Landscape features relevant to this assessment are summarised in Table 3-1 and shown on Figure 3-1 as required by Section 3.1 of the BAM.

Table 3-1 Summary of landscape features present within the subject site

Landscape feature	Subject site
Method applied for site context components	Site-based
Interim Biogeographic regionalisation of Australia (IBRA) bioregion	Sydney Basin
IBRA subregion	Hunter
Mitchell landscapes	Newcastle Coastal Ramp
Percentage native vegetation extent within buffer area	42 percent (1283 ha out of 3033 ha buffer area)
Rivers, streams and estuaries	The subject site is located within the Wallis Creek catchment. Wallis creek flows into the Hunter River approximately 10 km to the north of the subject site between East and West Maitland. Low undulating hills to the northwest and south of the subject site grade into floodplains that surround Wentworth Swamp. This swamp forms a large ephemeral waterbody that is located adjacent to the subject site. The largest hydrological feature in the subject site is Swamp Creek (refer to Figure 1-1). This water way flows adjacent to the subject site and crosses through the subject site at one narrow point where a proposed rail spur would be constructed to the east of the smelter site. A number of smaller first and/or second order ephemeral waterways that flow into Swamp Creek occur within the subject site. Swamp Creek drains into the adjacent Wentworth Swamp and ultimately to the Hunter River to the north of the site. Swamp Creek is not identified by DPI as key fish habitat (DPI 2007, DPI 2022).
Wetlands	There are no natural wetlands within the subject site although there are a number of constructed ponds surrounding the smelter site that contain wetland vegetation. A large ephemeral wetland known as Wentworth Swamp occurs to the north-west of the subject site (refer to Figure 1-1). This large wetland basin occurs on the floodplains of Swamp Creek and is recognised as a regionally significant wetland. The Hunter estuary wetlands that are identified as nationally important wetlands are located approximately 10 km to the south-east of the subject site. These wetlands would not be impacted by the proposal.
Connectivity features	The subject site joins onto a larger vegetation corridor that extends through to Werakata National Park to the west of the subject site. Although connectivity along this corridor has been impacted by the construction of the Hunter Expressway. Vegetation connectivity is largely restricted by agricultural and residential development to the south-west and north of the subject site. Cessnock Road and cleared land used for agriculture that has been identified for residential housing is located to the east of the subject site. North of the site is cleared land and residential development associated with the Gillieston Grove subdivision. South of the subject site is a patch of remnant native vegetation that is connected by a narrow-vegetated corridor to a larger patch of vegetation that surrounds the Kurri Kurri TAFE.
Areas of geological significance or soil hazard features	Areas of the subject site have a high probability for containing Acid Sulfate Soils, occurring 2-4 m below ground surface (DPIE, 1998; Naylor et al., 1998). There are no karst, caves, crevices, cliffs or other areas of geological significance located within the subject site.
Areas of outstanding biodiversity value	No areas identified under the BC Act as being of outstanding biodiversity value have been mapped in the subject site.
Other landscape features	Nil

3.5 Bioregion and IBRA subregion

The subject site occurs within the Hunter IBRA (Interim Biogeographic Regionalisation for Australia) subregion of the Sydney Basin IBRA bioregion (refer to Figure 3-1). The Sydney Basin IBRA bioregion lies on the central east coast of NSW and covers an area of about 3,624,008 ha which includes about 4.53 per cent of NSW. The region extends north from Batemans Bay to Nelson Bay and west to Mudgee and includes a significant proportion of the catchments of the Hawkesbury-Nepean, Hunter and Shoalhaven river systems.

3.6 Hydrology and Topography

The topography of the subject site consists of low undulating hills in the northwest and south of the subject site that grade into floodplains that surround Wentworth Swamp. This swamp forms a large ephemeral waterbody that is located adjacent to the subject site, part of which is situated within the north-eastern portion of the Hydro buffer land.

The subject site is located within the Wallis Creek catchment. Wallis creek flows into the Hunter River approximately 10 km to the north of the subject site between East and West Maitland.

Swamp Creek, which is a major tributary of Wallis creek is an ephemeral waterway that runs adjacent to and is intersected by the subject site at one point east of the smelter site. Swamp Creek consists of an intermittently flowing creek that retains water in a series of disconnected pools. The waterway flows in a north easterly direction into Wentworth Swamp and then into Wallis Creek further north (see Figure 1-1). Within the subject site there are also several smaller ephemeral drainage lines that feed into Swamp Creek.

Swamp Creek is a third order stream that is not mapped as Key Fish Habitat (DPI 2007, DPIE 2022).

3.7 NSW landscape region (Mitchell Landscapes)

The majority of the subject site is located within the Newcastle Coastal Ramp Mitchell Landscape within the Sydney Basin Bioregion (DECC 2008a) which is described as follows:

"Undulating lowlands and low to steep hills on complex patterns of faulted and gently folded Carboniferous conglomerate, lithic sandstone, felspathic sandstone, and mudstone, general elevation 50 to 275 m, local relief 40 to 150 m. Stony red texture-contrast soils on steep slopes, yellow and brown texture-contrast soils on lower slopes and deep dark clay loams along streams. Woodland of spotted gum (Corymbia maculata), forest red gum (Eucalyptus tereticornis), red ironbark (Eucalyptus sideroxylon), white mahogany (Eucalyptus acmenoides), large-fruited grey gum (Eucalyptus canaliculata), with sub-tropical rainforest elements in sheltered gullies. Similar eucalypts with forest oak (Allocasuarina torulosa) and grasses on lower slopes, merging to forest of smooth-barked apple (Angophora costata), red bloodwood (Corymbia gummifera), blackbutt (Eucalyptus pilularis) with bracken (Pteridium esculentum) and grasses nearer the coast." (DECC, 2002).

A smaller area of subject site is also located within the Lower Hunter Channels and Floodplains Mitchell Landscape (DECC 2008b), which is described as follows:

"Channel, floodplain, and estuarine swamps on Quaternary alluvial estuarine sediments of the Hunter River estuary tract, general elevation 0 to 30 m, local relief <10 m. Harsh brown texture-contrast soils on the third terrace, gradational sandy loam on the second terrace and loamy sand on the low terrace and floodplain. Acid peaty silty sand, silt and clay in swamps, uniform quartz sand with podsol development on marginal coastal dunes and sand sheets. Open grassland with scattered yellow box (Eucalyptus melliodora), forest red gum (Eucalyptus tereticornis), rough-barked apple (Angophora floribunda) on higher fluvial landscapes. Freshwater and brackish swamps with open water, aquatic plants and fringe woodlands of broad-leaved paperbark (Melaleuca quinquenervia), swamp mahogany (Eucalyptus robusta), river oak (Casuarina cunninghamiana), swamp oak (Casuarina glauca), common reed (Phragmites australis), river mangrove (Aegiceras corniculatum), grey mangrove (Avicennia marina) and extensive saltmarsh in tidal areas." (DECC, 2002).

The DECC (2002) description of the geology and geomorphology at the subject site was confirmed by GHD ecologists during the site surveys to be consistent with the Newcastle Coastal Ramp Mitchell Landscape. The DECC (2002) description of vegetation for Newcastle Coastal Ramp Mitchell Landscape broadly matches the survey results presented in Section 4.

Based on the vegetation, landforms and soils observed during the site surveys the Newcastle Coastal Ramp and the Lower Hunter Channels and Floodplains Mitchell Landscapes are a good fit for the biophysical environment at the subject site.

3.8 Soils and geology

3.8.1 Soil landscapes

Four soil landscapes have been mapped within the subject site (DPIE 2022d), Neith (S1560nh), Bolwarra Heights (9232bh), Bolwarra Heights variant a (9232bha) and Hunter (S1560hu). Descriptions of these soil landscapes are provided below.

Bolwarra Heights (9232bh)

The Bolwarra Heights soil landscape occurs on rolling low hills on Permian sediments in the East Maitland Hills region. Within the subject site these soils occur in the north-east on low hills adjacent to the floodplains of Wentworth Swamp. The soil landscape is predominantly associated with the geology of the Branxton Formation of the Maitland Group that is characterised by sandstone, siltstone, conglomerate and erratics. It also includes smaller areas of Muree Sandstone which are characterised by sandstone, conglomerate and siltstone, Greta Coal measures which include lenticular conglomerates, sandstone, shale spitting coal seams and Farley Formation which is associated with sandstone, mudstone, siltstone, shale and erratics (Kovak and Lawrie 1991).

Soils include moderately deep (<150 cm) well drained Yellow Podzolic Soils, Red Podzolic Soils and Brown Podzolic soils with some moderately deep, well drained Lithosols on crests and imperfectly drained yellow Sloths on lower slopes (Kovak and Lawrie 1991).

Bolwarra Heights variant a (9232bha)

This variant has similar landscape features, geology and soil characteristics to the Bolwarra Heights soil landscape however soils are shallow (<55 cm) (Kovak and Lawrie 1991).

Neith (S1560nh)

This soil landscape occurs on undulating rises and swamps with elevations of 40-80 m. Local relief is typically under 30 m. Within the subject site these soils are mapped surrounding the smelter site and extending into vegetation within the adjacent buffer zone. Geology is associated with the Branxton Formation which is characterised by siltstone, pebbly sandstone and minor coal parent rock and alluvium derived from the parent rock.

Soils include Grey Solodic soils comprised of a brown clayey sand and loamy sand topsoil over an olive grey sandy clay, massive, orange and grey mottle subsoil.

These soils have a high erodibility and generally low fertility (Kovak and Lawrie 1991).

Hunter (S1560hu)

The Hunter soil landscape covers the floodplains and river terraces of the Hunter River and its tributaries. The main soils are all formed from Quaternary alluvium and include Brown Clays and Black Earths on prior stream channels and on tributary flats. Soils are characterised by loam and sand alluvial soils that occur on levees and flats adjacent to present river channels, Red Podzolic soils and Lateritic Podzolic soils which are found on old terraces with Non-calcic Brown soils and Yellow Solodic Soils in some drainage lines (Kovak and Lawrie 1991).

3.8.2 Areas of geological significance

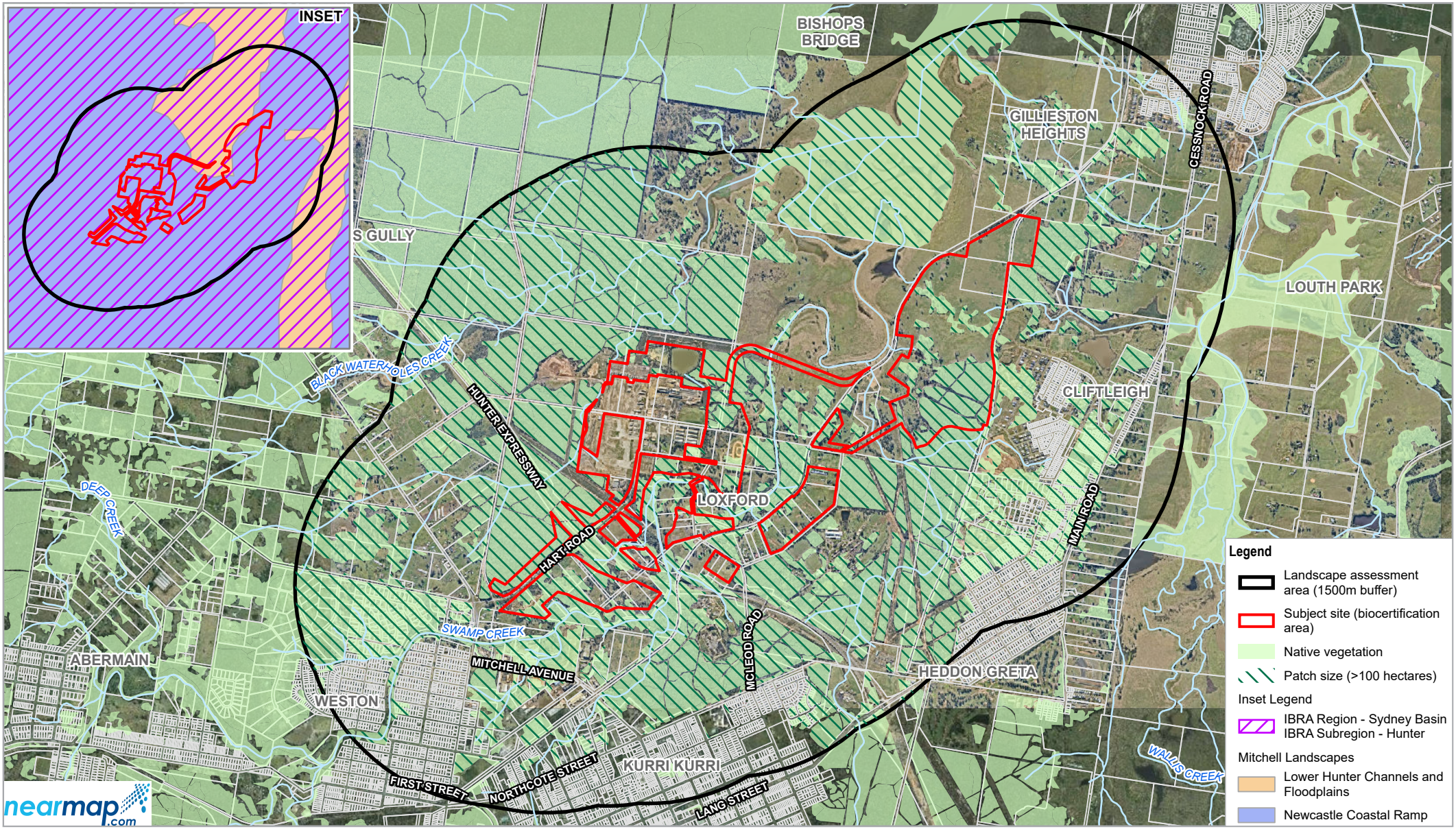
There are no karst, caves, crevices, cliffs or other areas of geological significance located within or adjacent to the subject site.

3.8.3 Soil hazards

Soil landscapes reports pertaining to the subject site and surrounding buffer area indicate that soils associated with the landscape have a minor to severe potential for erosion. The areas of severe potential for erosion are associated with the grey solodic soils common in areas of undulating low rises and swamps. The minor potential for erosion, however, is associated with the well-drained conglomerate soils which can be characteristic of tall-open forests (DPIE 2022d). Development within the subject site has the potential to result in increased sedimentation and erosion through soil disturbance and construction activities sue to the underlying soil landscapes within the subject site.

The subject site is also located within a mine subsidence district, with occasional pockets of the site being subject to apparent mine subsidence (DFSI - Spatial Services, 2012). This has led to erosion of some areas over time, where water has naturally collected and caused increased surface runoff and subsequent soil erosion. These occurrences occur on a marginal scale and does not appear to be substantially degrading native vegetation or habitat.

There is a high probability that Acid Sulphate Soils occur within small areas within the subject site (DPIE, 1998; Naylor et al., 1998). These occurrences have been estimated to occur from 2-4 m below ground surface. Areas of low probability also occur within the subject site. Despite this, the majority of the subject is considered to have no known occurrence of acid sulfate soils.



Paper Size ISO A4

0 0.3 0.6 0.9 1.2

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

N

GHD

Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Landscape Assessment

Figure 3-1

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Print date: 01 Jun 2022 - 14:31

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017; DSEWPaC: IBRA Bioregions, 2013; DECCW: Mitchell landscapes, 2008;public_NSW_Imagery: © Department of Customer Service 2020. Created by: fmackay

3.9 Site Context

3.9.1 Native vegetation cover

Native vegetation cover (woody and non-woody) was assessed on the subject site and within a 1500 metre buffer area surrounding the outside edge of the boundary of the site. Aerial photography was examined at scales between 1:2000 and 1:4000. The percent native vegetation cover within 1,500 metre buffer area was assessed to be 42 percent and includes (see Table 4-3):

- Remnant mapped native vegetation types (including wetland vegetation).
- Planted native vegetation types.
- Areas mapped as canopy only.

Areas that were excluded include:

- Cleared areas.
- Non-native vegetation.
- Dams, ponds and other waterbodies.
- Buildings.
- Non-native plantings.

The identification of native vegetation in the buffer areas was based on review of the Lower Hunter Vegetation Mapping, 2013. VIS_4513 (DPIE 2017) in combination with aerial photograph interpretation and ground-truthing during field surveys.

Table 3-2 Native vegetation cover

Native vegetation cover unit	1500 m buffer area
Total assessment area	3033 ha (nearest whole number)
Area of native vegetation cover (woody and non-woody)	1283 ha (nearest whole number)
Percentage native vegetation cover	42 percent
Cover class	30-70 percent

3.9.2 Patch size

Patch size is defined under the BAM (DPIE 2020a) as an area of native vegetation that:

- Occurs on the development site or biodiversity stewardship site (i.e. subject site).
- Includes native vegetation that has a gap of less than 100 metres from the next area of native vegetation (or ≤ 30 metres for non-woody ecosystems).

Patch size may extend into adjoining land that is not part of a development site or a biodiversity stewardship site. Patch size area is assigned to each vegetation zone as a class, being < 5 ha, 5-<25 ha, 25-<100 ha or ≥ 100 ha.

Native vegetation at the subject site is connected to a much larger patch that extends to the north and north-west of the site. The total size of this patch within the 1,500 m buffer area surrounding the subject site is about 1251 ha. Vegetation in the buffer area is largely associated with the land that formed part of the 'buffer lands' for the former Hydro Aluminium smelter site (see Figure 3-1). The overall patch size polygon includes additional areas of connected intact native vegetation, however for the purposes of this assessment, the total patch size has not been calculated outside of the buffer area, given the highest class was already reached within the buffer area. Therefore 101 ha was entered as the patch size for each of the vegetation zones in the BAM calculator.

3.9.3 Connectivity features

Connectivity is the capacity within the landscape to facilitate the movement of species via habitat linkages. Different species and faunal groups have different connectivity requirements. For example the movement of amphibians is typically restricted to waterbodies such as rivers, creeks and ponds, however some species such as the Green and Golden Bell Frog can travel across elevated terrain in damp conditions enabling different populations to link up. Birds by comparison are generally highly mobile and able to cover relatively large areas of land and are less impacted by barriers to movement such as roads and rail infrastructure.

The degree of connectivity ranges considerably across the across the subject site from contiguous habitat through to highly fragmented landscape with corridors limited to stepping-stone patches and scattered trees.

The eastern portion of the subject site is bordered to the northwest by the South Maitland Railway and agricultural land. Further west is Wentworth Swamp which adjoins a large patch of native vegetation (>2,000 ha) surrounding Sawyers Gully. Connectivity between the north-east of the subject site and remnant native vegetation to the west has been somewhat impacted by the construction of the South Maitland Railway. South of the rail native vegetation within the site is connected to a larger patch of vegetation that surrounds the Kurri Kurri TAFE.

To the north and west of the former smelter site there is a large, vegetated corridor that extends through to Werakata National Park. Connectivity along this corridor has been somewhat impacted to the south by the construction of the Hunter Expressway. Internal fragmentation within the patch is also relatively high due to the construction of roads, tracks and fire-trails that dissect this large vegetated patch.

To the south-west and north of the subject site vegetation connectivity is restricted by agricultural clearing and residential development.

3.9.4 Staff qualifications

This BDAR was prepared by Arien Quin in accordance with the BAM 2020. BAM plot data was collected by Alejandro Barreto and Arien Quin. A technical review of the report and credit calculations was undertaken by Ben Harrington.

Fauna surveys were completed by Luke O’Brien (GHD) and Brendan Ryan (OMVI Ecological).

Qualifications of all staff involved in the field surveys and preparation of this BDAR are presented in Table 3-3.

Table 3-3 Qualifications of ecology staff who have contributed to BCAR

Name	Position / Project Role	Qualifications	Relevant Experience
Ben Harrington	Technical Director-Biodiversity Technical review	BSc MSc Accredited BAM Assessor	17+ years
Arien Quin	Senior Ecologist- Lead BAM assessor and primary author of the BCAR Vegetation integrity plots Targeted threatened flora surveys, BAM credit calculations	BA/BSc Accredited BAM Assessor	15+ years
Cecilia Phu	Senior Ecologist Targeted threatened flora surveys,	B.Sc (Hons) Accredited BAM Assessor	14+ years
Ben Lewis	Principle Ecologist (Zoologist) Targeted threatened fauna surveys	B. App. Sc	20+ years
Alejandro Barreto	Senior Ecologist Vegetation mapping Vegetation integrity plots Targeted threatened flora surveys Hollow bearing tree assessment Owl surveys	BSc Biotechnology Accredited BAM Assessor	6+ years
Luke O-Brien	Fauna Ecologist Threatened fauna surveys and reporting SAII Assessments	BenvSc BSc (Hons)	5+ years
Craig Grabham	Senior Ecologist Bat call Analysis	B. App. Science (Hons) Anabat system training course (Titley Scientific, December 2012) Wildlife Acoustic's Song Meter/SongScope training (Faunatech, July 2015), Anabat Insight and bat call analysis workshop (Titley Scientific and Balance Environmental June 2019)	22 + years
Fiona MacKay	Senior GIS Technician GIS analysis and mapping	Engineering Drafting Certificate	30+ years
Kate Tierney	Ecologist Field survey assistant	BenvSc Blaws GDLP Accredited BAM Assessor	5+ years
Bianca Seal	Ecologist Data management Targeted threatened flora surveys Field survey assistant	BSc	3+ years

Name	Position / Project Role	Qualifications	Relevant Experience
Dr Ross Crates	Species expert – Swift Parrot and Regent Honeyeater SAII assessments for Swift Parrot and regent Honeyeater	BSc (Hons) PhD (conservation biology)	15+
Dr Frank Lemckert	Species expert – Green and Golden Bell Frog and Green Thighed Frog	BSc (PhD)	35+

4. Native vegetation

4.1 Flora species

A total of 196 flora species from 54 families were recorded within the subject site, comprising 151 native and 45 exotic species (seven of which are classified by the BAM as high threat weeds). The Poaceae (grasses, 34 species, 22 native), Myrtaceae (shrubs and trees, 27 species, all native), Fabaceae (Faboideae) (shrubs and other groundcovers, 19 species, 15 native) were the most diverse families recorded. Three threatened flora species were recorded within the site during the current survey. A full list of flora species recorded within the subject site is provided in Appendix D. Characteristic plant species are discussed below in relation to the vegetation zones occurring within the subject site.

4.2 Priority and high threat weeds

Two flora species listed as priority weeds (*Senecio madagascariensis* (Fireweed) *and Lantana camara* (Lantana) listed in the Hunter region (which includes the Cessnock local council area) were recorded within the subject site during the field surveys.

In addition, the following exotic species recorded in the subject site are classified as high threat weeds for the purposes of the BAM:

- *Bidens pilosa* (Cobbler's Pegs)
- *Cyperus eragrostis* (Umbrella Sedge)
- *Romulea rosea* (Onion Grass)
- *Andropogon virginicus* (Whisky Grass)
- *Ehrharta erecta* (Panic Veldtgrass)
- *Paspalum dilatatum* (Paspalum)
- *Acetosella vulgaris* (Sheep Sorrel)
- *Juncus acutus* (Spike Rush)
- *Cestrum parqui* (Green Cestrum)
- *Ligustrum sinense* (Small-leaved Privet)
- *Cenchrus clandestinum* (Kikuyu)
- *Megathyrsus maximus* (Guinea Grass)
- *Paspalum dilatatum* (Paspalum)
- *Hyparrhenia hirta* (Coolatai Grass)
- *Rubus fruticosus agg.* (Blackberry)
- *Chloris gayana* (Rhodes Grass)

4.3 Vegetation within the subject site

4.3.1 Vegetation extent

There is a total extent of 110.84 ha of native vegetation within the subject site. Of this 65.11 ha is comprised of intact remnant woodland patches and 45.71 ha has been substantially modified (see Figure 4-1). There is a further 104 ha of mixed grassland that is comprised predominantly of exotic grasses and forbs with a small number of native species present and does not comprise native vegetation according to the BAM. Vegetation integrity plots that were placed in these grassland areas confirmed that they are predominantly exotic and do not require offsetting as they have a VI score below 15.

4.3.2 Plant community types

Existing vegetation mapping of the subject site completed by Bell and Driscoll (2007) and EcoLogical (ELA 2016) was reviewed and ground-truthed. The overall condition of vegetation was assessed through general observation and comparison against the PCT condition benchmark data as well as using parameters such as species diversity, history of disturbance, weed invasion and canopy health. Candidate PCTs were identified using the BioNet Vegetation Classification database power query function. Plot survey data along with information collected regarding soil type and landscape position was then analysed and compared to PCT descriptions in the Vegetation Classification Database to confirm PCTs.

Results of field surveys and plot analysis indicate that vegetation within the development site corresponds to five native Plant Community Types (PCTs) and one exotic vegetation community. These are:

- Parramatta Red Gum – Narrow-leaved Apple – Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633).
- Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (PCT 1594).
- Grey-Gum –Rough-barked Apple shrubby open forest of the lower Hunter (PCT 1591).
- Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (PCT 1600).
- Typha rushland (PCT 1737).
- Mixed Grassland (non-native vegetation).

PCTs and associated vegetation zones within the subject site are shown on Figure 4-1 and are summarised in Table 4-1. The structure, species composition and condition of PCTs and vegetation zones within the subject site are described in Table 4-2 to Table 4-13. Plant species lists and plot data are provided in Appendix B and Appendix C along with benchmark values for each PCT.

Four of the PCTs identified within the subject site comprise occurrences of threatened ecological communities (TECs) under the BC Act. See Section 5.2.3 for additional description of occurrences of TECs at the subject site.

4.3.3 Vegetation zones

Historical clearing and management practices that have led to vegetation disturbance across parts of the site have resulted in areas numerous different vegetation condition states across the subject site. Where appropriate, PCTs have therefore been split into multiple vegetation zones according to different vegetation condition classes.

There is a total of 11 native vegetation zones within the subject site.

Table 4-1 Vegetation zones within the subject site

Vegetation zone	Plant community type	PCT ID	Condition class	Area in subject site (ha)	Patch size (ha)	Percent cleared	Biodiversity risk rating	Vegetation integrity score	BC Act Status	EPBC Act Status
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	Intact	38.80	(>100)	75	2	63.6	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	Not listed
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	Underscrubbed	8.04	(>100)	75	2	45.2	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	Not listed
3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	Regrowth	0.88	(>100)	75	2	34.3	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	Not listed
4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	1594	Intact	4.28	(>100)	0 (not assessed)	2	79.6	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner bioregions EEC	Part comprises River Flats Eucalypt Forest on coastal floodplains of the southern NSW and eastern Victoria CEEC

Vegetation zone	Plant community type	PCT ID	Condition class	Area in subject site (ha)	Patch size (ha)	Percent cleared	Biodiversity risk rating	Vegetation integrity score	BC Act Status	EPBC Act Status
5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (underscrubbed)	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	1594	Underscrubbed	6.56	(>100)	0 (not assessed)	2	58.9	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner bioregions EEC	Not listed
6 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact)	Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	1591	Intact	4.87	(>100)	26	2	45.7	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	Part comprises River Flats Eucalypt Forest on coastal floodplains of the southern NSW and eastern Victoria CEEC
7 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (underscrubbed)	Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	1591	Underscrubbed	10.12	(>100)	26	2	30	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	Not listed
8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	1600	Underscrubbed	4.99	(>100)	71	2	26	Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed

Vegetation zone	Plant community type	PCT ID	Condition class	Area in subject site (ha)	Patch size (ha)	Percent cleared	Biodiversity risk rating	Vegetation integrity score	BC Act Status	EPBC Act Status
9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (regenerating)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	1600	Regenerating	14.23	(>100)	71	2	42.3	Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed
10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	1600	Intact	17.17	(>100)	71	2	65.3	Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC	Not listed
11 Typha rushland (intact)	Typha rushland	1737	Intact	0.9	(>100)	70	1.5	77.6	Not listed	Not listed
Total area native vegetation				**110.84**						

Table 4-2 Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)

1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (Intact)		
PCT(OEH, 2020b)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	
PCT ID	1633	
Equivalent Map Units	Bell and Driscoll map unit 35a (Kurri Sand Heath Woodland)	
Survey effort	Four plots (1a_8, 1a_9, 1a_10, 1a_11)	
Vegetation formation	Dry Sclerophyll Forests (Shrubby sub-formation)	
Vegetation class	Sydney Sand Flats Dry Sclerophyll Forests	
Conservation significance	Kurri Sand Swamp Woodland in the Sydney Basin, EEC under the BC Act.	
Condition	This vegetation zone is classed as intact condition due to the following: • VI score of 63.6 • Remnant native vegetation with near-intact over storey • High native species richness and very low exotic species represented in the assemblage • Evidence of previous fire (2002), which has contributed to a more open understorey than is typical for this community type.	
Evidence used to define PCT	The PCT was chosen for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA. • The PCT is described as occurring on soils containing conglomerate variants and include brownish black gravelly loam overlayed on sandy clay loam and brown pedal clay. These soils are typical of those of the Bolwarra Heights and Neath Soil Landscapes that occur within the subject site. • The site occurs at a maximum elevation height of approximately 55 m; the PCT is described as occurring up to elevations of 100 m. • Diagnostic species listed in the Bionet Vegetation Database are largely consistent with species recorded within this PCT with five of the seven diagnostic species recorded within the vegetation zone. • Additional characteristic species identified below are largely consistent with those identified for this community in the BioNet Vegetation Classification Database (71 % of species recorded). • Mapping is largely consistent with vegetation community mapping completed for the site by Bell and Driscoll (2019) and EcoLogical (2016). Also see Section 5.2.3 for further discussion of evidence used to confirm the distribution of Kurri Sand Swamp Woodland EEC.	
Landscape position	Low rises and flats	

1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (Intact)	
Occurrence in subject site	Large patches of this PCT occur in the northern section of the subject site and to the south of the Hunter Expressway, both east and west of Hart Road. Smaller patches also surround the old Aluminium Smelter site, primarily to the east and south.
Structure	Low intermittently low open woodland to 15 metres with a dense two-layered mid-storey comprised of sclerophyllous shrubs. The ground layer is typically dominated by grasses, low shrubs and scattered forbs.
Over storey	Dominated by *Eucalyptus parramattensis* subsp. *decadens, Eucalyptus capitellata* (Brown Stringybark) and *Eucalyptus fibrosa* (Red Ironbark). Additional canopy species which occur at lower densities include *Angophora bakeri* (Narrow-leaved Apple) and *Eucalyptus tereticornis* (Forest Red Gum).
Mid storey	Contains a high diversity of shrubs with common species including *Callistemon linearis* (Narrow-leaved Bottlebrush), *Melaleuca nodosa* and *Hakea sericea* (Needlebush). A lower of low shrubs is also present and is typically comprises of species such as *Banksia collina, Melaleuca sieberi*, *Bursaria spinosa* (Native Blackthorn), *Leptospermum polygalifolium* subsp. *Polygalifolium* and *Melaleuca thymifolia* (Thyme Honey-myrtle).
Groundcover	Ground cover species are characteristic of native grasses and forbs. Native grass species which are dominant within the PCT include *Cynodon dactylon* (Common Couch) and *Entolasia stricta* (Wiry Panic) with minor occurrences of *Aristida vagans* (Threeawn Speargrass), *Imperata cylindrica* (Blady Grass) and *Lomandra glauca* (Pale Mat-rush). Typical forb species include *Dianella caerulea* (Blue Flax-lily) and *Pomax umbellata* (Pomax) whilst common rushes included *Lomandra glauca* (Pale Mat-rush) and *Juncus usitatus*. Additional species frequently recorded included *Hardenbergia violacea* (*False Sarsaparilla*) and *Cheilanthes sieberi* (Rock Fern).
Exotic species	Largely weed-free, with the exception of scattered occurrences of *Sida rhombifolia* (Paddy's Lucerne), *Solanum nigrum* (Black-berry Nightshade and *Hypochoeris radicata* (Catsear). One high threat weed (*Senecio madagascariensis* (Fireweed)) was recorded in low abundance through this vegetation zone.

Table 4-3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)

2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (Underscrubbed)		
PCT (OEH, 2020b)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	
PCT ID	1633	
Equivalent map units	Bell and Driscoll map unit 35a (Kurri Sand Heath Woodland)	
Survey effort	Three plots (1b_3, 1b_4, 1b_5)	
Vegetation formation	Dry Sclerophyll Forests (Shrubby sub-formation)	
Vegetation class	Sydney Sand Flats Dry Sclerophyll Forests	
Conservation significance	Kurri Sand Swamp Woodland in the Sydney Basin, EEC under the BC Act.	
Condition	The condition of this PCT has been classified as underscrubbed. This is due to: • VI score of 45.2 • A high exotic species richness and abundance • An open canopy and shrub layer which reflects historical clearing for grazing • Relatively young vegetation with very few hollow-bearing trees • Evidence of previous fire in some areas, which has impacted the composition and structure of the community	
Evidence used to define PCT	PCT 1633 was chosen for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA. • The PCT is described as occurring on soils containing conglomerate variants and include brownish black gravelly loam overlayed on sandy clay loam and brown pedal clay. These soils are typical of those of the Bolwarra Heights and Neath Soil Landscapes that occur within the subject site. • The site occurs at a maximum elevation height of approximately 40 m; the PCT is described as occurring up to elevations of 100 m. • Although this vegetation has been modified through past clearing, diagnostic species listed in the Bionet Vegetation Database are largely consistent with species recorded within this vegetation zone. • Additional characteristic species identified below are largely consistent with those identified for this community in the BioNet Vegetation Classification Database Also see Section 5.2.3 for further discussion of evidence used to confirm the distribution of Kurri Sand Swamp Woodland EEC.	
Landscape position	Flats and low rises	
Occurrence in the subject site	This vegetation community occurs on the low rises and flats in the very south of the subject site. The majority of this vegetation zone occurs on the eastern side of Hart Rd, however small patches also occur to the west of Hart Rd and north of the Smelter site.	
Structure	This vegetation zone is an open woodland that has been impacted by past clearing and grazing. The overstorey and midstorey of the community has been predominantly removed. The groundlayer consist of a diverse mixture of native and exotic grasses and forbs.	
Over storey	To 15 metres, dominated by *Eucalyptus parramattensis subsp decadens* (Parramatta Red Gum), *Angophora floribunda* (Rough-barked Apple), *Eucalyptus punctata* (Grey Gum) and *Eucalyptus tereticornis* (Forest Red Gum.	

2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (Underscrubbed)	
Mid storey	Typically characterised by a sparse layer of *Persoonia linearis* (Narrow-leaved Geebung), *Leptospermum trinervium* (Slender Tea-tree), *Melaleuca nodosa* and *Acacia longifolia*. Some areas of the vegetation community have been impacted by fire which has resulted in a dense mid-storey dominated by *Acacia irrorata* (Green Wattle).
Groundcover	High diversity of grasses, forbs and rushes. Native grass species included *Cynodon dactylon* (Common Couch), *Eragrostis brownii* (Brown's Lovegrass), *Aristida vagans* (Threeawn Speargrass), *Microlaena stipoides* (Weeping Grass), *Chloris ventricosa* (Tall Chloris) and *Entolasia stricta* (Wiry Panic). Forb species include *Dianella caerulea* (Blue Flax-lily) and *Pomax umbellata* (Pomax) whilst rushes included *Lomandra glauca* (Pale Mat-rush) and *Juncus usitatus*. Additional native species included *Hardenbergia violacea* (*False Sarsaparilla*) and *Cheilanthes sieberi* (Rock Fern).
Exotic species	This PCT had a high diversity of weed species, however appeared to be at low cover and abundance and variable between plots. *Senecio madagascariensis* (Fireweed) was the only high threat weed observed within plots, whilst a number of additional exotic species included *Briza major*, *Hypochaeris radicata* (Catsear), *Silene apetala*, *Ambrosia artemisiifolia* (Annual Ragweed), *Gamochaeta calviceps* (Cudweed) and *Sida rhombifolia* (Paddy's Lucerne).

Table 4-4 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)

3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)		
PCT (OEH, 2020b)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	
PCT ID	1633	
Equivalent map units	Bell and Driscoll map unit 35a (Kurri Sand Heath Woodland)	
Survey effort	One plot (1e_1)	
Vegetation formation	Dry Sclerophyll Forests (Shrubby sub-formation)	
Vegetation class	Sydney Sand Flats Dry Sclerophyll Forests	
Conservation significance	Kurri Sand Swamp Woodland in the Sydney Basin, EEC under the BC Act.	
Condition	The condition of this PCT has been classified as regrowth. This is due to: • VI score of 34.3 • Evidence of previous clearing and presence of relatively young regrowth • Evidence of disturbance which has resulted in a generally moderate cover of exotic species in the understorey.	
Landscape position	Flats and low rises	
Occurrence within the subject site	Occurs adjacent intact remnants of this PCT, adjacent to detention ponds located to the north of the smelter site.	
Structure	Regenerating woodland with a young canopy structure and mid-storey. The ground layer is typically dominated by exotic and native grasses.	
Over storey	Dominated by *Eucalyptus parramattensis* subsp *decadans* (Parramatta Red Gum) and *Casuarina glauca* (Swamp Oak). Additional canopy species which occur at low densities include *Angophora bakeri* (Narrow-leaved Apple) and *Allocasuarina torulosa* (Forest Oak).	
Mid storey	Contains a moderate diversity of shrubs with common species including *Leptospermum trinervium* (Slender Tea-tree), *Leptospermum polygalifolium*, *Lasiopetalum parviflorum* and *Hakea sericea* (Needlebush).	
Groundcover	Ground cover species are characteristic of native grasses and forbs. The dominant native grass species within the PCT is *Cynodon dactylon* (Common Couch). Smaller occurrences of *Juncus usitatus*, *Dianella caerulea* (Blue Flax-lily), *Imperata cylindrica* (Blady Grass) and *Cheilanthes sieberi* (Rock Fern) were also recorded within the vegetation zone.	
Exotic species	*Juncus acutus* (Sharp Rush) is present at a percentage cover of approximately 5 %. A sparse cover of additional exotic species is also present including *Sporobolus africanus* (Parramatta Grass), *Andropogon virginicus* (Whisky Grass), *Chloris gayana* (Rhodes Grass) and *Plantago lanceolata* (Lamb's Tongues).	

Table 4-5 Cabbage Gum – Rough-barked Apple grassy woodland on alluvial floodplains on the lower Hunter (intact)

4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)		
PCT (OEH, 2020b)	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	
PCT ID	1594	
Equivalent map units	Bell and Driscoll map unit 13e (Cabbage Gum Floodplain Woodland)	
Survey effort	Two Plots (2a_1, RFEF_3)	
Vegetation formation	Forested Wetlands	
Vegetation class	Coastal Floodplain Wetlands	
Conservation significance	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions, EEC under the BC Act. Part comprises River Flats Eucalypt Forest on coastal floodplains of the southern NSW and eastern Victoria, CEEC under the EPBC Act.	
Condition	The condition of this PCT has been classified as intact given the following characteristics: • VI score of 79.6 • Remnant native vegetation with intact over storey, midstorey and groundstorey • High native species richness and very low exotic species present within the floral assemblage • Near benchmark values for species diversity, leaf litter and fallen logs • Supports a moderate number of hollow-bearing trees and fallen timber.	
Evidence used to define PCT	PCT 1594 was chosen for the following reasons: • The subject site occurs within the PCTs described range (within Cessnock LGA and Maitland LGA and Hunter IBRA sub-region). • The PCT is described as occurring on underlying geology that is comprised of siltstone, pebbly sandstone and minor coal occurring on poorly drained flats. This soil description is consistent with the Neth soil landscape description which is mapped for the area. • Community dominated by Eucalyptus amplifolia (Cabbage Gum), with Eucalyptus punctata (Grey Gum) and Angophora floribunda (Rough-Barked Apple). Eucalyptus tereticornis (River Red-Gum) occasionally present. • Occurs on floodplains of Swamp Creek. • Community consists of an open forest with open shrub later and a typically grassy ground layer (some areas have a dense shrub layer present, likely a result of fire recent disturbance within the community). • Diagnostic species listed in the Bionet Vegetation Database are largely consistent with species recorded within this PCT with four of the six identified diagnostic species recorded within the vegetation zone. Additional characteristic species identified below are largely consistent with those identified for this community in the BioNet Vegetation Classification Database.	
Landscape position	Occurs on floodplains of the lower Hunter Valley	

4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)	
Occurrence within the subject site	Within the subject site this PCT occurs on the floodplains surrounding Swamp Creek to the east of the Smelter site.
Structure	An open forest to 20 m with a typically open shrub layer and grassy understorey. It should be noted that recent disturbance due to a fire within the area has altered the shrub layer such that in some areas there is dense regrowth of a number of Acacia spp. The majority of trees are relatively young with few hollows recorded.
Over storey	Dominated by *Eucalyptus amplifolia* (Cabbage Gum) and *Eucalyptus punctata* (Grey Gum) with smaller occurrences of *Eucalyptus fibrosa* (Red Ironbark), *Angophora floribunda* (Rough-barked Apple), *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus robusta* (Swamp Mahogany).
Mid storey	Patchy and structurally variable, with numerous dense shrubby patches throughout that are associated with regrowth after recent fires. Within areas with a dense mid storey *Acacia parvipinnula* (Silver-stemmed Wattle) dominates the shrub layer, particularly in plot 2a_2. Other shrub species present within the vegetation zone where the shrub layer is more open include scattered *Melaleuca nodosa*, *Bursaria spinosa* (Native Blackthorn) and *Grevillea linearifolia* (Linear-leaf Grevillea).
Groundcover	Moderately dense, species rich and structurally variable. In areas where an open shrub layer occurs, the ground layer is highly diverse with native grasses, rushes and ferns. Species within this vegetation community include *Cynodon dactylon* (Common Couch) *Panicum simile* (Two-colour Panic), *Microlaena stipoides* (Weeping Grass), *Entolasia stricta* (Wiry Panic). Characteristic rush species include many Lomandra sp. Including *Lomandra brevis, Lomandra glauca* (Pale Mat-rush), *Lomandra longifolia* (Spiny-headed Mat-rush) and *Lomandra confertifolia* (Matrush). Fern species which occur within the PCT include *Pteridium esculentum* (Bracken) and *Cheilanthes sieberi* (Rock Fern).
Exotic species	Whilst this PCT had a high native species diversity, a number of high threat exotic species occur, albeit at a low percentage cover (< 1%). High threat weeds recorded include *Andropogon virginicus* (Whisky Grass), *Ligustrum sinense* (Small-leaved Privet), *Megathyrsus maximus, Cestrum parqui* (Green Cestrum), *Ehrharta erecta* (Panic Veldtgrass), *Senecio madagascariensis* (Fireweed) and *Bidens pilosa* (Cobbler's Pegs).

Table 4-6 Cabbage Gum- Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (underscrubbed)

5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (Underscrubbed)		
PCT (OEH, 2020b)	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	
PCT ID	1594	
Equivalent map units	Bell and Driscoll map unit 13e (Cabbage Gum Floodplain Woodland)	
Survey effort	Three plots (2c_3, 2c_4, 2c_5)	
Vegetation formation	Forested Wetlands	
Vegetation class	Coastal Floodplain Wetlands	
Conservation significance	Listed as River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South-east Corner Bioregions, EEC under BC Act. Part comprises River Flats Eucalypt Forest on coastal floodplains of the southern NSW and eastern Victoria, CEEC under the EPBC Act	
Condition	The condition of this PCT has been classified as underscrubbed for the following reasons: • VI score of 58.9. • Evidence of clearing resulting in a more open canopy when compared to the adjacent 'intact' vegetation zone. • A moderate native species richness when compared to the adjacent 'intact' vegetation zone. • Moderate number of exotic species present in the floral assemblage. • Past clearing has resulted in modification of the structure and composition of the community. • A moderate abundance of leaf litter and high amount of woody debris within the understorey.	
Evidence used to define vegetation unit	PCT 1594 was chosen for the following reasons: • The subject site occurs within the PCTs described range (within Cessnock LGA and Maitland LGA and Hunter IBRA sub-region). • The PCT is described as occurring on underlying geology that is comprised of siltstone, pebbly sandstone and minor coal occurring on poorly drained flats. This soil description is consistent with the Neth soil landscape description which is mapped for the area. • Diagnostic species listed in the BioNet Vegetation Database are largely consistent with species recorded within this PCT with four of the six identified diagnostic species recorded within the vegetation zone. • Additional characteristic species identified below are largely consistent with those identified for this community in the BioNet Vegetation Classification Database • Occurs adjacent to more intact remnants of this PCT (described in Table 4.5 above) • Mapping is consistent with previous vegetation mapping completed within the subject site (ELA 2016, Bell 2019)	
Landscape position	Occurs on floodplains of the lower Hunter Valley.	

5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (Underscrubbed)	
Occurrence within the subject site	Within the subject site this vegetation zone occurs in small patches primarily within the south along the floodplain of Swamp Creek. This vegetation zone is also present surrounding the Smelter site to the south-east, with a smaller patch occurring in the northern section of the subject site adjacent to the existing rail tracks
Structure	This vegetation zone forms an open forest to 25 m with a typically open shrub layer and grassy understorey.
Over storey	The canopy structure within this vegetation community is dominated by *Angophora floribunda* (Rough-barked Apple) with smaller occurrences of *Eucalyptus amplifolia* (Cabbage Gum) and *Eucalyptus tereticornis* (River Red Gum).
Mid storey	Typically sparse. Common species include *Breynia oblongifolia* (Coffee Bush), *Exocarpos cupressiformis* (Cherry Ballart), include *Rubus parvifolius* (Native Raspberry), *Acacia parvipinnula* (Silver-stemmed Wattle) and *Acacia longifolia*.
Groundcover	Typically a dense ground cover layer of *Pteridium esculentum* (Bracken). Where the Bracken layer is sparser, species such as *Lomandra longifolia* (Spiny-headed Mat-rush), *Oplismenus aemulus, Microlaena stipoides* (Weeping Grass) and *Cynodon dactylon* (Common Couch) also occur.
Exotic species	A moderate number of weeds occur within this vegetation community, most of which are high threat and occur within the shrub stratum. These include *Ligustrum sinense* (Small-leaved Privet), *Cestrum parqui* (Green Cestrum) and *Lantana camara* (Lantana). *Ehrharta erecta* (Panic Veldtgrass) was also recorded in the ground stratum.

Table 4-7 Grey Gum – Rough Barked Apple shrubby open forest of the lower hunter (intact)

6 Grey-Gum – Rough-barked Apple shrubby open forest of the lower hunter (intact)		
PCT (OEH, 2020b)	Grey-Gum-Rough-baked Apple shrubby open forest of the lower hunter	
PCT ID	1591	
Equivalent map units	Bell and Driscoll map unit 19a (Grey Gum – Red Gum Forest)	
Survey effort	Two plots (2a_2, 2a_3)	
Vegetation formation	Dry Sclerophyll Forests (shrub/grass sub-formation)	
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests	
Conservation significance	Hunter Lowland Red Gum Forest in the Sydney Basin and NSW North Coast Bioregions, EEC under the BC Act. Part comprises River Flats Eucalypt Forest on coastal floodplains of the southern NSW and eastern Victoria, CEEC under the EPBC Act.	
Condition	The condition of this PCT has been classified as underscrubbed for the following reasons: • VI score of 45.7. • Remnant native vegetation with relatively intact overstorey, shrub and ground layer • Supports a high native species richness that is just below benchmark for trees and shrubs. • The vegetation zone has a very low abundance of exotic species represented in the floral assemblage. • Leaf litter and woody debris within the understorey is close to benchmark. • Supports a moderate number of hollow-bearing trees and fallen timber.	
Evidence used to define vegetation unit	PCT 1591 was chosen for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA, Hunter IBRA sub-region and within the Newcastle Coastal Ramp Mitchell Landscape. • Within the subject site community occurs on flats and low rises. • Dominant canopy species with the community are characteristic of those described by the BioNet Vegetation Classification database (OEH 2020c). Namely Eucalyptus punctata (Grey Gum) and Angophora floribunda (Rough-barked Apple). • The community has a predominantly shrubby mid-storey (plot data recorded a mean species richness for shrubs of 9 and 4.5 for grasses with a cover of 61 % for shrubs and 29 % for grasses). • Other PCTs considered include PCT 1591 Forest Red Gum on Floodplains of the lower Hunter which although floristically similar was largely ruled out due to the absence of Eucalyptus tereticornis (Forest Red Gum) within the vegetation zone, the landscape position which is not on a floodplain and structural elements discussed above (i.e. the predominantly shrubby rather than open mid-storey).	
Landscape position	Low slopes and rises.	
Occurrence within the subject site	Within the subject site this vegetation community occurs in a small patch directly east of the Smelter site, running parallel with the rail track. A larger patch also occurs to the north of the subject site, within close proximity to Cessnock Rd.	

6 Grey-Gum – Rough-barked Apple shrubby open forest of the lower hunter (intact)	
Structure	An open forest to 20 m with a typically shrubby midstorey and sparse ground layer dominated by grasses, small ferns and forbs.
Over storey	The canopy structure within this vegetation community is dominated by *Eucalyptus punctata* (Grey Gum) and *Angophora floribunda* (Rough-barked Apple) with smaller occurrences of *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus agglomerata* (Blue-leaved Stringybark)
Mid storey	The diverse shrub layer within this vegetation community dominated by *Melaleuca nodosa, Leptospermum polygalifolium* and *Bursaria spinosa* (Native Blackthorn). Other shrub species which occur at a smaller percentage cover include *Daviesia ulicifolia* (Gorse Bitter Pea), *Pultenaea spinos*a (A Bush Pea), Dillwynia retorta, *Acacia ulicifolia* (Prickly Moses), *Zieria smithii, Hakea sericea* (Needlebush*), Pittosporum undulatum* (Sweet Pittosporum) and *Denhamia silvestris* (Narrow-leaved Orangebark).
Groundcover	The groundlayer is characterised by native grass species including *Entolasia stricta* (Wiry Panic), *Cynodon dactylon* (Common Couch), *Aristida vagans* (Threeawn Speargrass) and *Eragrostis brownii* (Brown's Lovegrass). Additional native ground cover species include *Lomandra cylindrica, Hardenbergia violacea* (False Sarsaparilla), *Pomax umbellata* (Pomax), *Commelina cyanea* (Native Wandering Jew) and *Cassytha glabella*.
Exotic species	Exotic species diversity is very low within this vegetation community, with just two exotic species observed within plots. Despite being classified as high threat, *Ehrharta erecta* (Panic Veldtgrass) and *Senecio madagascariensis* (Fireweed) occur at very low percentage covers and were only recorded within plot 3a_2.

Table 4-8 Grey Gum –Rough-barked Apple shrubby open forest of the lower Hunter (underscrubbed)

7 Grey-Gum – Rough-barked Apple shrubby open forest of the lower Hunter (underscrubbed)		
PCT (OEH, 2020b)	Grey-Gum-Rough-baked Apple shrubby open forest of the lower hunter	
PCT ID	1591	
Equivalent map units	Bell and Driscoll map unit 19a (Grey Gum – Red Gum Forest)	
Survey effort	Three plots (3b_3, 3b_4, 3b_5)	
Vegetation formation	Dry Sclerophyll Forests (shrub/grass sub-formation)	
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests	
Conservation significance	Hunter Lowland Red Gum Forest in the Sydney Basin and NSW North Coast Bioregions, EEC under the BC Act.	
Condition	The condition of this PCT has been classified as underscrubbed for the following reasons: • VI score of 30 • Canopy has been thinned through past clearing • Understorey has been cleared and grazed resulting in a largely absent shrub layer and modified ground layer dominated by exotic perennial grasses.	
Evidence used to define vegetation unit	PCT 1591 was chosen for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA, Hunter IBRA sub-region and within the Newcastle Coastal Ramp Mitchell Landscape. • The community occurs on low rises and flats • Dominant canopy species with the community are characteristic of those described by the BioNet Vegetation Classification database (OEH 2020c). Namely Eucalyptus punctata (Grey Gum) and Angophora floribunda (Rough-barked Apple). • The community has a predominantly shrubby mid-storey (plot data recorded a mean species richness for shrubs of 9 and 4.5 for grasses with a cover of 61 % for shrubs and 29 % for grasses). • Other PCTs considered include PCT 1591 Forest Red Gum on Floodplains of the lower Hunter which although floristically similar was largely ruled out due to the absence of Eucalyptus tereticornis (Forest Red Gum) within the vegetation zone, the landscape position which is not on a floodplain and structural elements discussed above (i.e. the predominantly shrubby rather than open mid-storey).	
Landscape position	Low slopes, undulating hills and rises.	
Occurrence within the subject site	Within the subject site this vegetation community occurs in small patches directly east of the Smelter site between the rail tracks and Bowditch Ave.	
Structure	An open forest with a sparse midstorey and the ground layer is dominated by exotic grasses and forbs	

7 Grey-Gum – Rough-barked Apple shrubby open forest of the lower Hunter (underscrubbed)	
Over storey	The canopy structure within this vegetation community is dominated by *Eucalyptus punctata (*Grey Gum) and *Angophora floribunda* (Rough-barked Apple). Other canopy species that occur occasionally include *Eucalyptus moluccana* (Grey Box) and *Eucalyptus crebra* (Narrow-leaved Ironbark)
Mid storey	Typically very sparse to absent with *Melaleuca nodosa* recorded at a low percentage cover through the community.
Groundcover	Dominated by exotic grasses and forbs including *Sida rhombifolia* (Paddy's Lucerne), *Megathyrsus maximus, Sporobolus africanus* (Parramatta Grass), *Senecio madagascariensis* (Fireweed), *Bidens pilosa* (Cobbler's Pegs). Native grass and forb species included *Cynodon dactylon* (Common Couch) and *Chloris ventricosa* (Tall Chloris) and *Einadia hastata* (Berry Saltbush). With *Dichondra repens* (Kidney Weed), *Poa sieberiana* (Snowgrass), *Themeda triandra* (Kangaroo Grass), *Microlaena stipoides* (Weeping Grass) and *Glycine tabacina* (Variable Glycine) also present in low abundance.
Exotic species	Exotic species diversity is very low within this vegetation community, with just two exotic species observed within the plots. Despite being classified as high threat, *Ehrharta erecta* (Panic Veldtgrass) and *Senecio madagascariensis* (Fireweed) occur at very low percentage covers and only within plot 3a_2.

Table 4-9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)

8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)		
PCT (OEH, 2020b)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	
PCT ID	1600	
Equivalent map units	Bell and Driscoll map unit 17a Lower Hunter Spotted Gum Ironbark Forest)	
Survey effort	Two plots (5b_7, 5b_9)	
Vegetation formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)	
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests	
Conservation significance	Lower Hunter Spotted Gum- Ironbark Forest in the Sydney Basin Bioregion EEC under the BC Act.	
Condition	The condition of this PCT has been classified as underscrubbed. This is due to: • VI score of 26. • Canopy has been thinned through past clearing. • Understorey has been cleared and grazed resulting in a largely absent shrub layer and highly modified ground layer dominated by exotic herbs and perennial grasses.	
Evidence used to define PCT	Although this community has been highly modified PCT 1600 was chosen as the best fit for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA, Hunter IBRA sub-region and within the Newcastle Coastal Ramp Mitchell Landscape. • The PCT is described as occurring on an underlying geology comprised of siltstone and conglomerate on hill slopes and low rises. This geology is aligned with the soil landscapes mapped for this vegetation zone (Balwarra Heights and Neith soil landscapes). • Dominant canopy species of the site are characteristic of those described by the BioNet Vegetation Classification database. This include Eucalyptus crebra (Narrow-leaved Ironbark) and Eucalyptus fibrosa (Red Ironbark) with Corymbia maculata (Spotted Gum) also present. A number of diagnostic species also occur, including Lomandra confertifolia (Matrush), Pratia purpurascens (Whiteroot) and Brunoniella australis (Blue Trumpet). Although this vegetation zone has been highly modified through past clearing and associated ongoing agricultural activities, the species present indicate that this community is more closely aligned to PCT 1600 than the closely aligned PCT 1593. The presence of Corymbia maculata (Spotted Gum) is the primary distinguishing factor along with the more open understorey in PCT 1600. Within this vegetation zone the understory has been highly altered due to clearing and grazing pressures so the community structure cannot be used as a determining factor for distinguishing between these two communities. The presence of Spotted Gum (as well as other diagnostic species) however suggests that this vegetation zone is more closely aligned to PCT 1600 than to 1953.	

8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	
Landscape position	Low slopes and rises.
Occurrence within the subject site	This vegetation community primarily occurs in within the disturbed agricultural paddocks in the north of the subject site as discontinuous patches running north to south. Smaller patches also occur around the perimeter of the Smelter site, with a small patch also present in the very south of the subject site.
Structure	This vegetation zone consists of scattered paddock trees to 20 m with a grassy understorey. The shrub layer has been predominantly removed although occasional low shrubs are present.
Over storey	Remnant canopy species include *Eucalyptus fibrosa* (Red Ironbark), *Eucalyptus moluccana* (Grey Box) *Eucalyptus punctata* (Grey Gum), *Corymbia maculata* (Spotted Gum), and *Eucalyptus acmenoides* (White Mahogany).
Mid storey	Largely absent with occasional *Daviesia ulicifolia* (Gorse Bitter Pea) *Acacia ulicifolia* (Prickly Moses), *Melaleuca nodosa*, and *Leucopogon juniperinus* (Prickly Beard-heath).
Groundcover	Comprised of a mixture of exotic forbs and grasses and common native species. Common native species include *Cynodon dactylon* (Common Couch) *Themeda triandra* (Kangaroo Grass), *Imperata cylindrica* (Blady Grass), *Microlaena stipoides* (Weeping Grass), *Aristida vagans* (Threeawn Speargrass) and *Eragrostis brownii* (Brown's Lovegrass). Native forb species present within this vegetation community include *Dianella caerulea* (Blue Flax-lily), *Oxalis perennans* (Oxalis), *Pomax umbellata* (Pomax) *Einadia hastata* (Berry Saltbush) and *Lomandra confertifolia* (Matrush)
Exotic species	A high abundance of weeds occurs within this vegetation community, many of which are high threat weeds. Dominant species include *Senecio madagascariensis* (Fireweed), *Lantana camara* (Lantana), *Andropogon virginicus* (Whisky Grass), *Lotus subbiflorus* (Hairy Birds-foot Trefoil), *Facelis retusa* (Annual Trampweed), *Sida rhombifolia* (Paddy's Lucerne), *Plantago lanceolata* (Lamb's Tongues), *Vulpia bromoides* (Squirrel Tail Fesque) and *Briza minor* (Shivery Grass).

Table 4-10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (regenerating)

9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter		
PCT (OEH, 2020b)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	
PCT ID	1600	
Equivalent map units	Bell and Driscoll map unit 17a Lower Hunter Spotted Gum Ironbark Forest)	
Survey effort	Three plots (5b_5, 5b_6, 5d_1)	
Vegetation formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)	
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests	
Conservation significance	Lower Hunter Spotted Gum- Ironbark Forest in the Sydney Basin Bioregion EEC under the BC Act	
Condition	The condition of this PCT has been classified as regenerating for the following reasons: • VI score of 42.3 • Vegetation has been previously cleared and consists of generally young regenerating vegetation approximately 10-15 years old • Supports a moderate diversity of native species • Contains a moderate number and abundance of weed species including a number of high threat weeds • Lack of mature or hollow-bearing trees and general absence of fallen timber.	
Evidence used to define vegetation unit	PCT 1600 was chosen as the best fit for this vegetation zone for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA, Hunter IBRA sub-region and within the Newcastle Coastal Ramp Mitchell Landscape • The PCT is described as occurring on an underlying geology comprised of siltstone and conglomerate on hill slopes and low rises. This geology aligns with the soil landscapes mapped for this vegetation zone (Balwarra Heights and Neith soil landscapes) • Dominant canopy species regenerating is characteristic of those described within the BioNet Vegetation Classification database. Namely Eucalyptus crebra (Narrow-leaved Ironbark) and Eucalyptus fibrosa (Red Ironbark), Corymbia maculata (Spotted Gum) and Eucalyptus molucanna (Grey Box). • Occurs adjacent to intact remnant of this PCT Other similar PCTs that were considered include PCT 1601, PCT 1602 and 1593. Although these PCTs have similar diagnostic and characteristic species these were discounted for the reasons outlined in Table 4-9 above.	
Landscape position	Low slopes and rises.	
Occurrence within the subject site	Occurs as a large patch within the centre of the site as two smaller patches adjacent to Hart Road.	
Structure	Regenerating shrubland with a dense shrubby midstorey and the ground layer characterised by a diversity of grasses with a mix of graminoids; small ferns and forbs.	

9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	
Over storey	Generally absent with occasional *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus fibrosa* (Red Ironbark) with *Corymbia maculata* (Spotted Gum), *Eucalyptus punctata* (Grey Gum) and *Eucalyptus moluccana* (Grey Box) seedlings.
Mid storey	The shrub stratum is characterised by regenerating *Melaleuca nodosa* and *Bursaria spinosa* (Native Blackthorn). Other common species include *Acacia falcata, Persoonia linearis, Pultenaea retusa, Acacia ulicifolia, Daviesia ulicifolia, Breynia oblongifolia* (Coffee Bush), *Melaleuca sieberi* and *Callistemon linearis* (Narrow-leaved Bottlebrush). The lower shrub layer includes species such as *Pultenaea retusa* (Notched Bush-pea), *Acacia ulicifolia* (Prickly Moses) *and Daviesia ulicifolia,*
Groundcover	The ground layer is characterised by native grass species including *Themeda triandra* (Kangaroo Grass), *Cynodon dactylon* (Common Couch), *Imperata cylindrica* (Blady Grass), *Entolasia stricta* (Wiry Panic), *Aristida vagans* (Threeawn Speargrass), *Microlaena stipoides* (Weeping Grass), and *Eragrostis brownii* (Brown's Lovegrass). Other common species include *Lomandra confertifolia* (Matrush*, Lomandra multiflora (Many-headed Mat-rush*), *Pratia purpurascens* (Whiteroot*)* and *Hovea linearis*
Exotic species	There is a relative low abundance and diversity of weed within this vegetation zone. High threat weeds recorded include *Lantana camara* (Lantana), *Senecio madagascariensis (Fireweed), Paspalum dilatatum (Paspalum) and Andropogon virginicus (Whisky Grass)*. Other exotic species within this vegetation zone include *Sida rhombifolia* (Paddy's Lucerne), *Plantago lanceolata* (Lamb's Tongues), *Setaria parviflora, Trifolium repens* (White Clover), *Facelis retusa* (Annual Trampweed) and *Lotus subbiflorus* (Hairy Bird's-foot Trefoil).

Table 4-11 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)

10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter		
PCT (OEH, 2020b)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	
PCT ID	1600	
Equivalent map units	Bell and Driscoll map unit 17a Lower Hunter Spotted Gum Ironbark Forest)	
Survey effort	Three plots (5a_3, 5a_4, 5a_8)	
Vegetation formation	Dry Sclerophyll Forests (Shrub/grass sub-formation)	
Vegetation class	Hunter-Macleay Dry Sclerophyll Forests	
Conservation significance	Lower Hunter Spotted Gum- Ironbark Forest in the Sydney Basin Bioregion EEC under the BC Act	
Condition	The condition of this PCT has been classified as intact for the following reasons: • VI score of 65.3 • Remnant native vegetation with relatively intact overstorey, shrub and ground layer • Supports a high native species richness that is just below benchmark for trees and shrubs. • The vegetation zone has a very low abundance of exotic species represented in the floral assemblage • Leaf litter and woody debris within the understorey is at close to benchmark • Supports a moderate number of hollow-bearing trees and fallen timber.	
Evidence used to define vegetation unit	PCT 1600 was chosen as the best fit for this vegetation zone for the following reasons: • The site occurs within the PCTs described range, within Cessnock LGA, Hunter IBRA sub-region and within the Newcastle Coastal Ramp Mitchell Landscape. • The PCT is described as occurring on an underlying geology comprised of siltstone and conglomerate on hill slopes and low rises. This geology aligns with the soil landscapes mapped for this vegetation zone (Balwarra Heights and Neith soil landscapes). • Dominant canopy species of the site are characteristic of those described by the BioNet Vegetation Classification database. Namely Eucalyptus crebra (Narrow-leaved Ironbark) and Eucalyptus fibrosa (Red Ironbark), Corymbia maculata (Spotted Gum) and Eucalyptus molucanna (Grey Box). • All diagnostic species listed in the BioNet Vegetation Classification database for this PCT were recorded within the vegetation zone. Other similar PCTs that were considered include PCT 1601, PCT 1602 and 1593. Although these PCTs have similar diagnostic and characteristic species these were discounted for the following reasons: • PCT 1601 typically occurs on flats where this vegetation zone within the subject site is located on low hills and rises. • Only 60 percent of the species identified as diagnostic within the BioNet Vegetation Classification database for PCT 1601 were recorded within this vegetation zone (as opposed to 100 percent identified for PCT 1600). • Eucalyptus mollucana (Grey Box) is not listed as a characteristic canopy species for	

10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	
	PCT 1601. • Only 75 percent of the species identified as diagnostic within the BioNet Vegetation Classification database for PCT 1602 were recorded within this vegetation zone (as opposed to 100 percent identified for PCT 1600). • *Eucalyptus fibrosa* (Red Ironbark) or *Eucalyptus mollucana* (Grey Box) are not listed as characteristic canopy species for PCT 1602. • *Eucalyptus crebra* (Narrow-leaved Ironbark) or *Eucalyptus mollucana* (Grey Box) are not listed as characteristic canopy species for PCT 1598. Only 40 percent of the species identified as diagnostic within the BioNet Vegetation Classification database for PCT 1593 were recorded within this vegetation zone (as opposed to 100 percent identified for PCT 1600).
Landscape position	Low slopes and rises.
Occurrence within the subject site	Occurs as a large patch within the centre of the site as two smaller patches adjacent to Hart Road.
Structure	An open forest with a typically shrubby midstorey and the ground layer is dominated by grasses with a mix of graminoids; small ferns and forbs
Over storey	The canopy within this vegetation community is dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus fibrosa* (Red Ironbark) with *Corymbia maculata* (Spotted Gum) and *Eucalyptus moluccana* (Grey Box) also occurring occasionally. *Notelaea longifolia* (Large Mock-olive) also occurs in low abundance within the canopy stratum.
Mid storey	The shrub stratum is characterised by *Melaleuca nodosa* and *Bursaria spinosa* (Native Blackthorn). Other common species include *Myrsine variabilis, Breynia oblongifolia* (Coffee Bush), *Melaleuca sieberi*, *Callistemon linearis* (Narrow-leaved Bottlebrush) and *Melaleuca linariifolia* (Flax-leaved Paperbark). The lower shrub layer includes species such as *Pultenaea retusa* (Notched Bush-pea), *Pultenaea spinosa* (Spiny Bush-pea), *Correa reflexa* (Native Fushia) and *Hibbertia vestita* (Hairy Guinea Flower).
Groundcover	The ground layer is characterised by native grass species including *Entolasia stricta* (Wiry Panic), *Cynodon dactylon* (Common Couch), *Imperata cylindrica* (Blady Grass) *Aristida vagans* (Threeawn Speargrass), *Microlaena stipoides* (Weeping Grass), *Themeda triandra* (Kangaroo Grass) and *Eragrostis brownii* (Brown's Lovegrass). Other common species include *Lomandra cylindrica, Lomandra filiformis* (Wattle Matt-rush), *Lomandra longifolia* (Spiny-headed Mat-rush), *Lomandra confertifolia* (Matrush, *Lomandra multiflora (Many-headed Mat-rush)*), *Pratia purpurascens* (Whiteroot *Hardenbergia violacea* (False Sarsaparilla), *Lepidosperma laterale* (*Pomax umbellata* (Pomax), *Brunoniella australis* (Blue Trumpet) *Commelina cyanea* (Native Wandering Jew) and *Cassytha pubescens*.
Exotic species	There is a low abundance and diversity of weed within this vegetation zone. One high threat weed was recorded *Lantana camara* (Lantana), which occurs to a minor extent within the vegetation community. *Sida rhombifolia* (Paddy's Lucerne) was also recorded scattered through the vegetation zone.

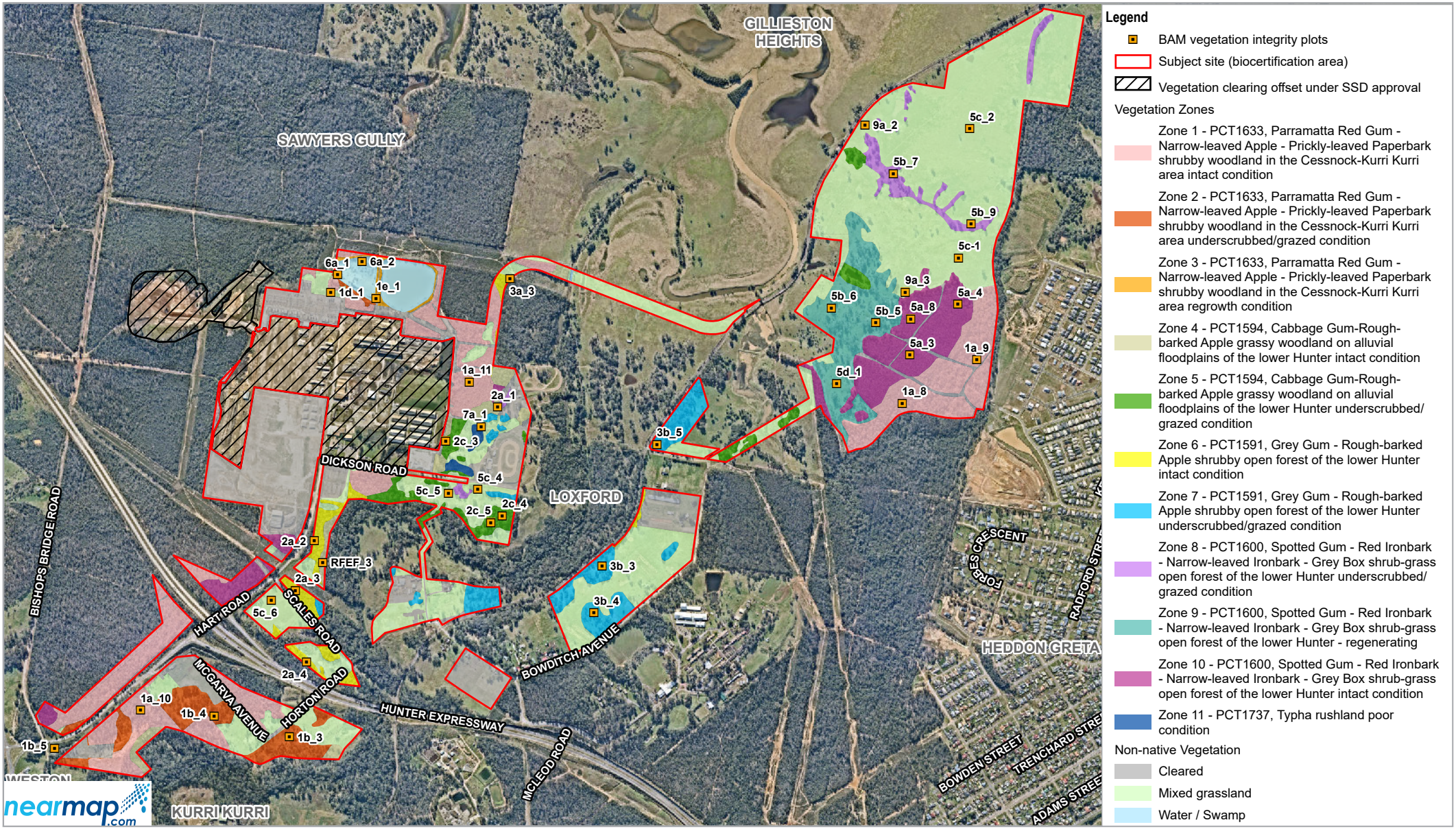
Table 4-12 Typha rushland

11 Typha Rushland		
PCT (OEH, 2020b)	Typha rushland	
PCT ID	1737	
Equivalent map units	Nil	
Survey effort	One plot (7a_1)	
Vegetation formation	Freshwater Wetlands	
Vegetation class	Coastal Freshwater Lagoons	
Conservation significance	Does not comprise part of a TEC listed under BC Act or EPBC Act	
Condition	The condition of this PCT has been classified as intact as: • VI score of 77.6 • It is a derived community that has colonised man-made ponds to the east of the Smelter Site • Supports a high cover of native vegetation growth • Low abundance of weeds present	
Evidence used to define vegetation unit	This vegetation has colonised a disused surge pond located to the east of the smelter site. The PCT was chosen as the best fit for this vegetation for the following reasons: • The site occurs within the PCTs described range, within the Hunter IBRA sub-region. • This vegetation community is located at 10 m elevation, within the described 50 m elevation. • Species present are characteristic of those described for the PCT in the BioNet vegetation classification database (OEH 2020c). Namely Typha orientalis (Broad-leaved Cumbungi) and Cynodon dactylon (Common Couch) with Melaleuca quinquenervia (Broad-leaved Paperbark) observed on the margins of the vegetation community.	
Landscape position	Localised depressions at low elevations	
Occurrence within the subject site	This vegetation community primarily occurs to the east of the Smelter site (east of the old Loxford Park Speedway) within a man-made pond known as the east surge pond.	
Structure	Dense cover of aquatic vegetation lacking an over and mid-storey, dominated by *Typha orientalis* (Broad-leaved Cumbungi).	
Over storey	Absent	
Mid storey	Absent	
Groundcover	The vegetation within the ponds is characterised by native aquatic species. The vegetation is dominated by a dense cover of *Typha orientalis* (Broad-leaved Cumbungi) with occasional occurrences of *Baumea articulata* (Jointed Twig-rush), *Triglochin procera* (Water Ribbons), *Ranunculus inundatus* (River Buttercup), *Cynodon dactylon* (Common Couch) and *Juncus usitatus*.	
Exotic species	Exotic species diversity is relatively low within this vegetation community. *Andropogon virginicus* (Whisky Grass), *Verbena bonariensis* (Purpletop), *Setaria pumila* (Pigeon Grass), *Paspalum dilatatum* (Paspalum) occur at low cover and abundance.	

Table 4-13 Mixed Grassland

Mixed Grassland/Exotic vegetation		
PCT (OEH, 2020b)	N/A	
PCT ID	N/A	
Equivalent map units	Nil	
Survey effort	Nine plots (5c_1; 5c_2; 5c_3, 5c_4, 5c_5, 5c_6, 9a_1, 9a_2, 9a_3)	
Vegetation formation	N/A	
Vegetation class	N/A	
Conservation significance	Low conservation value. Non-native vegetation.	
Condition	Mixed grassland has been classified as non-native vegetation and excluded from BAM credit calculations for the following reasons: • VI score of 4.4 • There is no canopy or shrub layer • Vegetation is dominated by exotic groundcover species, including high threat weeds • Overall there is relatively low species diversity The floristic composition contains a very low native species richness and cover	
Evidence used to define vegetation unit	• A low diversity and abundance of native species within the vegetation community. • Evidence of historical clearing for grazing and agriculture. • Ongoing grazing of the site has contributed to a dominance of exotic perennial grasses. • A high diversity and cover of exotic species, including high threat weeds. • Throughout the disturbed grazed paddocks in the north-east of the subject site there are small patches of native grasses scattered through the predominantly exotic grasslands. A number of BAM plots were located in areas that had a higher native species richness and abundance, compared to the surrounding exotic grassland. An assessment was undertaken to determine if these areas should be mapped as a separate vegetation zone (plots 9a_1, 9a_2 and 9a_3). These plots had vegetation integrity score of less than 15 (VI =4.4) and do not meet the definition of native vegetation or threatened species habitat requiring offsets according to the BAM (DPIE 2020a). therefore for the purpose of this assessment all areas of disturbed grassland were mapped as a single “mixed grassland” vegetation zone.	
Landscape position	N/A	
Occurrence within the subject site	Occurs within the agricultural paddocks and cleared land throughout the site where evidence of past vegetation clearing occurs. The largest patch of exotic vegetation occurs to the north-east of the site and is currently utilised for agricultural grazing.	
Structure	This vegetation community is an exotic grassland, with a dense understorey dominated by exotic species. Sparse remnant trees occur with no mid-storey structure.	
Over storey	The canopy structure is relatively absent from this vegetation community apart from very few scattered remnant paddock trees.	
Mid storey	No mid-storey within the vegetation community.	

Mixed Grassland/Exotic vegetation	
Groundcover	Native ground cover has a very low diversity and is dominated by exotic species including *Vulpia bromides* (Squirrel Tail Fescue), *Ambrosia artemisiifolia* (Annual Ragweed), *Paspalum notatum* (Bahia Grass) and *Setaria parviflora*. Small patches also contain a higher abundance of the native grasses *Cynodon dactylon* (Common Couch) and, *Microleana stipoides* (Weeping Grass). Other natives to be observed within the plots, but at very low percentage covers include *Microtis parviflora* (Slender Onion Orchid), *Cheilanthes sieberi* (Rock Fern), *Eragrostis brownii* (Brown's Lovegrass), *Dichelachne micrantha* (Shorthair Plumegrass), *Themeda triandra* (Kangaroo Grass), *Einadia nutans (Ruby Saltbush) and Wahlenbergia gracilis (Sprawling Bluebell).*
Exotic species	The ground storey is dominated by exotic grasses and herbaceous species including *Ambrosia artemisiifolia* (Annual Ragweed), *Hypochoeris radicata* (Catsear), *Vulpia bromoides* (Squirrel Tail Fesque), *Senecio madagascariensis* (Fireweed), *Lotus subbiflorus* (Hairy Birds-foot Trefoil), *Trifolium repens* (White Clover), *Facelis retusa* (Annual Trampweed) and *Paspalum dilatatum* (Paspalum).



Paper Size ISO A4

0 0.15 0.3 0.45 0.6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Vegetation

Figure 4-1

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Print date: 01 Jun 2022 - 14:31

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; ELA: Vegetation mapping, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

4.4 Terrestrial fauna and fauna habitat resources

4.4.1 Faunal assemblage

A total of 131 fauna species (126 native and five exotic) were recorded within the subject site including. A full list of fauna species recorded is provided in Appendix B. The faunal assemblage comprises 87 bird species, ten frog species, 6 reptile species and 28 mammal species.

4.4.2 Fauna habitat resources

The subject site is composed of patches of native vegetation forming a mosaic with areas previously cleared and utilised for agricultural grazing. The subject site is located to the east of an extensive patch of connected native vegetation greater than 2,000 ha in area.

The following habitat features and resources were identified within the subject site and indicate the potential presence of threatened species that contribute to the credit calculations:

- Mature canopy trees that provide nectar, fruits, leaves and foraging, roosting or nesting substrates, including supporting invertebrate prey diversity for insectivorous fauna.
- High cover of blossom-bearing trees, including highly productive *Eucalyptus* species.
- A number of small farm dams that would provide foraging and breeding habitat for a range of species including waterbirds, amphibians and some species of microbat.
- Large, hollow-bearing trees, including hollows in a range of size classes from <5 cm up to >50 cm diameter hollows.
- Leaf litter and fallen logs, which provide foraging and shelter substrate for small terrestrial animals.
- Presence of drainage lines and pools of standing water surrounded by vegetation.
- Presence of culverts which provide potential roost sites for microbats.
- Burrows, dens and warrens as well as scattered patches of dense understorey shrubs providing refuge habitat for small terrestrial animals.
- Flowering myrtaceous trees, specific food trees (e.g. *Allocasuarina*) and shrubs which provide foraging habitat for a range of arboreal mammals and birds.
- Approximately a third of the site (107 ha) consists of cleared land used for grazing that would provide foraging habitat for macropods, raptors and some species of microbats.

The subject site or its surrounds does not contain any cliff lines, extensive rock outcrops, caves or disused mines.

The BAM assessment of habitat resources at the subject site was completed with reference to the above observations. Additional discussion of habitat resources for species credit entities is provided in Section 5.1.

4.5 Aquatic habitat resources

The subject site includes a small section of Swamp Creek, where this waterway crosses a proposed rail spur on the north-west side of the smelter site. This intermittently flowing creek may provide a small amount of breeding, foraging and shelter resources for common frogs, reptiles, birds and some species of mircobats. The creek line is not likely to provide habitat for threatened fish as none are known to occur in the Wallis Creek catchment, nor is it mapped as key fish habitat (DPI 2007, DPI 2022).

There is also several small ephemeral first order drainage lines within the subject site. These relatively undefined drainage lines contain very few aquatic habitat resources although may provide corridors for the movement of frogs and some smaller aquatic species after large rainfall events.

4.6 Groundwater dependant ecosystems

Groundwater plays an integral role in sustaining a range of aquatic and terrestrial ecosystems including wetland, springs, rivers as well as a number of vegetation types.

The *NSW State Groundwater Dependent Ecosystems Policy* defines groundwater dependent ecosystems (GDEs) as ecosystems which have their species composition, and their natural ecological processes determined by groundwater (DLWC 2002). Ecosystems vary dramatically in the degree of dependency of groundwater, from having no apparent dependence through to being entirely dependent on it (DLWC 2002).

Dependence (or interaction) of the vegetation communities identified within the subject site on groundwater was determined by searching the Atlas of GDEs (BOM 2020b). This Atlas predicts the occurrence of groundwater dependent ecosystems and ecosystems that potentially use groundwater. It shows ecosystems that interact with the subsurface expression of groundwater (including vegetation ecosystems) or the surface expression of groundwater (such as rivers and wetlands). The Atlas also shows the likelihood that landscapes are accessing water in addition to rainfall, such as soil water, surface water or groundwater. Native vegetation within the subject site is mapped as vegetation with moderate to high potential for being reliant on the subsurface presence of groundwater.

5. Conservation significance

5.1 Identification of threatened species under the BAM

5.1.1 Identifying threatened species for assessment

The BAM calculator automatically generates a list of threatened species potential ecosystem or species credits entities (i.e. 'predicted' and 'candidate' threatened species respectively) based on the IBRA subregion, percent native vegetation cover, patch size class and PCT data for the subject site cross-referenced with the Threatened Biodiversity Database Collection (TBDC).

Additional species not generated by the BAM calculator can be added to the list to be assessed for ecosystem and/or species credits if the species are considered likely to occur within, or to use habitats within the subject site (based on review of available ecology reports, environmental impact statements, scientific literature or detection on site during survey). For this reason, additional species identified through the desktop assessment (e.g. identified from database searches as occurring within or having the potential to occur within 10 km of the subject site) were also considered for addition to the list of predicted and candidate species (refer to Appendix A). An assessment of the likelihood that additional species not predicted by the BAM calculator was undertaken. This assessment determined that it is unlikely that any additional threatened biota (not already predicted by the calculator) would occur and therefore no additional species were added to the list of species requiring targeted survey within the subject site.

5.1.2 Refinement of list of threatened species for assessment

Once the list of potential predicted and candidate threatened species have been identified, this list can be further refined by undertaking an additional assessment of the habitat constraints or microhabitats within the subject site.

Predicted threatened species can be removed from assessment for ecosystem credits if all of the habitat constraints described for the species in the TBDC are absent from the site, otherwise the species must be retained for assessment of ecosystem credits.

Candidate threatened species can be removed from assessment for species credits if:

- All of the habitat constraints described for the species in the TBDC are absent from the site.
- Where habitat is determined to be significantly degraded.
- Where vegetation is missing key structural elements or other microhabitat features.

No targeted survey is required for species that are not confirmed candidate threatened species. For species that are confirmed, targeted seasonal survey is required to determine presence on site in order to assess species credits.

The following sections present the list of predicted and candidate species identified for the assessment of ecosystem and species credits. It also identifies and provides justifications for the exclusion of any threatened species from further assessment where applicable.

5.1.3 Predicted threatened species (ecosystem credit entities)

Based on the bioregional context for the assessment and the PCTs, patch size, vegetation cover and habitat resources present at the subject site, the BAM calculator generates a list of threatened fauna species that are predicted to utilise the subject site. The potential for these predicted species to occur within the subject site were further refined based on the desktop assessment, habitat resources observed during field surveys and the knowledge and experience of the assessor.

The suite of predicted threatened species associated with ecosystem credits for the subject site, including those species recorded during field surveys and others not recorded but which could occur given the presence of relevant habitat resources on the site, are listed in Table 5-1. For each predicted threatened species a sensitivity class rating and the associated PCT (s) is also provided. Targeted surveys are not required for these species.

In accordance with the BAM , the following predicted species that were generated by the BAM calculator are excluded from further assessment for ecosystem credits:

- Curlew Sandpiper (*Calidris ferruginea*) (foraging).
- Great Knot (*Calidris tenuirostris*) (foraging).
- Comb-crested Jacana (*Irediparra gallinacean).*
- Broad-billed Sandpiper (Limicola falcinellus) (foraging).
- Black-tailed Godwit (Limosa limosa) (foraging).
- Terek Sandpiper *(Xenus cinereus).*

Reasons for exclusion are provided in Table 5-1.

Additional threatened species that were considered for assessment for ecosystem credits based on known occurrences within the locality (particularly within 1 km of the Subject site) are not considered likely to occur within, or to utilise habitats within the Subject site (see likelihood of occurrence assessment, Appendix A).

Table 5-1 Predicted threatened species (ecosystem credit species)

Common name	Scientific name	Sensitivity class[1]	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Magpie Goose	*Anseranas semipalmata*	Moderate	1737	Yes	-
Regent Honeyeater (foraging)[2]	*Anthochaera phrygia*	High	1600	Yes	-
Australian Bittern	*Botaurus poiciloptilus*	Moderate	1737	Yes	-
Curlew Sandpiper (foraging)	*Calidris ferruginea*	High	1737	No	Not within an area mapped as important habitat by DPE (2022)
Great Knot (foraging)	*Calidris tenuirostris*	High	1737	No	Not within an area mapped as important habitat by DPE (2022)

Common name	Scientific name	Sensitivity class[1]	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Gang-gang Cockatoo (foraging) [2]	*Callocephalon fimbriatum*	Moderate	1633, 1591,1600	Yes	-
Glossy Black-Cockatoo (foraging) [2]	*Calyptorhynchus lathami*	High	1633, 1600	Yes	-
Spotted Harrier	*Circus assimilis*	Moderate	1737	Yes	-
Speckled Warbler	*Chthonicola sagittata*	High	1633, 1594, 1591, 1600	Yes	-
Brown Treecreeper (eastern subspecies)	*Climacteris picumnus victoriae*	High	1633, 1594, 1591, 1600	Yes	-
Varied Sittella	*Daphoenositta chrysoptera*	Moderate	1633, 1594, 1591, 1600	Yes	Recorded in the subject site
Spotted-tailed Quoll	*Dasyurus maculatus*	High	1633, 1594, 1591, 1600	Yes	-
Black-necked Stork	*Ephippiorhynchus asiaticus*	Moderate	1737	Yes	-
White-fronted Chat	*Epthianura albifrons*	Moderate	1737	Yes	-
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	High	1633, 1600	Yes	-
Little Lorikeet[3]	*Glossopsitta pusilla*	High	1633, 1591, 1600	Yes	Recorded in the subject site
Painted Honeyeater	*Grantiella picta*	Moderate	1633, 1600	Yes	-
White-bellied Sea-Eagle (foraging)[2, 3]	*Haliaeetus leucogaster*	High	1633, 1737, 1600	Yes	Recorded in the subject site
Little Eagle (foraging) [2]	*Hieraaetus morphnoides*	Moderate	1633,1591, 1737, 1600	Yes	-
Comb-crested Jacana	*Irediparra gallinacea*	Moderate	1737	No	Habitat constraints for this species are not present in PCT 1737 at the subject site, i.e. there is not a good surface cover of floating aquatic vegetation
Black Bittern	*Ixobrychus flavicollis*	Moderate	1737	Yes	-
Swift Parrot (foraging)[2]	*Lathamus discolor*	Moderate	1633, 1600	Yes	-
Broad-billed Sandpiper (foraging)	*Limicola falcinellus*	High	1737	No	Not within an area mapped as important habitat by DPE (2022)
Black-tailed Godwit (foraging)	*Limosa limosa*	High	1737	No	Not within an area mapped as important habitat by DPE (2022)
Square-tailed Kite (foraging)[2]	*Lophoictinia isura*	Moderate	1633, 1600	Yes	-

Common name	Scientific name	Sensitivity class[1]	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Hooded Robin (south-eastern form)	*Melanodryas cucullata cucullata*	Moderate	1633, 1594, 1591, 1600	Yes	-
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	Moderate	1633, 1600	Yes	-
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	High	1633, 1600	Yes	Recorded in the subject site
Little Bentwing-bat (foraging)[2,]	*Miniopterus australis*	High	1633, 1600	Yes	Recorded in the subject site
Large Bent-winged Bat (foraging)[2, 3]	*Miniopterus orianae oceanensis*	High	1633, 1600	Yes	Recorded in the subject site
Turquoise Parrot	*Neophema pulchella*	High	1633, 1594, 1591, 1600	Yes	-
Barking Owl (foraging)[2]	*Ninox connivens*	High	1633, 1594, 1591, 1600	Yes	-
Powerful Owl (foraging)[2]	*Ninox strenua*	High	1633, 1600	Yes	-
Corben's Long-eared Bat	*Nyctophilus corbeni*	High	1633	Yes	-
Blue-billed Duck	*Oxyura australis*	Moderate	1737	Yes	-
Eastern Osprey (foraging)[2,]	*Pandion cristatus*	Moderate	1737	Yes	-
Yellow-bellied Glider	*Petaurus australis*	High	1633, 1600	Yes	-
Scarlet Robin	*Petroica boodang*	Moderate	1594, 1591, 1600	Yes	-
Koala (foraging) [2]	*Phascolarctos cinereus*	High	1633, 1600	Yes	-
Grey-crowned Babbler (eastern subspecies)	*Pomatostomus temporalis temporalis*	Moderate	1633, 1600	Yes	Recorded in the subject site
Grey-headed Flying-fox (foraging) [2,]	*Pteropus poliocephalus*	High	1633, 1600	Yes	Recorded in the subject site
Australasian Painted Snipe	*Rostratula australis*	Moderate	1737	Yes	-
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	High	1633,1600	Yes	-
Greater Broad-nosed Bat	*Scoteanax rueppellii*	High	1633,1600	Yes	-
Diamond Firetail	*Stagonopleura guttata*	Moderate	1600	Yes	-

Common name	Scientific name	Sensitivity class[1]	Associated PCT (s)	Confirmed predicted species	Reason for exclusion from predicted species list and /or additional comments
Eastern Grass Owl (foraging)	*Tyto longimembris*	Moderate	1737	Yes	-
Masked Owl (foraging) [2]	*Tyto novaehollandiae*	High	1633,1600	Yes	-
Terek Sandpiper (foraging)	*Xenus cinereus*	High	1737	No	Not within an area mapped as important habitat by DPE (2022)

[1] Sensitivity to gain class – High = high sensitivity to potential gain, Moderate = moderate sensitivity to potential gain.

[2] These species are dual credits species (i.e. predicted ecosystem credit species based on the presence of foraging habitat as well as species credit species when breeding habitat occurs).

5.1.4 Candidate threatened species (species credit entities)

Threatened species that cannot be reliably predicted to occur at a site based on vegetation surrogates or landscape feature are identified by the TBDC as 'species credit species'. In some circumstances, the particular habitat components of species assessed for ecosystem credit species, such as the breeding habitat of a cave roosting bat or forest owls, are also assessed for species credits.

Searches of threatened species databases and review of previous ecological reports pertaining to the site were completed to determine in addition species to those generated by the BAM credit calculator that are known or predicted to occur in the locality (refer to likelihood of occurrence table in Appendix A). The likelihood of occurrence of this additional potential candidate threatened species were reviewed, giving consideration to the habitats available in the subject site.

Potential candidate threatened species that could occur in the subject site based on the habitat resources observed during field surveys were confirmed as candidate threatened species. 'Confirmed' candidate threatened species require targeted survey in accordance with Section 5.3 of the BAM (DPIE 2020a). The list of confirmed candidate threatened species is presented in Table 5-2; these species were subjected to targeted survey. Surveys were conducted in the appropriate season for all confirmed candidate threatened species and so the targeted survey results can be considered a reliable indicator of their presence or absence at the subject site.

Table 5-2 also includes confirmed candidate species credit species that are assumed present because the subject site within an area of important habitat as mapped by DPIE (2022).

A number of species could be reliably discounted as occurring within the subject site based on the habitat types present and/or the known distribution of the species. A number of dual credit fauna species have foraging habitat present but either no potential breeding habitat was identified during the field surveys, or the species does not breed in the area. These species are not 'confirmed candidate threatened species' for the purposes of this assessment and do not require further assessment. Detailed justification for the conclusion is provided in Table 5-3 and/or the 'habitat/constraints' fields in the credit calculator.

Targeted surveys for confirmed candidate species were undertaken in August, October and November 2019, February, April and October 2020 and October, November and December 2021 (refer to Table 2-7).

Five species credit species were recorded in the subject site during the field survey (refer to Section 5.2). In addition to these, the Squirrel Glider and *Acacia bynoneana* have been previously recorded on the subject site (ELA, 2016). Although neither of these species were detected during targeted surveys completed as part of this BCAR it has been assumed that the site would still be providing habitat for these species and have therefore been included as 'assumed present' species credit entities.

Table 5-2 Confirmed candidate species credit species

Common name	Scientific name	Biodiversity risk rating	Survey months	Survey completed	Recorded within subject site
Regent Honeyeater (Breeding)	*Anthochaera phrygia*	High (2)	n/a	Subject site within an area of important habitat as mapped by DPE (2022) therefore species is assumed present	
Bynoe's Wattle	*Acacia bynoeana*	High (2)	All year	Oct and Nov	Yes[1]
Trailing Woodruff	*Asperula asthenes*	High (2)	Oct-Dec	Oct and Nov	No
Bush Stone-curlew	*Burhinus grallarius*	High (2)	All year	Nov	No
Netted Bottle Brush	*Callistemon linearifolius*	Moderate (1.5)	Oct-Jan	Oct and Nov	Yes
Gang-gang Cockatoo (breeding)	*Callocephalon fimbriatum*	High (2)	Oct-Jan	Nov	No
Glossy Black-Cockatoo	*Calyptorhynchus lathami*	High (2)	Jan-Sep	Feb and Aug	No
Eastern Pygmy-possum	*Cercartetus nanus*	High (2)	Oct-Mar	Nov	No
Wallum Froglet	*Crinia tinnula*	Moderate (1.5)	All year	Feb and Nov	No
Leafless Tongue Orchid	*Cryptostylis hunteriana*	Moderate (1.5)	Nov-Jan	Nov	No
White-flowered Wax Plant	*Cynanchum elegans*	High (2)	All year	Oct and Nov	No
Pine Donkey Orchid	*Diuris tricolor*	Moderate (1.5)	Sep -Oct	Oct	No
Singleton Mallee	*Eucalyptus castrensis*	Very High (3)	All year	Oct and Nov	No
Slaty Red Gum	*Eucalyptus glaucina*	High (2)	All year	Oct and Nov	Yes
Parramatta Red Gum	*Eucalyptus parramattensis subsp. decadens*	High (2)	All year	Oct and Nov	No
Pokolbin Mallee	*Eucalyptus pumila*	Very High (3)	All year	Oct and Nov	Yes
Small-flower Grevillea	*Grevillea parviflora subsp. parviflora*	High (2)	Aug-Nov	Oct and Nov	Yes
White-bellied Sea-Eagle (breeding)	*Haliaeetus leucogaster*	High (2)	Jul-Dec	Aug	No
Little Eagle (breeding)	*Haliaeetus morphnoides*	Moderate (1.5)	Aug-Oct	Aug	No
Pale-headed Snake	*Hoplocephalus bitorquatus*	High (2)	Nov-Mar	Feb and Nov	No
Swift Parrot (Important habitat)	*Lathamus discolor*	Moderate (1.5)	n/a	Subject site within an area of important habitat as mapped by DPE (2022) therefore species is assumed present	
Green and Golden Bell Frog	*Litoria aurea*	High (2)	Nov-Mar	Feb, Nov and Dec	No
Square-tailed Kite (Breeding)	*Lophoictinia isura*	Moderate (1.5)	Sept-Jan	Nov	No
Maundia triglochinoides	*Maundia triglochinoides*	High (2)	Nov-March	Nov	No
Biconvex Paperback	*Melaleuca biconvexa*	Moderate (1.5)	All year	Oct and Nov	No
Little Bent-wing Bat (Breeding)	*Miniopterus australis*	Very High (3)	Dec-Feb	Feb	No

Common name	Scientific name	Biodiversity risk rating	Survey months	Survey completed	Recorded within subject site
Large Bent-wing Bat (Breeding)	*Miniopterus orianae oceanensis*	Very High (3)	Dec-Feb	Feb	N
Large-leafed monotaxis	*Monotaxis macrophylla*	High (2)	Aug-Feb	Oct and Nov	Yes
Southern Myotis	*Myotis macropus*	High (2)	Oct-Mar	Nov and Feb	Yes (adjacent site)
Barking Owl (breeding)	*Ninox connivens*	High (2)	May-Dec	Aug	No
Powerful Owl (breeding)	*Ninox strenua*	High (2)	May-Aug	Aug	No
Ozothamnus tessalatus	*Ozothamnus tessalatus*	Moderate (1.5)	Sep-Oct	Oct	No
Tall Knotweed	*Persicaria elatior*	High (2)	Dec-May	Dec	No
Greater Glider	*Petauroides volans*	High (2)	All year	Feb	No
Squirrel Glider	*Petaurus norfolcensis*	High (2)	All year	Feb	Yes[1]
Brush-tailed Phascogale	*Phascogale tapoatafa*	High (2)	Dec-Jun	Feb	No
Common Planigale	*Planigale maculata*	High (2)	All year	Nov	No
Scant Pomaderris	*Pomaderris queenslandica*	High (2)	All year	Oct and Nov	No
Singleton Mint Bush	*Prostanthera cinoliffera*	High (2)	Sept-Oct	Oct and Nov	No
Pterostylis chaetophora	*Pterostylis chaetophora*	High (2)	Sept-Nov	Oct and Nov	No
Heath Wrinklewort	*Rutidosis heterogama*	High (2)	All year	Oct and Nov	No
Black-eyed Susan	*Tetratheca juncea*	High (2)	Sept-Oct	Oct	No
Austral Toadflax	*Thesium austral*	Moderate (1.5)	Nov-Feb	Nov	No
Masked Owl (breeding)	*Tyto novaehollandiae*	High (2)	May-Aug	Aug	No
Mahony's Toadlet	*Uperoleia mahonyi*	High (2)	Oct-Mar	Feb and Nov	No
Zannichellia palustris	*Zannichellia palustris*	High (2)	Oct-Jan	Nov	No

[1] Recorded within subject site during previous surveys (ELA 2015).

Table 5-3 Potential candidate species not requiring survey

Common name	Scientific name	Justification
Broad-billed Sandpiper (Breeding)	*Limicola falcinellus*	Subject site not within an area of important habitat as mapped by DPE (2022)
Black-tailed Godwit (Breeding)	*Limosa limosa*	Subject site not within an area of important habitat as mapped by DPE (2022)
Brushed-tailed Rock Wallaby	*Petrogale penicillata*	Subject site not within 1 km of rocky escarpments, gorges, steep slopes, boulder piles, rock outcrops or clifflines
Curlew Sandpiper (Breeding)	*Calidris ferruginea*	Subject site not within an area of important habitat as mapped by DPE (2022)
Eastern Cave-Bat	*Vespadelus troughtoni*	Subject site does not contain any caves and is not within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines or, tunnels. Site does not have any old buildings or sheds that would provide suitable habitat for this species.
Great Knot	*Calidris tenuirostris*	Subject site not within 5 km of the coast and tidal influenced water bodies (geographic restrictions)
Green-thighed Frog	*Litoria brevipalmata*	Species expert determined that the site does not contain suitable habitat for this species (refer to Appendix E)
Grey-headed Flying Fox (breeding)	*Pteropus poliocehalus*	Subject site does not contain any breeding camps
Koala (Breeding)	*Phascolarctos cinereus*	Subject site does not contain areas identified via survey as important habitat
Large Bent-wing Bat (Breeding)	*Miniopterus orianae oceanensis*	Subject site does not contain caves, tunnels, mines, culverts or other structures known or suspected to be used for breeding
Large-eared Pied Bat	*Chalinolobus dwyeri*	Subject site does not contain any caves and is not within two kilometres of rocky areas containing caves, overhangs, escarpments, outcrops, crevices or boulder piles, or within two kilometres of old mines or, tunnels. Site does not have any old buildings or sheds that would provide suitable habitat for this species
Little Bent-wing Bat (Breeding)	*Miniopterus australis*	Subject site does not contain caves, tunnels, mines, culverts or other structures known or suspected to be used for breeding
North Rothbury Persoonia	*Persoonia pauciflora*	Subject site not within 10 km of North Rothbury (geographic limitation)
Pink-tailed Legless Lizard	*Aprasia parapulchella*	Subject site does not contain rocky areas and/or within 50 m of rocky areas
Rough Doubletail	*Diuris praecox*	Species distribution limited to Newcastle LGA (geographic limitations)
Terek Sandpiper (Breeding)	*Xenus cinereus*	Subject site not within an area of important habitat as mapped by DPE (2022)

5.2 Threatened species survey results

5.2.1 Threatened flora

Three threatened flora species were identified within the subject site during the current survey (see Figure 8-1 to Figure 8-3). These are:

- Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*), which is listed as a vulnerable species under the BC Act and EPBC Act. Approximately 1,495 individuals of this species were recorded within the site within five discrete areas. A species polygon has been created that includes areas of suitable habitat for the Small-flowered Grevillea.
- Netted Bottle Brush (*Callistemon linearifolius*) which is listed as a vulnerable species under the BC Act. A total of 400 individuals of this species were recorded within the subject site.
- Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*) which is listed as a vulnerable species under the BC Act and EPBC Act. A total 3224 individuals of this species were recorded within the subject site.

One additional threatened flora species (Bynoe's Wattle (*Acacia bynoeana*)) which is listed as an endangered species under the BC Act and a vulnerable species under the EPBC Act) has previously been recorded within the subject site (ELA 2016) as shown on Figure 8-4. Six Bynoe's wattle individuals were recorded scattered along an access track in the north-east of the subject site (ELA 2016). Targeted surveys that were completed in October and November 2019 and October 2020 did not record this species within the development site. Given these individuals were growing along an access track it is possible that they have been impacted by vehicle movements, it is also possible that the extended drought period in recent years has resulted in mortality of these individuals. Nevertheless as this species can be inconspicuous when not in flower, is known to appear periodically and may survive within a stored soil seed bank (Benson and McDougall 1996), these individuals have been assumed to still be present within the site.

Suitable habitat for candidate threatened flora species was traversed on foot at an appropriate time of year for identifying each of the species identified in Table 2-5. Field staff were able to traverse all areas of suitable threatened flora habitat, in a manner that reflected threatened species survey guidelines (DPIE 2020b, Cropper 1993). Candidate threatened flora species not recorded during the targeted surveys can be excluded from occurring at the subject site, given they were not observed during targeted surveys.

Detailed stem counts for *Eucalyptus parramattensis* subsp *decadens* and *Callistemon linearifolius* were completed as part of the targeted field surveys for the BCAR. For species that are assessed using area calculations, points were collected for individuals and/or groups of individuals within the subject site. These points combined with previous records within the development site were then used to inform the threatened species polygons (ELA 2016 and DPIE 2019). Targeted surveys completed by ELA in 2015 were completed in accordance with the OEH threatened species survey guidelines and were undertaken by skilled and experienced botanists. A shape file showing GPS tracks of parallel transverses completed by GHD and ELA has been provided as part of the package of GIS files submitted with this BCAR.

5.2.2 Threatened fauna

Ecosystem credit species

Eight threatened fauna species classified as ecosystem credit species were recorded during field survey. These are:

- Grey-crowned babbler (*Pomatostomus temporalis*)
- Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*)
- Grey-headed flying fox (*Pteropus poliocephalus*)
- Little Bent-wing Bat (*Miniopterus australis*)
- Large Bent-wing Bat (probable) (*Miniopterus orianae oceanensis*)
- Varied Sittella (*Daphoenositta chrysoptera*)
- Little Lorikeet (*Glossopsitta pusilla*)
- White-bellied Sea-eagle (*Haliaeetus leucogaster*)

All these species area listed as vulnerable under the BC Act. The Grey-headed Flying-fox is also listed as a vulnerable species under the EPBC Act.

Dual credit species

The Grey-headed Flying-fox (*Pteropus poliocephalus*), the Little Bent-wing Bat (*Miniopterus australis*) the Large Bent-wing Bat (*Miniopterus orianae oceanensis*) and the White-bellied Sea Eagle (*Haliaeetus leucogaster*) are listed in the TBDC as dual credit species meaning that that they require offsets through ecosystem credit species for impacts to foraging habitat and through species credits where breeding habitat is impacted. For the purposes of this assessment all four of these species are considered to be ecosystem credit entities only, as there are no Grey-headed Flying-fox breeding camps or suitable breeding habitat for the Large Bent-wing Bat or Little Bent-wing Bat (i.e. caves, tunnels, mine shafts) located within or adjacent to the subject site. Similarly, there were no large stick nests or White-bellied Sea Eagles carrying nesting material observed within the subject site during surveys completed to target breeding habitat for this species.

Species credit species

Two species credit type threatened fauna species were identified within the subject site during field surveys:

- Southern Myotis (*Myotis macropus*) (listed as a vulnerable species under the BC Act).
- Large-eared-Pied Bat (*Chalinolobus dwyeri*) (listed as a vulnerable species under the BC Act and EPBC Act).

Approximately ten Southern Myotis individuals were observed roosting within a culvert that runs under an active train track adjacent to the site.

Calls of the Large-eared Pied Bat (*Chalinolobus dwyeri*) were recorded within the subject site on an Anabat Express Zero Crossing detector (Titley Scientific) on two separate nights during the survey period (refer to refer to Figure 8-5 for location of recording). This species is likely to be utilising the site for foraging habitat only as there is no breeding habitat (i.e. caves, scarps, cliffs, rock overhangs, disused mines or suitable old buildings) present within or nearby to the subject site (within 2 km). As no breeding habitat occurs at or adjacent to the subject site a species polygon is not required for this species (OEH 2018).

Squirrel Gliders (*Petaurus norfolcensis*) have been previously observed within the subject site (ELA 2016). Although this species was not recorded during targeted surveys completed in February 2020, based on the known previous records and presence of suitable habitat it is assumed that this species is present within the subject site.

As described above, the Grey-headed Flying-fox is a dual credit species that is listed as a vulnerable species under the BC Act and the EPBC Act. A number of individuals were recorded flying over and foraging within the subject site during surveys completed in November 2019 and February 2020. There is potential for Grey-headed Flying-fox to utilise myrtaceous species within the site for foraging. No Grey-headed Flying-fox roosts were recorded within the site.

Ultrasonic recordings of bat calls taken during targeted surveys completed in November 2019 and February 2020 identified 58 definite calls of the Little Bent-wing Bat and nine 'probable' calls of the Large Bent-wing Bat. The site contains foraging habitat for both these species however does not contain any breeding habitat for these species (caves, tunnels, mines, culverts or other structures suitable for breeding) and as such they are not considered species credit entities for the purpose of this assessment.

Dual credit species with mapped important habitat within the subject site

For a small number of species, the habitat constraint information in the TBDC refers to an important habitat map (Biodiversity Assessment Method (BAM) section 5.1.3). Important habitat maps identify areas that are considered essential to support critical life stages of the species, e.g. breeding areas or locations important for foraging/over-wintering for migratory species. These species are dual credit species assessed for species (important habitat map) and ecosystem credits (all other areas the species is likely to occur).

A small number of dual credit species have important habitat maps. The approach is restricted to species that are highly mobile and difficult to reliably detect by survey, and for which DPIE holds extensive, long-term data sets that indicate the importance of areas in the landscape.

No further survey is required if the subject land is on an important habitat map for a species unless the species profile in the TBDC states otherwise. The species is considered present and the part of the subject land that is within the important habitat map forms the species polygon used to generate species credits (BAM section 5.2.5 Box 2). Any remaining habitat on the subject land, e.g. foraging, unmapped locations used by these species is assessed for ecosystem credits.

There is important habitat mapped within the subject site for two threatened species; the Swift Parrot (*Lathamus discolor*) and Regent Honeyeater (*Anthochaera phrygia*). Species credits have therefore been calculated for areas within the subject site that are covered by the important habitat mapping (refer to Figure 8-8 and Figure 8-8) (DPIE 2022f).

Threatened species not detected during targeted survey

There is broadly suitable habitat for the remaining candidate threatened fauna species listed in Table 5-2 within the subject site. However as none were recorded during multiple targeted field surveys undertaken at a suitable time of year to detect these species (including spotlighting, call play back, Anabat detector, camera trap, pit fall traps, harp traps and Elliott trap surveys completed for this BCAR as well as previous comprehensive surveys within the site (ELA 2016 Cenwest 2004), these candidates threatened fauna species can be reliably discounted as occurring at the subject site. As such no species credits are required to be calculated for the remaining candidate threatened fauna species which were not detected at the subject site.

Species polygons have been mapped for all species credit species recorded within the subject site. The method for calculating species polygons is outlined in Section 8.1.2.

5.2.3 Threatened ecological communities

Four endangered ecological communities (EECs) listed under the BC Act and one critically endangered ecological community (CEEC) listed under the EPBC occur within the subject site (refer to Figure 5-1 and Figure 5-2).

- Vegetation mapped within the site as PCT 1633 comprises part of an occurrence of Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC.
- Vegetation mapped as PCT 1491 comprises part of an occurrence of Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC.
- Vegetation mapped as PCT 1600 comprises part of an occurrence Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC.
- Vegetation mapped as PCT 1594 comprises an occurrence of River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions EEC. Parts of this community also meet the condition thresholds for the CEEC listed under the EPBC Act as River-flat Eucalypt Forest on Coastal floodplains of southern NSW and eastern Victoria.

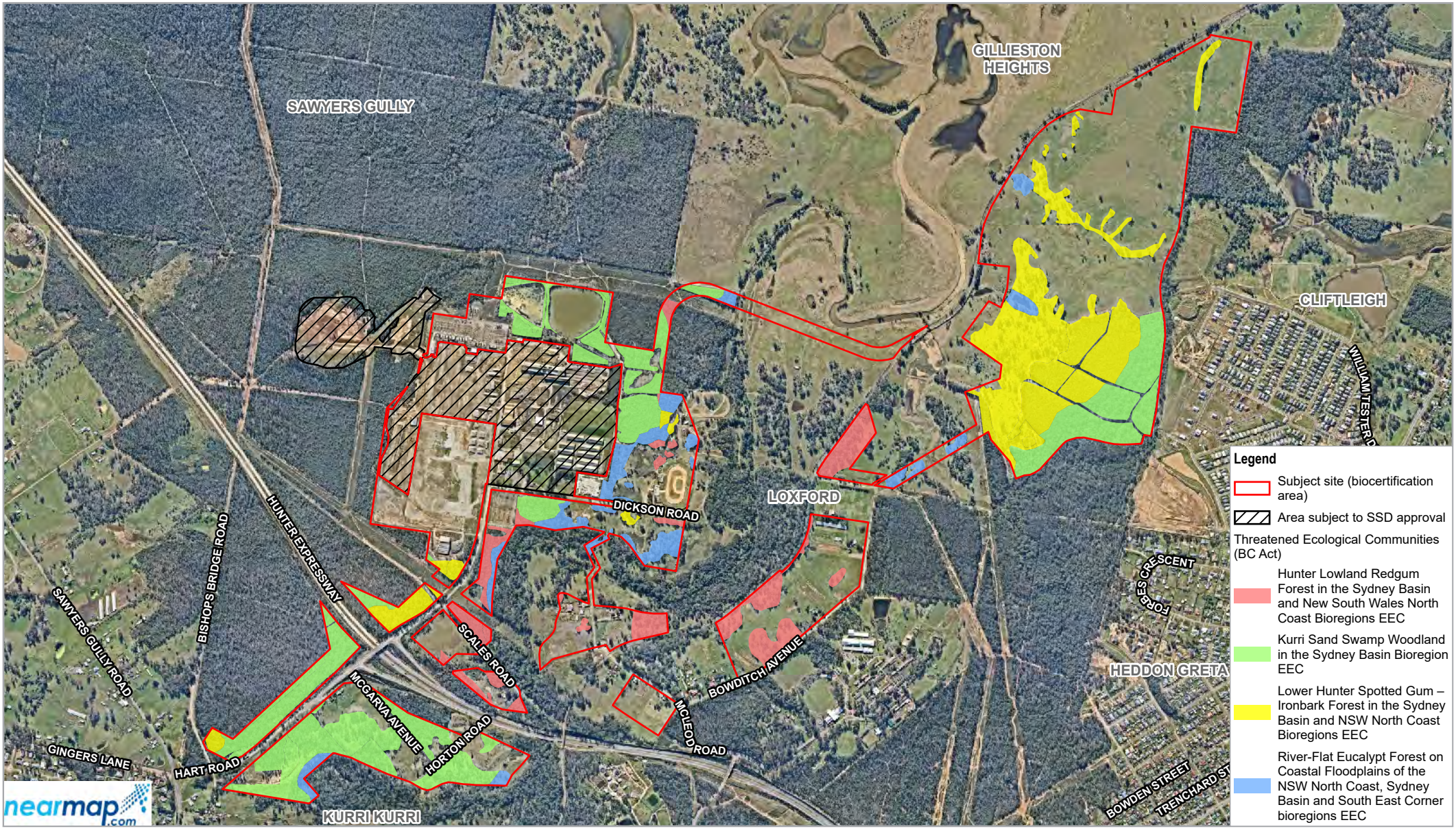
Table 5-4 lists the PCTs within the subject site that are commensurate with EECs and describes the key attributes of the EECs noting how these align with the assigned PCT.

Table 5-4 Threatened ecological communities within subject site

PCT	EEC listing	Conforming attributes	Area (ha)
(PCT 1633) Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion	An analysis of the landscape position, soil landscape, geology and floristics of this PCT within the subject site with reference to the final determination for Kurri Sand Swamp Woodland in the Sydney Basin Bioregions (TSSC 2010) indicates that PCT 1594 within the subject site conforms to this EEC for the following reasons: • The community occurs within the Sydney Basin Bioregion and within the local government areas of Maitland and Cessnock, which is within the known distribution of the ecological community. • Occurs on soils developed over poorly-drained Tertiary sand deposits that blanket Permian sediments in the Kurri Kurri area. • Low woodland dominated by Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*). *Angophora bakeri* also present in lower numbers. • Shrubby mid-storey dominated by *Melaleuca nodosa.* • Other characteristic species are present in this community, including *Eucalyptus capitellata, Eucalyptus fibrosa, Aristida vagans, Lambertia formosa, Leptospermum polygalifolium, Dillwynia retorta, Melaleuca thymifolia and Entolasia stricta* • Disturbed remnants are considered to form part of the community.	47.73
(PCT 1594) Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions	An analysis of the landscape position, soil landscape, geology and floristics of this PCT within the subject site with reference to the final determination for River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner bioregions (TSSC 2011a) indicates that PCT 1594 within the subject site conforms to this EEC for the following reasons: • Associated with silts, clay-loams and sandy loams on periodically inundated alluvial flats, drainage lines and river terraces associated with coastal floodplains • Generally occurs below 50 m elevation but may occur up to 250 m – Within the subject site this PCT occurs at an elevation of approximately 25-50 m • Often fringe treeless floodplain lagoons or wetlands with semi-permanent standing water. Within the subject site this vegetation occurs within the floodplain surrounding Wentworth Swamp • Vegetation structure consist of an open woodland dominated by Cabbage Gum (*Eucalyptus amplifolia*) and Rough-barked Apple (*Angophora floribunda*) • Numerous flora species recorded within the PCT included on list of diagnostic species provided in the scientific determination for this EEC including Forest Red Gum (*Eucalyptus tereticornis*), Native Blackthorn (*Bursaria spinosa*), Weeping Grass (*Microlaena stipoides*), Wiry Panic (*Entolasia stricta*), Spiny-headed Mat-rush (*Lomandra longifolia*) and Rock Fern (*Cheilanthes sieberi*) • There are relatively low numbers of She Oaks, Paperbarks and no Swamp Mahogany trees were recorded within this PCT	10.83 (BC Act EEC) 7.3 (EPBC Act CEEC)

PCT	EEC listing	Conforming attributes	Area (ha)
		Detailed survey and analysis of this vegetation against key diagnostic characteristics outlined in the conservation advice for River-flat Eucalypt Forest on coastal floodplains of southern NSW and eastern Victoria confirms that 7.6 ha of PCT 1594 within the subject site comprises a C2 moderate condition occurrence of the related CEEC listed under the EPBC Act for the following reasons: • Occurs in the Sydney Basin IBRA region • Occurs within the lower hunter catchment • Occurs at elevation less than 50 meters ASL • Occurs on alluvial landforms on river terraces of swamp creek • Canopy cover greater than 20 percent and dominated by *Eucalyptus amplifolia* • Other species present are characteristic of the species listed in Appendix A of the conservation advice • Patch sizes included areas greater than 0.5 ha	
(PCT 1591) Grey Gum – Rough-braked Apple shrubby open forest of the lower Hunter	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions	An analysis of the landscape position, soil landscape, geology and floristics of this PCT within the subject site with reference to the final determination for Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions (TSSC 2011b) indicates that PCT 1591 within the subject site conforms to this EEC for the following reasons: • Site located within the Sydney Basin bioregion • Within subject site occurs on gentle slopes arising from depressions and drainage flats on Permian sediments • Dominate species include Grey Gum (*Eucalyptus punctata*) and Narrow-leaved Ironbark (*Eucalyptus crebra*) • Whilst the midstorey is quite shrubby in area rather than sparse as indicated by the EEC determination, this is likely a product of recent fires in the area Detailed survey and analysis of this vegetation against key diagnostic characteristics outlined in the conservation advice for River-flat Eucalypt Forest on coastal floodplains of southern NSW and eastern Victoria confirms that 0.3 ha of PCT 1591 within the subject site comprises a C2 moderate condition occurrence of the related CEEC listed under the EPBC Act for the following reasons: • Occurs in the Sydney Basin IBRA region • Occurs within the lower hunter catchment • Occurs at elevation less than 50 meters ASL • Occurs on alluvial landforms on river terraces of swamp creek • Canopy cover greater than 20 percent and dominated by *Eucalyptus mollucana* • Other species present are characteristic of the species listed in Appendix A of the conservation advice • Patch sizes included areas greater than 0.5 ha	14.99 (EEC BC Act) 0.3 (EPBC Act CEEC

PCT	EEC listing	Conforming attributes	Area (ha)
(PCT 1600) Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	An analysis of the landscape position, soil landscape, geology and floristics of this PCT within the subject site with reference to the final determination for Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions (TSSC 2019) indicates that PCT 1600 within the subject site conforms to this EEC for the following reasons: • Subject site occurs on Permian geology in the Hunter Valley • Vegetation forms an open forest • EEC known to occur in the Cessnock LGA • Community dominated by *Eucalyptus crebra* (Narrow-leaved Ironbark) and *Eucalyptus fibrosa* (Red Ironbark) with *Corymbia maculata* (Spotted Gum) and *Eucalyptus moluccana* (Grey Box) also occurring occasionally • Community is strongly associated with the Neath and Branxton soil landscapes • Shrub layer is characterised by Native Blackthorn (*Bursaria spinosa*), *Pultenaea spinosa, Melaleuca nodosa* and Coffee Bush (*Breynia oblongifolia*) • Grass and forb species characteristic of the EEC are present including Threeawn Speargrass (*Aristida vagans*), Weeping Grass (*Microlaena stipoides*), Kangaroo Grass (Weeping Grass), Wattle Matt-rush (*Lomandra filiformis*), Spiny-headed Mat-rush (*Lomandra longifolia*), Many-headed Mat-rush (*Lomandra multiflora),* and False Sarsaparilla (*Hardenbergia violacea*) This ecological community belongs to a complex of communities that include Spotted Gum as a dominant species. An analysis against the key characteristics outlined in the Final *Determination* for Central Hunter Spotted Gum –Ironbark –Grey Box Forest (TSSC 2011c) which is also known to occur in the Cessnock region determined that the vegetation on site more closely aligns to Lower Hunter Spotted Gum-Ironbark Forest EEC for the following reasons:	36.38
		• Presence of Eucalyptus fibrosa as a dominant species within canopy layer is one of the features that differentiates this community from Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC • The shrub layer is dominated by prickly shrubs within the Lower Hunter Community.	



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Threatened ecological communities (BC Act)

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Figure 5-1

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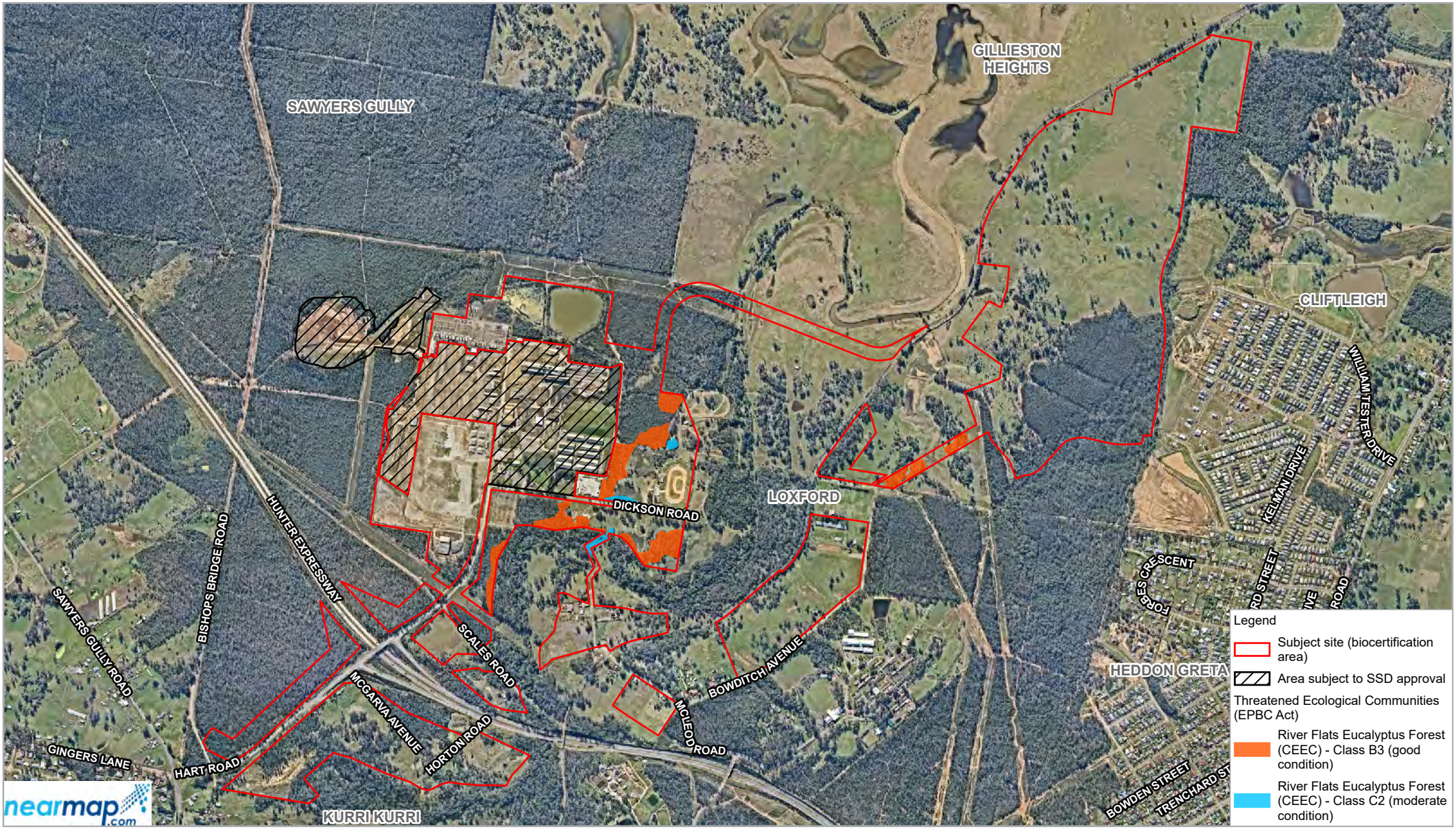
Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; LPI: DTDB / DCDB, 2017. Created by: fmackay



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Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Threatened ecological communities (EPBC Act)

Project No. **22-20284**
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Date **01/06/2022**

Figure 5-2

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Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

6. Measures to avoid and minimise impacts

6.1 Overview

The proposed development has involved a lengthy and dedicated iterative and integrative design process, to avoid and minimise impacts on biodiversity values, as far as practicable. This process has been coupled with the need to still enable a viable development, which aims to achieve the economic, employment and environmental objectives for the Hunter region identified in the NSW State Plan 2021, Hunter Regional Plan 2036 and the Greater Newcastle Metropolitan Plan 2036.

Development on the land proposed for biodiversity certification will however result in unavoidable direct impacts on native biota and their habitats. There is also the potential for indirect impacts on retained areas of native vegetation adjacent to the subject site, both during construction and from the resulting residential and industrial use of the land.

The proposed rezoning masterplan for the site is shown in Figure 1-2. Development on the subject site would include the removal or modification of approximately 110.84 ha of native vegetation.

Specific mitigation measures are recommended to minimise likely impacts on biodiversity values. These measures are presented according to the hierarchy of avoidance and mitigation of impacts, and finally the provision of offsets to compensate for residual impacts of the proposal that cannot be avoided or mitigated.

The masterplan has undergone several iterations to respond to the subject site's identified opportunities and constraints, including its biodiversity values. The preferred masterplan has been specifically designed to avoid and minimise impacts on threatened ecological communities and other biodiversity values such as threatened biota and seeks to maintain habitat connectivity with surrounding lands to the north and west of the site. To further minimise the proposals potential impacts on biodiversity values, a series of mitigation and management measures have been identified for implementation during the construction and operational phases of future development on the subject site.

6.2 Avoidance of impacts

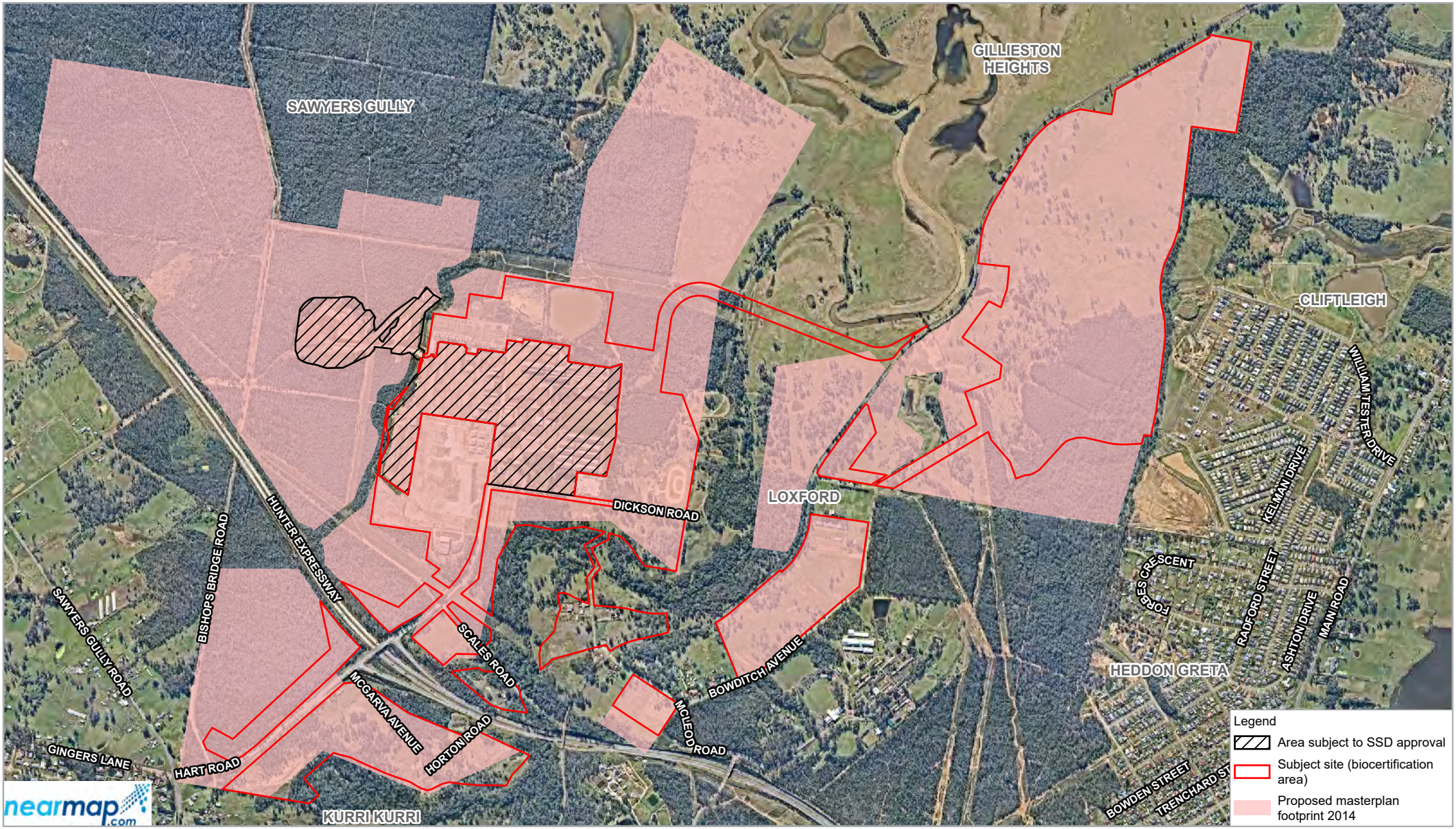
The proposed development site rezoning masterplan footprint has undergone a number of revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value within the Hydro lands could be avoided as far as is practical. Various iterations of the masterplan footprint have been developed and amended in response to detailed understanding of the site’s biodiversity values and offsets requirements. Hydro’s intention through the rezoning process and development of the preliminary masterplan was to avoid and minimise impacts on areas of the site with high biodiversity values within the site (including habitat for Swift Parrot and Regent Honeyeater) and to balance their offset requirements for land identified for development with likely credits that would be created within the areas proposed for conservation.

The Hydro lands include the 270 ha subject site assessed in this BCAR as well as approximately 1750 ha of adjoining land, part of which is proposed to be conserved as a stewardship site that will be used to generate credits to offset the impacts of the rezoning proposal. In 2014, an initial assessment was completed that assessed and evaluated a range of identifiable constraints within the entire Hydro land parcel. This assessment process produced a preliminary masterplan for the site. The intention of the preliminary masterplan was to be able to identify broad characteristics and potential land uses, which was then subject to more detailed study and refinement. In general, the characteristics that were considered when developing the preliminary masterplan for the site were developable land, conservation land and flood prone/rural land. Regarding the native vegetation on site, the assessment considered and put forward the conservation of areas of highest biodiversity value, which are located to the north-west of the site and focused areas for development predominantly in previously disturbed areas and isolated patches of low and/or poor condition vegetation or at the edges of larger patches of existing vegetation.

Following the design of the preliminary masterplan, a Biodiversity Certification Assessment (BCA) of the site was prepared in accordance with the provisions in the now repealed *Threatened Species Conservation Act 1995* (ELA 2016). As part of this assessment an initial desktop assessment using the BioBanking Assessment Methodology (BBAM) calculator was undertaken to determine if the quantum and type of offsets proposed would satisfy the credits required by the proposal. It became clear that at this early stage that the proposed credits generated in the conservation area was not sufficient to offset the development footprint identified in the Preliminary Masterplan. The results of this assessment indicated there would be a considerable 'shortfall' in the credits required to offset the development impacts from the proposed onsite conservation area. Based on recommendations in the BCA (ELA 2016), Hydro amended the masterplan to further avoid impacts on biodiversity values, with the footprint of the development lands reduced from 1229 ha to 657 ha, resulting in the avoidance of impacts to an additional 570 ha of EEC and 572 ha of potential Swift Parrot and Regent Honeyeater habitat (based on previous assessments). Initial calculations completed as part of the BCA indicated at that time the credit balance between development and conservation land was in positive, with surplus ecosystem credits likely to be generated.

Further refinement and update of the rezoning masterplan was undertaken in 2019 in order to further reduce impacts to areas of high biodiversity value. This resulted in the area of development land being further reduced to 243 ha. These amendments resulted in the further avoidance of approximately 45 ha of Kurri Kurri Sand Swamp Woodland EEC (representing high quality Regent Honeyeater and Swift Parrot habitat) located around the proposed containment cell and areas to the north-east of the smelter site.

The reduction in the project footprint as a result of avoidance measures between the original 2014 Masterplan and current Masterplan for the site is provided in Figure 6-1.



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Avoidance of impacts

Figure 6-1

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Print date: 01 Jun 2022 - 14:35

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

6.2.1 Biodiversity Stewardship Site

Approximately 770 ha of the Hydro Lands will be secured within a biodiversity stewardship site (BSS). Credits generated within the BSS would be retired to enable the development to commence. The proposed BSS will be protected and managed through the establishment of a Biodiversity Stewardship Agreement (BSA) under the BC Act. The biodiversity credits generated by the BSS would be used to meet the credit requirements for development of the subject site as far as possible. Additional credits may be needed to meet the credit requirements of the development in accordance with the BAM. Any shortfall in credits would be sourced from either alternative BSS site/s, purchased through the "open market" or via a payment into the BCF in accordance with the trading rules associated with the BOS and the requirements for offsetting impacts to MNES under the Amending Agreement, as applicable.

The proposed BSS broadly occurs on the large parcels of Hydro land that occur to the north and west of the subject site, but also includes parts of the vegetated riparian corridors along Swamp Creek. PCTs within the BSS are broadly reflective of the vegetation community's that occur in the subject site.

The proposed BSS contains areas of high biodiversity values, including a large population of Parramatta Red Gum as well as Small Flowered Grevillia and Netted Bottlebrush. The site also provides known habitat for the Squirrel Glider, Southern Myotis as well as a range of other threatened fauna. The BSS also contains areas of mapped important habitat for the Regent Honeyeater and Swift Parrot.

The proposed stewardship site would be assessed in accordance with the BAM and a separate Biodiversity Stewardship Site Assessment Report (BSSAR) would be prepared that would describe the ecosystem and species credits generated at the site. A Site Management Plan (SMP) would be prepared to describe the restoration and management actions required to be undertaken at the site to improve biodiversity values. The SMP would be accompanied by a Total Fund Deposit (TFD) amount which would determine the funds that would be required to implement the restoration and management program in perpetuity. An application for a BSA would then be lodged with the Biodiversity Conservation Trust (BCT).

Further information regarding the proposed measures that would be undertaken to offset the proposed development are provided in Appendix K.

6.3 Proposed measures to mitigate impacts

6.3.1 Construction phase

Construction Environmental Management Plan

A Construction Environmental Management Plan(s) (CEMP) would be required for the construction phase of the Project to comply with the conditions of approval for future Development Applications at the site. CEMPs are required to specify environmental safeguards for the protection of biodiversity values on neighbouring properties and waterways in accordance with relevant Government policy and guidelines and development conditions. Mitigation measures will typically include, as a minimum, industry-standard measures for the management of soil, surface water, weeds and pollutants, as well as site-specific mitigation measures and procedures to mitigate impacts of flora and fauna and SAII entities.

The mitigation and management measures relating to direct, indirect and prescribed impacts are summarised in Table 6-1 would be expected to be implemented as part of the CEMPs for future development at the subject site in order to minimise the potential impacts of the proposal on biodiversity values including SAII entities.

Vegetation would be removed in four stages over several years. This would further help to minimise impacts of vegetation removal through reducing immediate competition within surrounding vegetation following each round of clearing.

Table 6-1 Mitigation measures (construction)

Impact	Mitigation	Timing	Responsibility
General	All workers are to be provided with an environmental induction prior to starting work on site. This would include information on the ecological values of the site, protection measures to be implemented to protect biodiversity and penalties for breaches.	Prior to clearing/construction works.	Construction contractor
	Prepare a flora and fauna management sub-plan as part of the CEMP, incorporating recommendations below, and expanding on specific details where necessary.	Prior to clearing/construction works.	Construction contractor
	Measures to suppress dust implemented during clearing and construction.	Throughout clearing and construction phases.	Construction contractor
	Limit disturbance of vegetation to the minimum necessary to undertake the proposal.	Prior to works commencing.	Construction contractor
	Any lighting used during construction should be appropriately positioned to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats	Prior to works commencing.	Construction contractor
BSS	Identify and fence the proposed BSS as described under 'vegetation clearing' in order to exclude access by construction personnel and avoid indirect impacts. Ensure that construction contractors are aware of the biodiversity value and sensitivity of the BSS through site inductions and toolbox meetings.	Prior to clearing/construction works.	Construction contractor
Vegetation clearing	Prior to the commencement of any work in or adjoining areas of native vegetation, a survey would be carried out to mark the construction impact boundary. The perimeter of this area will be fenced using high visibility fencing and clearly marked as the limits of clearing. All vegetation outside this fence line will be clearly delineated as an exclusion zone to avoid unnecessary vegetation and habitat removal. Fencing and signage must be maintained for the duration of the construction period. Fencing should be designed to allow fauna to exit the site during clearing activities. Clearing will be undertaken in stages to reduce immediate competition for resources in surrounding vegetation.	Prior to clearing / Daily inspections of exclusion zones during works in area.	Construction contractor and qualified ecologist
Sedimentation	Stockpiles of fill or vegetation should be placed within existing cleared areas (and not within areas of adjoining native vegetation).	Prior to clearing/ construction works.	Construction contractor
	Sediment fences should be installed to prevent transfer of sediments into adjacent vegetation.	Prior to clearing/ construction works.	Construction contractor
Introduction of Weeds and Pathogens	A weed and pest species management sub-plan would be developed and implemented as part of project CEMP to manage weeds and pathogens during the construction and operational phase of the proposal. This sub-plan would include but not be limited to the following:	Prior to clearing/ construction works.	Construction contractor
	Provisions for identify the location and extent of any priority and/or high threat environmental weeds within the site	Prior to clearing/ construction works.	Construction contractor and qualified ecologist
	Protocols for the management of noxious and environmental weeds	Prior to clearing/ construction works.	Construction contractor and qualified ecologist

Impact	Mitigation	Timing	Responsibility
	Protocols to prevent the introduction and/or spread of pathogens and weeds	Prior to any plant or machinery being brought onto the site.	Construction contractor
	Protocols to limit the spread of weed propagules downstream of subject site.	Prior to clearing/ throughout construction works.	Construction contractor
Removal of fauna habitat	The flora and fauna management sub-plan would be developed and implemented to minimise impacts to fauna during clearing works. This plan would include but not be limited to: • Provisions for preclearing surveys to identify significant habitat features such as hollow bearing trees, logs and nests • Protocols for the removal of hollow bearing trees and other identified significant habitat features • Protocols to prevent introduction or spread of chytrid fungus in accordance with Office of Environment and Heritage Hygiene protocol for the control of disease in frogs (DECCW 2008c) • Protocols for the salvage and relocation of fallen logs and hollows (where appropriate) • Staged removal of vegetation to minimise competition for resources within surrounding vegetation • Provisions to have suitably qualified ecologist present during vegetation clearing • Protocols for the appropriate handling, capture and release of fauna • Provisions for stages vegetation removal to increase the opportunity for fauna to vacate the site and disperse into areas of adjoining habitat to evade injury • Protocols for post clearing reporting	Prior to clearing.	Qualified Ecologist / Construction contractor
Water Quality and aquatic habitats	Erosion and sediment control plans should be prepared in accordance with Volume 2D of Managing Urban Stormwater: Soils and Construction (DECC 2008d). The erosion and sediment control plans would be established prior to the commencement of construction and be updated and managed throughout as relevant to the activities during the construction phase.	Prior to construction commencing.	Construction contractor
	Erosion and sediment control controls would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality.	Weekly during construction phase or after any significant rainfall event.	Construction contractor
	Stabilised surfaces should be reinstated as quickly as practicable after construction.	Immediately following clearing.	Construction contractor
	Appropriate speeds are to be enforced to limit dust generation and minimise chances of fauna mortality through vehicle strike.	During construction	Construction contractor
	All stockpiled material should be stored in bunded areas and kept away from waterways to avoid sediment or contaminants entering the waterway.	During construction	Construction contractor
	Spill kits would be made available to construction vehicles. A management protocol for accidental spills would be put in place.	During construction	Construction contractor

6.3.2 Operational Phase

It is recognised that there are interface issues associated with the occupation of the subject site, in particular in areas adjoining the proposed biodiversity stewardship site and the potential for indirect impacts on biodiversity values. There will be a need to continue to explore different mechanisms to appropriately manage potential interface impacts, including plans of management and covenants on title at the subject site.

Environmental Management Plans (EMPs) (or similar) would be required for the operational life of the proposal and would be prepared prior to the issue of the subdivision certificates. Future plans would include, as a minimum, measures to appropriately manage matters such as stormwater infrastructure, open space and APZ's as well as industry-standard measures for the management of soil, surface water, weeds and pollutants. The proposed mitigation measures would include environmental safeguards for protection of the retained areas, neighbouring properties and waterways in accordance with relevant policy documentation and Government guidelines.

In order to appropriately address the potential impacts of the proposal on biodiversity, the mitigation and management measures outlined in Table 6-2 would be implemented as part of the EMP for the site. Table 6-2 has been prepared with reference to section 9.3 of the BAM and includes an assessment of the risk of these mitigation measures not succeeding and adaptive management responses to address any consequences.

Further detail regarding environmental management and mitigation measures and details of monitoring required to help identify any shortfalls in the implementation of the proposed mitigation measures and appropriate management responses would be further developed once the subdivision layout and specific uses throughout the subject site have been confirmed. Include.

Table 6-2 Environmental management measures (operation)

Impact	Mitigation	Timing	Responsibility	Risk	Adaptive management response
General subject site management	All property owners / tenants are to be provided with an environmental induction prior to occupying site. This would include information on the biodiversity values of the site and surrounding area, protection measures to be implemented to protect biodiversity and any penalties for breaches. In particular, site occupiers would be made aware of the biodiversity value and sensitivity of the BSS and any restrictions on access and activities.	Prior to occupying the site.	Contractor	Nil	N/A
General subject site management	Animal and speed limit signposting to raise resident, visitor and driver awareness and enforce appropriate speed limits along the proposed access road to reduce the likelihood of vehicle strike and mortality of native fauna.	In perpetuity	Landowner	Failure to comply with speed limits resulting in fauna mortality.	Construction of speed humps or other physical speed deterrents.
Edge effects	APZs will be managed to act as a buffer to minimise edge effects potentially including weed, light and erosion impacts on adjacent areas of retained vegetation.	In perpetuity	Landowner/s	Increased extent or cover of exotic plants in APZs threatening adjoining areas of native vegetation.	Periodic monitoring and adaption and/or intensification of bush regeneration activities to reduce weed cover, restore native vegetation cover etc as required.
	Control of priority weeds within the subject site to prevent the spread of propagules into adjacent areas of native vegetation.	In perpetuity	Landowner/s	Increased extent or cover of priority weeds.	Periodic monitoring and adaption and/or intensification of weed control activities.
	Street lighting and security lighting to be designed to direct light away from adjoining bushland areas and to limit the impacts of light spill on native fauna habitats. Lighting design must identify and adopt technologies that are least likely to adversely affect fauna use of habitat through impacts such as disruption of microbat foraging. This should consideration of light colour and intensity, provision of light shields and other measures as appropriate to the position of lighting relative to off-site habitats.	In perpetuity	Landowner	Disturbance of fauna habitat adjacent to subject site.	Redesign lighting to minimise impacts to adjacent habitat.
Water Quality and aquatic habitat	Water Sensitive Urban Design infrastructure, perimeter roads and setbacks would be included in APZ. Water Sensitive Urban Design infrastructure should be appropriately maintained. This includes Gross Water Pollution Traps, ponds and bioretention basins.	In perpetuity	Landowner/Council	Poorly maintained infrastructure may result in downstream impacts to Swamp Creek.	Water Sensitive Urban Design infrastructure to be repaired or upgraded.

Impact	Mitigation	Timing	Responsibility	Risk	Adaptive management response
	Erosion and sediment control would be regularly inspected, particularly following rainfall events, to ensure their ongoing functionality.	After any significant rainfall event	Landowner/Council	Failure of erosion and sediment controls may result in downstream impacts to Swamp Creek.	Erosion and sediment controls showing signs of deterioration to be repaired or replaced as required.
	All stockpiled chemicals and materials should be stored in bunded areas and kept away from waterways to avoid contaminants entering the waterway.	In perpetuity	Landowner	Failure of bunds may result in contamination.	Bunds showing signs of deterioration to be repaired or replaced as required.
BSS management	An appropriate restriction on title be placed on lands through a Biodiversity Stewardship Agreement (BSA) The BSS will be managed to protect and enhance biodiversity values under the BSA.	As soon as practical after approval of the proposal.	Landowner	Inadequate protection of BSS.	Include as a requirement in conditions of approval for the proposal.
BSS management	Identify and fence the proposed BSS along boundaries with the subject site in order to exclude unauthorised access and avoid indirect impacts. Boundaries with other areas of native vegetation should be left unfenced to allow for fauna movement and for firefighting activities. Install boundary fencing to provide a clear physical barrier to human access and incorporate appropriate signage; gates as appropriate to allow management activities; and a strip of silt fencing along the base to help mitigate sedimentation and transmission of weeds. Ensure that site occupiers and visitors are aware of the biodiversity value and sensitivity of the BSS.	Prior to occupying the site.	Landowner / contractor	Inadequate maintenance of fences. Failure of fences to mitigate impacts.	Addressed by the BSA.
Impacts to SAII entities	Undertake noisy miner control within the adjoining BSS to reduce potential edge effect impacts Noisy miner control will be undertaken as part of ongoing pest management obligations within the adjoining BSS.	In perpetuity	BSS owner	Increased noisy miner population reducing suitability of habitat with the BSS for Swift Parrot and Regent Honeyeater.	Increase frequency and intensity of noisy miner control adjacent to site.

7. Impact Assessment

7.1 Direct Impacts

7.1.1 Removal or modification of vegetation

Conferral of biodiversity certification on the 270 ha subject site would result in direct impacts on approximately 110.84 ha of native vegetation (Table 7-1).

The clearing of native vegetation would involve the removal of threatened flora species as well as a moderate diversity of non-threatened native plants, including mature and hollow-bearing trees. Mature trees have value within plant populations because they take longer to replace and are sources of habitat, pollen and seed.

The flora species credit species subject to direct clearing are outlined below in Table 7-2.

As a precautionary measure, it has been assumed that the proposal would result in the total clearing of the subject site. The future values of the composition condition scores, structural condition scores and function condition scores would be zero for the vegetation zones within the subject site.

In practice it is likely that direct impacts associated with development on the land proposed for biodiversity certification would be concentrated around the building envelopes and that some areas would include APZs would not be entirely cleared. The measures to minimise impacts summarised in Section 6.3 would help restrict both direct and indirect impacts on native vegetation and associated habitats in the subject site.

Table 7-1 Clearing of native vegetation and habitat at the subject site

Vegetation zone	Management zone	Area within the subject site (ha)	Current vegetation integrity score	Future vegetation integrity score
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	Total removal	38.80	63.6	0
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	Total removal	8.04	45.2	0
3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)	Total removal	0.88	34.3	0
4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)	Total removal	4.28	79.6	0
5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (underscrubbed)	Total removal	6.56	58.9	0

Vegetation zone	Management zone	Area within the subject site (ha)	Current vegetation integrity score	Future vegetation integrity score
6 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact)	Total removal	4.87	45.7	0
7 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (underscrubbed)	Total removal	10.12	30	0
8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	Total removal	4.99	26	0
9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (regenerating)	Total removal	14.23	42.3	0
10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)	Total removal	17.17	65.3	0
11. Typha rushland	Total removal	0.9	77.6	0
	Total	**110.84**		

Table 7-2 Flora species credit species subject to direct impact

Scientific name	Common name	Unit of measure	No. of individuals/stems	Area (ha)
Acacia bynoeana	Bynone's Wattle	Area	6 ELA 2016)	2.72
Callistemon linearifolius	Netted Bottlebrush	Count	400	-
Eucalyptus parramattensis subsp *decadens*	Parramatta Red Gum	Count	3224 (including 1069 adults, 1604 juveniles and 548 seedlings)	-
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	Area	1495	10.86

7.1.2 Removal of habitat and habitat resources

The vegetation that would be removed from the subject site provides foraging, shelter and breeding habitat resources for a range of native fauna species, including a number of threatened species that are listed as both ecosystem and species credit species as well as for common fauna species.

Threatened fauna species that are species credit species which would be impacted through the removal of habitat and habitat resources are outlined below in Table 7-3.

Table 7-3 Fauna species credit species subject to direct impact

Scientific name	Common name	Area (ha)
Lathamus discolor	Swift Parrot	66.55
Anthochaera phygia	Regent Honeyeater	50.27
Myotis macropus	Southern Myotis	26.97
Petaurus norfolcensis	Squirrel Glider	84.49

In addition, the clearing of 110.84 ha of native vegetation would include the removal of mature and hollow-bearing trees. Mature trees have value for fauna populations as sources of foraging resources such as leaves, nectar, sap or seed and substrate for invertebrate prey.

The proposal would remove a substantial number of hollow bearing trees including trees with large hollows. Hollow-bearing trees are critical habitat components for many tree-dwelling fauna species, including arboreal mammals, microchiropteran bats and woodland birds that rely on hollows for shelter and breeding habitat. Due to the long timeframe it takes for hollows to form in eucalypts (usually greater than 150 years) (Gibbons et al 2000), the loss of these hollows represents a long-term reduction in habitat resources for fauna. The removal of hollows throughout the site would reduce the extent of potential breeding habitat for native species in the area and could potentially remove breeding habitat for threatened species including the Little Lorikeet and Squirrel Glider as well as roosting habitat for threatened micro-bats which are known to occur within the site. Figure X shows location of hollow bearing trees recorded within the subject site (note that the BAM does not require detailed hollow bearing tree assessments to be completed as part of this BCAR and that hollows were recorded as part of assessment done as part of the Forest Owl and Glossy Black Cockatoo targeted surveys which focused on mapping of larger hollows within the site. Comprehensive hollow bearing tree assessments would be completed as part of pre-clearance survey work (as outlined in Section 6.3).

The proposal would also remove habitat resources such as leaf litter and fallen logs, which provide foraging and shelter substrate for small terrestrial animals and ground-foraging birds. There would be a reduction in foraging habitat available for a number of ecosystem credit species that have been recorded at the site (refer to Section 5.1.3) and potentially for the Swift Parrot and the Regent Honeyeater, since a large proportion of the native vegetation that would be directly impacted is mapped as important habitat for these species.

The proposal would also remove exotic grassland which would provide some habitat for some generalist fauna species typical of disturbed grassland environments such as Kangaroos, common birds and reptile species, including the Australian Magpie, Little Raven, Noisy Miner and Grass Skink.

In the context of the areas of remaining native woodland and wetland vegetation surrounding the subject site, particularly in the large area proposed to be retained within the regrowth stewardship site, the proposal would remove a small proportion of available habitat resources for local populations of native fauna.

7.1.3 Fauna injury and mortality

As described above, the subject site provides a variety of habitat resources for native fauna species, including foraging, roosting and shelter resources for threatened species as well as common native fauna. Groundcover vegetation, leaf litter and woody debris would provide shelter and foraging substrate for reptiles, frogs and invertebrates. Construction is likely to result in the injury or mortality of some individuals of less mobile fauna species and other small terrestrial fauna that may be sheltering in vegetation within the subject site during clearing activities. There are a large number of hollow-bearing trees that were identified in the subject site and therefore there is a potential risk of injury or mortality to any species which may be using these hollows, such as microbats, arboreal mammals or hollow-nesting birds, at the time of vegetation clearing. Hollow dependent fauna would also be impacted through loss of habitat within the site. The potential for impacts on fauna utilising hollows would be reduced through pre-clearance surveys of habitat trees and protocols for low impact felling of habitat trees (see Table 6-1). Alternative habitat resources and refuge from construction activities is available throughout large areas of retained native vegetation adjoining the subject site, including throughout the proposed conservation area. More mobile native fauna such as native birds, bats, terrestrial and arboreal mammals that may be sheltering in vegetation in the subject site are likely to evade injury during construction activities.

Recommendations have been made in Section 6.3 to minimise the risk of vegetation clearing activities resulting in the injury or mortality of resident fauna.

7.1.4 Fragmentation or isolation of habitat

Habitat fragmentation through the clearing of vegetation can increase the isolation of remnant vegetation patches, increase edge effects and create barriers to the movements of small and sedentary fauna such as ground dwelling mammals, reptiles and amphibians. Furthermore, habitat fragmentation can create barriers to the movement of pollinator vectors, such as insects, and consequently affect the life cycle of both common and threatened flora.

The northeast of the subject site has been substantially disturbed and consist predominantly of agriculture land that in places is adjacent to remnant patches of native vegetation. A patch of PCT 1633 would be removed from the margin of a larger patch of native vegetation that extends south from the subject site and borders the Heddon Greta and Cliftleigh residential housing estates. The removal of this vegetation would reduce connectivity to remnant vegetation that is located north of the Cliftleigh estate. This patch of vegetation is already partially fragmented and isolated as a result of previous land clearing associated with agricultural activities and urban development with only a narrow corridor of vegetation connecting this patch to remnant vegetation located to the south.

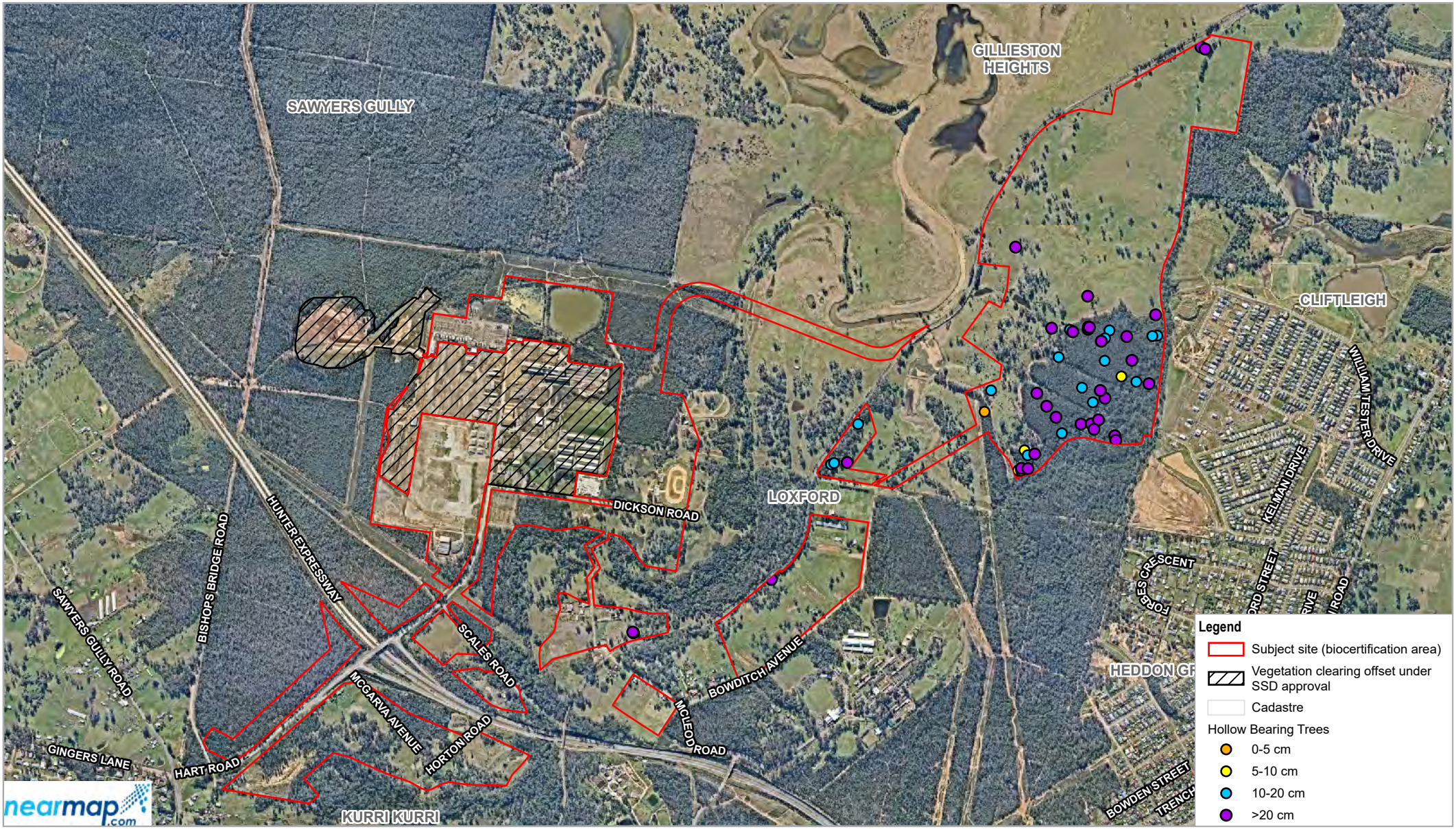
Surrounding the smelter site in the west of the subject site the proposed development adjoins a large tract of vegetation that extends to the north-west of the site. Near Hart Road and the Hunter Expressway the construction of an off ramp would result in the removal of vegetation from the edges or margins of this large patch. Vegetation proposed to be removed is located on the periphery of this patch and as such would not result in the further fragmentation or isolation of any areas of habitat although it would increase the distance between existing patches of native vegetation.

Impacts resulting from the proposal would include an increase in gaps in habitat within the surrounding locality.

Given the existing degree of fragmentation in the locality and the moderate extent of vegetation clearing proposed on the edge of a large patch of habitat, it is unlikely that the project would create any significant or new barriers to the movement of pollinator and seed dispersal vectors, such as insects and birds.

7.1.5 Aquatic habitats

A small section of Swamp Creek runs through the subject site to the east of the smelter site where a proposed rail spur would connect to the existing rail. In this area the single rail track would be elevated to avoid impacts to the creek. Construction of the rail spur would include management measures to mitigate impacts to Swamp Creek, including erosion and sediment control measures in accordance with conditions associated with a Controlled Activity approval under the *Water Management Act 2000*. A stormwater management plan would also be developed and implemented for the proposal that would include measures to prevent contaminants from entering the creek via the network of unnamed drainage lines that occur within the site.



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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Hollow Bearing Trees

Figure 7-1

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Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

7.2 Indirect Impacts

7.2.1 Sediment and erosion

The proposed development has the potential to result in sedimentation and erosion within the subject site and adjoining areas through soil disturbance and construction activities. Sediment laden runoff to waterways can alter water quality and adversely affect aquatic life. Erosion may also impact native vegetation by undermining vegetation resulting in tree instability and potential for uprooting, especially vegetation associated with drainage lines.

7.2.2 Pollution

Future development has the potential to result in pollution and contaminated runoff, in particular as a result of hydrocarbon leaks or spills from vehicles or equipment. Areas of industrial development may result in pollution and contaminated runoff entering waterways, residential gardens may also generate contamination through pesticide or herbicide use and pet faeces. This can reduce habitat condition and quality in adjacent vegetation or waterways.

7.2.3 Weed invasion and edge effects

Weed species are effective competitors for food and habitat resources and have the potential to exclude native species and modify the composition and structure of vegetation communities.

'Edge effects' can include increased noise and light or erosion and sedimentation at the interface of intact vegetation and cleared areas. Edge effects may result in impacts such as changes to vegetation type and structure, increased growth of exotic plants, increased predation of native fauna or avoidance of habitat by native fauna. Edge effects would result from construction activities and then continue to affect vegetation and habitats adjoining the subject site. This may include dumping of garden refuse and other rubbish as has occurred along the boundary and access tracks of the subject site.

Altered environmental conditions along new edges can allow invasion by pest animals specialising in edge habitats and/or change the behaviour of resident animals. Edge zones can be subject to higher levels of predation by introduced mammalian predators and native avian predators.

Much of the native vegetation in the subject site proposed for biocertification is currently subjected to grazing and is made up of small isolated patches, or patches with large edge to area ratios, making them susceptible to edge effects in their current state. Other areas are in generally good condition with a low abundance and diversity of exotic species present.

The proposal would result in an increase in the length of interface of existing vegetation adjoining urban development. Vegetation adjoining the site contains mostly intact vegetation in relatively good condition. There is therefore a risk that construction activities may increase the degree of weed infestation through dispersal of weed propagules (seeds, stems and flowers) into areas of retained native vegetation via erosion (wind and water) and associated with construction activities. The risk of introduction of weeds would continue during the operation of the proposal as members of the public may enter adjoining vegetation.

The creation of new edges within areas of native vegetation also has the potential to introduce impacts associated with noise and light into areas of adjacent vegetation. This may result in disruptions to fauna utilising vegetation adjacent to the site (as described below).

There is a risk that weed invasion and the influence of edge effects would have an ongoing negative impact on the adjoining areas of intact native vegetation. Mitigation measures including the development of a weed management sub-plan as part of the project CEMP would be implemented to mitigate these potential impacts (refer to Section 6.3.1).

Other relevant mitigation measures to reduce the impacts of edge effects include the establishment of APZs which would be designed to act as a buffer from the development lands, lighting design to minimise light spill as well as dust suppression and erosion and sediment measures during construction.

7.2.4 Introduction and spread of pests and pathogens

Disturbance associated with vegetation clearing, vehicle traffic and general day to day operations of the proposal during construction increase the potential for the spread, introduction and establishment of pest species, diseases and pathogens.

Construction activities within the subject site may, in general, have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*), Myrtle Rust (*Uredo rangelii*) and Chytrid fungus (*Batrachochytrium dendrobatidis*) into adjacent habitat through vegetation disturbance and increased visitation. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Phytophthora and Myrtle Rust may result in the dieback or modification of native vegetation and damage to fauna habitats. Chytrid fungus may harm frog populations once introduced into an area.

The potential for impacts associated with these pathogens is moderate considering large areas within the subject site are subject to grazing with large areas consisting of predominantly introduced pasture.

Diseases and pathogens can be introduced or spread to site via dirt or organic material attached to machinery, vehicles, equipment and employees. The potential for significant or new impacts associated with these pathogens is relatively low, given the suburban context of the subject site. To help mitigate the risk of pathogens being brought onto and/or spread through the site all machinery brought to site will be washed down and inspected to be free of soils, seeds and other organic material in accordance with Section 6.3.1.

7.2.5 Noise, vibration and light impacts on fauna

Construction activities would increase noise levels and vibration in the vicinity of the subject site during construction, through plant and machinery operation. Native fauna may temporarily or permanently vacate or avoid areas disturbed by construction activities.

The majority of the proposed construction works would be undertaken during standard, daytime construction hours. Exemptions and approval for works outside of the above standard construction hours may be required during certain circumstances and would require approval from consent authorities.

As such, construction noise would be temporary and generally confined to daylight hours. There would be an increase above existing background noise and vibration levels. Once the development is completed there may also be some indirect impacts from noise and light around the immediate periphery of the subject site. To help mitigate these impacts lighting within the development will be designed to limit the light spill into retained vegetation adjoining the site.

7.2.6 Aquatic disturbance and impacts on fish habitat

The introduction of pollutants from the proposal into the surrounding environment, if uncontrolled, could potentially impact on water quality further downstream.

There are limited opportunities for aquatic disturbance and impacts on fish habitat since the subject site primarily excludes areas of aquatic habitat. There is potential for the introduction of pollutants from the proposal into the surrounding aquatic environment through the ephemeral drainage lines that flow through the site. If uncontrolled, this could potentially impact on water quality further downstream. Potential water quality impacts would be managed through the implementation of mitigation measures, including the provision of sedimentation basins, silt fences and other structures to intercept runoff. Details would be included in a Stormwater Management Plan.

No endangered aquatic communities, aquatic fauna or marine vegetation listed under the FM Act or EPBC Act occur in the subject site and no significant impacts on riparian vegetation or habitats downstream of the development footprint are anticipated as a result of the proposal.

7.3 Operation phase

There are a number of potential impacts to surrounding vegetation that may occur as a result of the operation of the proposal. These include:

- Generation of additional light and noise and associated changes to use of habitat by fauna such as disruption of nocturnal foraging activity in areas proximate to development.
- Erosion and sedimentation as a result of runoff from hard stand areas.
- Introduction of weed propagules or pathogens by vehicle and/or residents.
- Pollution and contaminated runoff from use of chemicals.
- Fauna mortality as a result of collision with vehicles.
- Predation of local populations of fauna by pets (particularly cats and dogs).
- Increased risk of fire.
- Rubbish dumping.

Given current land uses at the subject site and in adjacent areas, including the location of residential land immediately to the south and east of the subject site, the proposal would not result in a substantial increase in the operation of any of these potential impacts. Management of the proposed Regrowth stewardship site, particularly weed management, would also help to mitigate the impact of edge effects and other indirect impacts on retained vegetation adjoining the development site.

These potential impacts are linked to human occupation of the site and are likely to persist indefinitely. Mitigation measures to be implemented to minimise these potential impacts are discussed in Section 6.3.2.

7.4 Assessment of serious and irreversible impacts

Under the BC Act, a determination of whether an impact is serious and irreversible must be made in accordance with the principles set out in Section 6.7 of the BC Regulation.

The principles are aimed at capturing impacts which are likely to contribute significantly to the risk of extinction of a threatened species or ecological community in New South Wales. These impacts will:

- Cause a further decline of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to be in a rapid rate of decline.
- Further reduce the population size of the species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very small population size.
- Impact on the habitat of a species or ecological community that is currently observed, estimated, inferred or reasonably suspected to have a very limited geographic distribution.
- Impact on a species or ecological community that is unlikely to respond to measures to improve habitat and vegetation integrity and is therefore irreplaceable.

The decision-maker must determine whether or not an impact on biodiversity values is likely to be a serious and irreversible impact (SAII). The framework allows for decision-makers to take into account the scale of an impact and the potential for avoidance and mitigation. These factors are weighed against the status and vulnerabilities of the potential SAII entity to ultimately determine if a proposal would result in a SAII (DPIE 2019). If there is a SAII for site proposed to be bio-certified, the development may be approved but the approval authority must take those impacts into consideration and determine whether there are any additional and appropriate measures that would minimise those impacts if approval were granted.

Two potential SAII entities (the Swift Parrot and the Regent Honeyeater) would be impacted by the proposal. The Swift Parrot and Regent Honeyeater are considered SAII entities on the basis of Principle 1 (evidence of rapid decline) and Principle 2 (species currently in a rapid rate of decline) listed in Appendix A of the *Guidance to assist a decision-maker to determine a serious and irreversible impact* (DPIE 2019a).

The area of important habitat for Swift Parrot and Regent Honeyeater within the subject site has been identified based on the BAM Important Area Map contained within the BAM-C (DPIE 2022f). Based on this mapping, the Swift Parrot and the Regent Honeyeater are both assumed to potentially utilise part of the subject site for foraging.

The Important Areas map for Swift Parrot has been developed based on applying a buffer area of 2 km to areas where there have been five or more birds recorded over any two or more years, or single sightings of more than 40 birds (DPIE 2022e). The NSW State Vegetation Type Map (including draft East Coast classification) was then used to select Plant Community Types associated with the swift parrot within the buffers. Any areas of vegetation less than one hectare were excluded.

Throughout the Hydro site the important habitat mapping appears to be somewhat arbitrary with the boundary of the mapped important habitat being located through the middle of a large patch of contiguous vegetation that extends to the north-west of the site that is known to contain similar vegetation types as the subject site. As noted above the mapping has been developed using NSW State Vegetation Type Mapping, with mapped PCTs associated with the Swift Parrot within the buffer area selected as important habitat. This vegetation mapping has been completed at a broad scale and contains numerous inaccuracies. For example, areas of cleared land, exotic grassland and Typha wetland that would not provide any foraging habitat for this species have been mapped as important habitat.

To determine more accurately the extent and quality of important habitat for the Swift Parrot and Regent Honeyeater within the site a species expert was engaged to undertake a detailed assessment of habitat for these two SAII entities across the Hydro site (including the subject site and proposed adjacent BSS). The purpose of the expert assessment was to determine whether vegetation within the site is likely to be important for these two species and to also quantify the quality of habitat throughout the site.

The expert report determined that a large extent of the mapped important habitat within the site is not likely to comprise important habitat for either of these species and recommended the important habitat mapped within the site for Swift Parrot should be reduced to 47.55 ha and the important habitat mapped for the Regent Honeyeater should be reduced 34.63 ha (Appendix F).

Reasons provided in the expert report for the proposed reduction in areas of mapped important habitat included:

- Lack a canopy cover (some areas have been historically cleared, whist in others there is no mature canopy cover present.
- Errors in the remote vegetation classification (some mapped habitat contains non-native, planted vegetation whilst in others key feed tree species are absent or only form a very small proportion of the total canopy cover.
- Poor tree health (some areas have trees that are dead or have been subject to historically high levels of disturbance).
- Lack of key habitat features or surrogate bird species for example long-flowered mistletoe is a key breeding resource for Regent Honeyeaters within the lower Hunter Valley, however field surveys revealed that all mistletoe species are extremely scares within the subject site. Surveys also found other threatened species that can serve as indicators of potential Swift Parrot Habitat were either not detected or were sparsely distributed at low abundances within the subject site) (Crates 2022).

The expert report states that the Regent Honeyeater and Swift Parrot habitat within the subject site is of low to moderate quality, relative to other areas of mapped important habitat within the lower Hunter Valley, such as parts of Werakata National Park and the Hunter Economic Zone (Roderick et al. 2014). The species expert determined that the site was not likely to provide any breeding habitat for the Regent Honeyeater and considered it unlikely that Swift Parrots or Regent Honeyeaters would utilise mapped habitats within the subject site. The expert report also concludes that none of the mapped important habitat within the site is likely to be critical habitat for either species (Crates 2022).

The expert report is included as Appendix F of this BCAR.

Assessments of impacts on these two SAII entities have been completed based on Dr Crates assessment of the subject site and are included in Appendix G.

7.4.1 Cumulative impact assessment – Swift Parrot and Regent Honeyeater

A cumulative impact assessment has been completed to help assess the impacts on Regent Honeyeater and Swift Parrot within the local area. The assessment included a review of major projects that have been either approved (included recently constructed) or are under assessment within the Cessnock, Maitland, Port Stephens and Lake Macquarie LGAs.

The assessment reviewed 416 projects listed on the DPIE planning portal as well other BCAR projects currently under assessment in the Lower Hunter region (DPIE 2022g).

The cumulative assessment has been based on publicly available data and/or data made available through government agencies. It is acknowledged that there may be additional proposals currently being assessed through council development applications that have not been included in this cumulative assessment, noting however that under the BOS any proposals assessed under Part 4 of the EP&A Act (other than an application for state significant development or an application for a complying development certificate) that are likely to have a SAII on biodiversity values must be refused development consent.

Results of the assessment indicate that approximately 898 ha of potential foraging habitat for the Regent Honeyeater and 1241 ha of potential foraging habitat for the Swift Parrot has been approved for removal in the Cessnock, Maitland, Port Stephens, and Lake Macquarie LGAs since 2007. Impacts to a further 74 ha of Regent Honeyeater and 145 ha of Swift Parrot foraging habitat is currently under assessment within the Hunter LGA, either for major projects or land proposed for biocertification.

The environmental assessments for 36 of the 416 projects reviewed indicate likely impacts to foraging habitat for either the Regent Honeyeater or Swift Parrot. Of these projects nine represent approximately 90 percent of the total clearing of potential Regent Honeyeater and Swift Parrot habitat foraging habitat that has been approved in the Lower Hunter region since 2007 (DPIE 2022g). These are:

- Huntlee Stage 1 development (approximately 359 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)
- Modification to Huntlee PA (approximately 24.8 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)
- Minmi, Link Road North and South Residential Development (Northern Estates) (approximately 306 ha of potential foraging habitat for Swift Parrot)
- F2 Freeway to Branxton Link (approximately 127 ha of potential foraging habitat for Regent Honeyeater and 181 ha of potential foraging habitat for Swift Parrot)
- Main Northern Railway -Maitland to Minimbah (approximately 80.4 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)
- M1 Pacific Motorway extension to Raymond Terrace (approximately 68 ha of potential foraging habitat for Regent Honeyeater and 83 ha of potential foraging habitat for Swift Parrot)
- Brandy Hill Expansion Project (approximately 49 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)
- Cabbage Tree Road Sand Quarry (approximately 48 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)

- Mackas Sand Project (approximately 48 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)
- Greta Rail Facility (approximately 17.9 ha of potential foraging habitat for Regent Honeyeater and Swift Parrot)

Of the 74 ha of Regent Honeyeater and 145 ha of Swift Parrot potential foraging habitat that is currently proposed to be impacted by projects currently under assessment, most of the proposed impacts are associated with three major projects:

- Kurri Kurri Lateral Pipeline Project, which would remove approximately 46.83 ha of potential foraging habitat for Regent Honeyeater and 51.8 ha of potential foraging habitat for Swift Parrot, of which 0.46 ha is mapped as important habitat for the Swift Parrot.
- Fennell Bay Residential Redevelopment Biodiversity Certification, which would remove approximately 59.4 ha of potential foraging habitat for Swift Parrot of which 14.8 ha has been mapped by BCD as important habitat for the species.
- Bobs Farm Sand Mine Project, which would remove approximately 25.9 ha of potential foraging habitat for Swift Parrot and Regent Honeyeater, none of which is mapped as important habitat for either species.

It is difficult to accurately determine the area of important habitat for the Swift Parrot and Regent Honeyeater that has been impacted in the Lower Hunter as the important habitat mapping for these species has only been available for the past five years. A review of the current important habitat maps against the locations of these historic projects suggests that as a conservative estimate approximately 115 ha of important habitat for Regent Honeyeater and 533.8 ha of important habitat for the Swift Parrot has been removed in the Lower Hunter region since 2007. This would represent approximately 3 percent of the currently important habitat mapping for Swift Parrot and approximately 0.5 percent of the currently mapped Regent Honeyeater important habitat within the Hunter IBRA subregion. A further 19.91 ha of mapped important habitat for the Swift Parrot and 0.46 ha of mapped important habitat for the Regent Honeyeater is currently being proposed for removal within the Lower Hunter region (which would equate to approximately 0.1 percent of the mapped important habitat for Swift Parrot and 0.004 percent of the mapped important habitat for the Regent Honeyeater within the Hunter IBRA subregion).

In addition to the above, approximately 48 ha of mapped important habitat for this species may also be impacted as a result of a proposed rezoning at Williamtown Special Activation Precinct (draft masterplan currently on public exhibition). More detailed assessment and quantification of impacts of this project would be available once the master plan has been finalised and detailed ecological assessments completed.

Furthermore, the Hunter Economic Zone (HEZ), which contains approximately 900 ha of important habitat for the Swift Parrot and Regent Honeyeater was rezoned for industrial purposes in 2002 indicating the site is vulnerable to impacts of development. At present however there are no existing approvals to develop the HEZ site and there have been several court cases ruling against development. The Cessnock City Council Local Strategic Planning Statement (PSPS) also outlines plans to investigate rezoning significant environmental lands to an appropriate environmental zone suggesting that in the future important habitat for the Regent Honeyeater and Swift Parrot within the site is likely to be protected from impacts.

7.5 Identification of prescribed additional biodiversity impacts

The *Biodiversity Conservation Regulation 2017* (BC Regulation) (clause 6.1) identifies additional biodiversity impacts to which the BOS applies. These 'prescribed impacts' are the impacts on biodiversity values which are not related to, or are in addition to, native vegetation clearing and habitat loss. These types of impacts are used by the decision-maker to inform the determination and conditions of consent for developments. These include:

- Impacts on the habitat of threatened entities including:
  - Karst, caves, crevices, cliffs, rocks and other geological features of significance
  - Human-made structures
  - Non-native vegetation
- Impacts on areas connecting threatened species habitat, such as movement corridors.
- Impacts that affect water quality, water bodies and hydrological processes that sustain threatened entities.
- Impacts on threatened and protected animals from turbine strikes from a wind farm (not relevant to this proposal).
- Impacts associated with vehicle strike.
- Impacts on threatened species or fauna that are part of a TEC from vehicle strikes.

The BAR must identify the relevant prescribed impacts and the suite of threatened species that use or rely on the habitat values or would be affected by the impact, as specified in BAM Section 6. The likelihood, extent and magnitude of prescribed impacts must then be assessed using the approach specified in the BAM section 8.3. Those of relevance to this proposal are described in the sections below.

7.5.1 Karst, caves, cervices, cliffs and other geological features of significance

The proposal would not impact on karst, caves, cervices, cliffs and other geological features of significance. There is very little rock present within the subject site that would be impacted by the project. This prescribed impact is therefore not relevant to the proposal.

7.5.2 Man-made structures

The site contains a number of man-made structures, including two large detention basins and a number of small dams. These structures may provide foraging habitat for a range of bat species including the Southern Myotis (*Myotis macropus*) which was recorded roosting in a culvert adjacent to the subject site (refer to Figure 8-5 for location of culvert). Impacts to Southern Myotis habitat have been assessed and offsets calculated in Section 7.4 of this report. It is unlikely that these detention basins would provide any significant habitat for any other threatened biota.

7.5.3 Non-native vegetation

The proposed development would include the removal or modification of 132.84 ha of non-native vegetation. The 132.84 ha of non-native vegetation proposed for biodiversity certification comprises mixed grassland, cleared land/hardstand and/or open water as shown on Figure 4-1.

The ground cover within mixed grassland areas is dominated by exotic species, including *Vulpia bromides* (Squirrel Tail Fescue), *Ambrosia artemisiifolia* (Annual Ragweed), *Paspalum notatum* (Bahia Grass) and *Setaria parviflora*. These areas have been sampled by BAM vegetation integrity plots and confirmed as non-native vegetation, with a VI score <15 and as such not requiring the calculation of offsets according to the BAM (see Table 4-13).

Non-native vegetation does not comprise habitat for any threatened flora species (see Section 5.2.1) and provides minimal habitat resources for threatened fauna species. Only mobile fauna species of open country would occur in non-native vegetation at the proposal site. Raptors including the White Bellied Sea Eagle may hunt over non-native grassland on occasion. Similarly, microchiropteran bats may forage above the non-native grassland. Bird species that forage in woodland areas may also forage in the adjacent non-native grassland on occasion. No threatened fauna species would rely on habitat resources in these areas for their survival in the locality but may use these areas on occasion as part of a much larger home range.

Given the extensive areas of alternative foraging habitat within the locality it is highly unlikely that the removal of a small amount of exotic vegetation would result in any adverse impacts to these species.

7.5.4 Habitat connectivity

Habitat fragmentation through the clearing of vegetation can increase the isolation of remnant vegetation and create barriers to the movements of small and sedentary fauna such as ground dwelling mammals, reptiles and amphibians. Furthermore, habitat fragmentation can create barriers to the movement of pollinator vectors, such as insects, or seed vectors, such as birds, and consequently affect the life cycle of both common and threatened flora.

Connectivity from the development site to large tracts of remnant vegetation to the north and west of the site is already impacted due to the presence of major roads, agricultural land and the presence of infrastructure associated with the former smelter site.

The development would result in an increase in the gaps between remnant patches of vegetation and reduce connectivity between patches.

A patch of remnant native vegetation consisting of PCTs 1600 and 633 would be removed from the outer edge of a larger patch of vegetation that extends south from the subject site and borders the Heddon Greta and Cliftleigh residential housing estates. The removal of this vegetation would reduce connectivity to a small area of isolated remnant vegetation that is located to the north of the Cliftleigh Estate. The removal of this vegetation is likely to reduce the ability for fauna including threatened biota such as Squirrel Gliders to move between these two patches. The construction of a rail spur to the east of the smelter site may also impact connectivity between vegetation in the east and north-west of the site. Although as mentioned above connectivity between these patches has already been substantially impacted due to existing infrastructure and clearing associated with agricultural development.

Other threatened fauna species recorded within the subject site are highly mobile species and as such it is unlikely that the project would impact the movement of these species across their ranges.

Impacts to habitat connectivity have been avoided and minimised by designing the development so that the vegetated corridor along Swamp Creek is retained and protected within the proposed BSS. This would ensure that habitat connectivity is maintained along Swamp Creek through to the extensive tracks of vegetation located to the north-west and south of the site. The Swamp Creek habitat corridor would be improved and maintained through management actions prescribed in the Site Management Plan (SMP) that would be developed for the proposed BSS.

7.5.5 Vehicle strike

The Hunter Express Way is located adjacent to the subject site. This road is a major highway that experiences high volumes of traffic. Hart Road, another major arterial road traverses the site, perpendicular to the Hunter Express Way. There is also a network of dirt tracks through the subject site.

The proposal would result in an increase in cars and other vehicles during construction and operation. Exclusion fencing would be installed between the boundary of the subject site and the adjoining native vegetation to prevent movement of ground-dwelling fauna into the site. There is however still a risk that increased vehicle activity may result in native fauna being struck and killed. The potential risk of vehicle strike is most relevant to common species such as kangaroos which often graze along roadsides. Vehicle strike poses is a higher risk for owls and ground feeding birds as they are known to utilise urban areas where they can take advantage of an abundance of prey such as mice, rats and possums that often thrive in urban environments. Furthermore, owls will often pick up prey from the sides of roads making them more vulnerable to being struck.

Mitigation measures would include signposting and enforcement of appropriate speed limits along proposed access roads to reduce the likelihood of vehicle strike and mortality of native fauna. Appropriate fencing would also be maintained between the subject site and areas of adjoining native vegetation.

7.5.6 Water bodies, water quality and hydrological processes

There are two constructed detention ponds located to the north of the smelter site (refer to Figure 4-1) which would be decommissioned as a result of the proposal. These ponds provide a small amount of potential habitat for a range of threatened biota. Targeted surveys were completed at these ponds for candidate species, including the Green and Golden Bell Frog (*Litoria aurea*), Green Thighed Frog (*Litoria brevipalmata*), Wallum Froglet (*Crinia tinnula*) and the threatened flora species *Maundia triglochinoides* and Tall Knot Weed (*Persicaria elatior*). None of these species were recorded during targeted surveys it is therefore considered unlikely that the removal of these ponds would result in adverse impacts to threatened biota.

Impacts associated with the decommissioning of these ponds on the Southern Myotis (*Myotis macropus*) which was recorded adjacent to the subject site have been captured in this assessment by including these ponds as waterbodies used to map species polygons over native vegetation in adjacent areas (refer to Section 8.1.2).

There would be minor if any impacts on aquatic habitat downstream of the proposal site with impacts likely to be localised to minor ephemeral drainage lines located in the vicinity of the subject site. There is no evidence that aquatic habitat in the vicinity of the proposal site would be occupied by any threatened biota Impacts to waterbodies, water quality and hydrological processes would be avoided and minimised through the development and implementation of a stormwater management and erosion and sedimentation control plans as part of the projects CEMP.

7.6 Consideration of MNES

Development on the land proposed for biodiversity certification would result in impacts to the following threatened communities and species that are listed as MNES under the EPBC Act:

- Removal of approximately 7.6 ha of vegetation commensurate with the EPBC listing for River Flats Eucalypt Forest on coastal floodplains of the southern NSW and eastern Victoria (listed as a CEEC under the EPBC Act).
- Removal of approximately 1495 Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*) (listed as a vulnerable species under the EPBC Act) individuals and 10.87 ha of occupied habitat.
- Removal of approximately 3224 (including 1069 adults, 1604 juveniles and 548 seedlings) Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*) (listed as a vulnerable species under the EPBC Act) individuals and 49.5 ha of occupied habitat.
- Removal of 84.1 ha of potential foraging habitat for the Swift Parrot (*Lathamus discolor*) (listed as a critically endangered species under the EPBC Act), of which 47.6 ha is considered by a species expert as being important habitat for the Swift Parrot (Crates 2022).
- Removal of 36.4 ha of potential foraging habitat for the Regent Honeyeater (*Anthochaera phrygia*) (listed as a critically endangered species under the EPBC Act), of which 34.6 ha is described as important habitat by a species expert (Crates 2022).
- Removal of approximately 84.1 ha of potential foraging habitat for the Grey Headed Flying Fox (*Pteropus poliocephalus*) (listed as a vulnerable species under the EPBC Act).
- Removal of approximately 84.1 ha of potential foraging habitat for Large-eared-Pied Bat (*Chalinolobus dwyeri*) (listed as a vulnerable species under the BC Act and EPBC Act).
- Removal of approximately 84.1 ha of potential foraging habitat for the White-bellied Sea-eagle (*Haliaeetus leucogaster*) (listed as a migratory species under the EPBC Act).
- Removal of habitat with historic records of Bynoe's Wattle (*Acacia bynoeana*) Bynoe's Wattle is listed as a vulnerable species under the EPBC Act. Note that this species was not recorded within the site during recent targeted surveys completed as part of this BCAR however has been assumed present due to historic records within the site.

Assessments of significance (AoS) have been prepared in accordance with the '*Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999'* (DotE, 2013) for impacts on MNES recorded within the subject site and are presented in Appendix H.

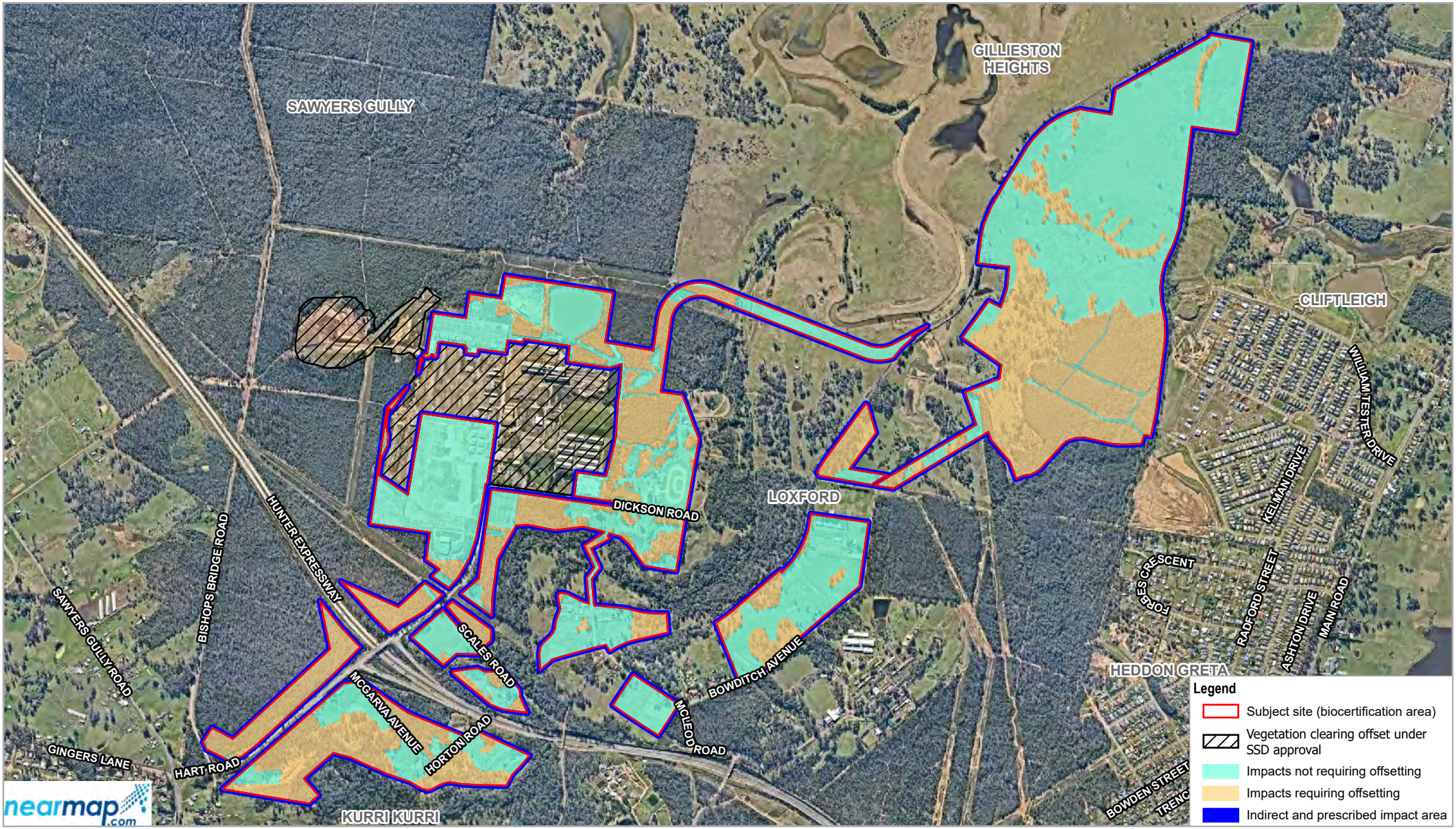
AoS were completed for the following MNES:

- River-flat eucalypt forest on coastal floodplains of southern NSW and eastern Victoria
- Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*)
- Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)
- Bynoe's Wattle (*Acacia bynoeana*)
- Grey-headed flying fox (*Pteropus poliocephalus*)
- Large-eared-Pied Bat (*Chalinolobus dwyeri*)
- Swift Parrot (*Lathamus discolor*)
- Regent Honeyeater (*Anthochaera phrygia*)
- White-Bellied Sea Eagle (*Haliaeetus leucogaster*)

These assessments determined that the proposal has the potential to have a significant impact on the following MNES:

- River-flat eucalypt forest on coastal floodplains of southern NSW and eastern Victoria CEEC
- Small-flower Grevillea
- Parramatta Red Gum
- Swift Parrot
- Regent Honeyeater

As required under the EPBC Act a referral will be prepared and submitted to DCCEEW. This BCAR will form part of the documentation required to support and referral for the project.



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Impact summary

Figure 7-2

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Print date: 01 Jun 2022 - 14:32

Data source: Nearmap: Imagery Dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

8. Offset requirements

8.1 Impacts requiring offset

Impacts associated with development on the land proposed for biodiversity certification that will require offsetting comprise the removal of 110.84 ha of native vegetation and associated habitat for threatened biota. Impacts within the subject site that require biodiversity offsets are shown on Figure 7-2.

8.1.1 Ecosystem credits

The data from the fieldwork and mapping was entered into version 1.4.0.00 of the BAM credit calculator as a 'biocertification' assessment to determine the number and type of biodiversity credits that would be required to offset impacts from the proposal (BAM calculator Case 00016379/BAAS17098/19/00016384 / Revision: 10)The Biodiversity credit report is included in Appendix D and is summarised below.

There is 110.84 ha of native vegetation and associated threatened species habitat at the subject site that would be removed for future development. We have assumed that all vegetation and habitat resources in the subject site would be removed and so the 'future vegetation integrity score' was entered as zero.

Ecosystem credits that would be required to offset the direct impacts from the proposal are shown in Table 8-1.

Table 8-1 Ecosystem credits required to offset direct impacts of the proposal

Plant community type	PCT ID	Direct impact area (ha)	VI Score loss	BC Act status[1]	Ecosystem credits required to offset direct impacts	HBT Credits
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	1633	38.80	63.6	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	1235	1235
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	1633	8.04	45.2	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	181	182
3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)	1633	0.88	34.3	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	15	0
4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)	1594	4.28	79.6	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and south-east Corner bioregions EEC	170	170
5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (underscrubbed)	1594	6.56	58.9	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and south-east Corner bioregions EEC	193	0
6 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact)	1591	4.87	45.7	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	111	111
7 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (underscrubbed)	1591	10.12	30	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	152	0
8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	1600	4.99	26	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregoins	65	0
9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (regenerating)	1600	14.23	42.3	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC	301	301
10 Spotted Gum - Red Ironbark - Narrow-	1600	17.17	65.3	Central Hunter Ironbark—Spotted Gum—	560	560

Plant community type	PCT ID	Direct impact area (ha)	VI Score loss	BC Act status[1]	Ecosystem credits required to offset direct impacts	HBT Credits
leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)				Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC		
11. Typha rushland	1737	0.9	77.6	Not a TEC	35	0
TOTAL		**110.84**				

EEC = endangered ecological community, TEC = threatened ecological community

8.1.2 Species credits

Species credits would be required to offset impacts on the following threatened species:

- Bynoe's Wattle (*Acacia bynoeana*)
- Netted Bottlebrush (*Callistemon linearifolius*)
- Parramatta Red Gum (*Eucalyptus parramattensis* subsp*. decadens*)
- Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*)
- Southern Myotis (*Myotis macropus*)
- Squirrel Glider (*Petaurus norfolcensis*)
- Swift Parrot (*Lathamus discolor*)
- Regent Honeyeater (*Anthochaera phygia*)

Species credits species that have been assessed by direct stem counts include Parramatta Red Gum and Netted Bottlebrush. All other species credit species have been assessed using an area polygon (refer to Table 8-2).

Species polygons have been prepared for all flora and fauna species credit species that have been confirmed as present through survey, assumed to be present, or are likely to use the suitable habitat at the subject site. The species polygons identify the areas of suitable habitat for a species credit species on the subject site (see Figure 8-1, Figure 8-2, Figure 8-3, Figure 8-3 and Figure 8-5).

The species polygons were mapped following the protocols for each species listed in the Threatened Biodiversity Data Collection in accordance with the BAM. The methods for calculating the species polygons for the species credit species recorded at the subject site are provided in Table 8-2.

The Little Bent-wing Bat, Large Bent-wing Bat, Grey-headed Flying-fox and the White-bellied Sea-eagle were recorded within the subject site during field surveys and are confirmed predicted threatened species for this assessment. The ecosystem credits listed above would offset the removal of foraging habitat for these species. Each of these threatened fauna species are dual credit species. Species credits must be calculated for impacts to breeding habitat for these species. Targeted surveys and habitat assessments confirmed that there is no breeding habitat for any of these threatened fauna species in the subject site, or within the likely area that would be subject to indirect impacts. Therefore, no species credits are required for impacts to these threatened faunas.

Species credit requirements for the proposal are summarised in Table 8-3.

Table 8-2 Method for calculating species polygons

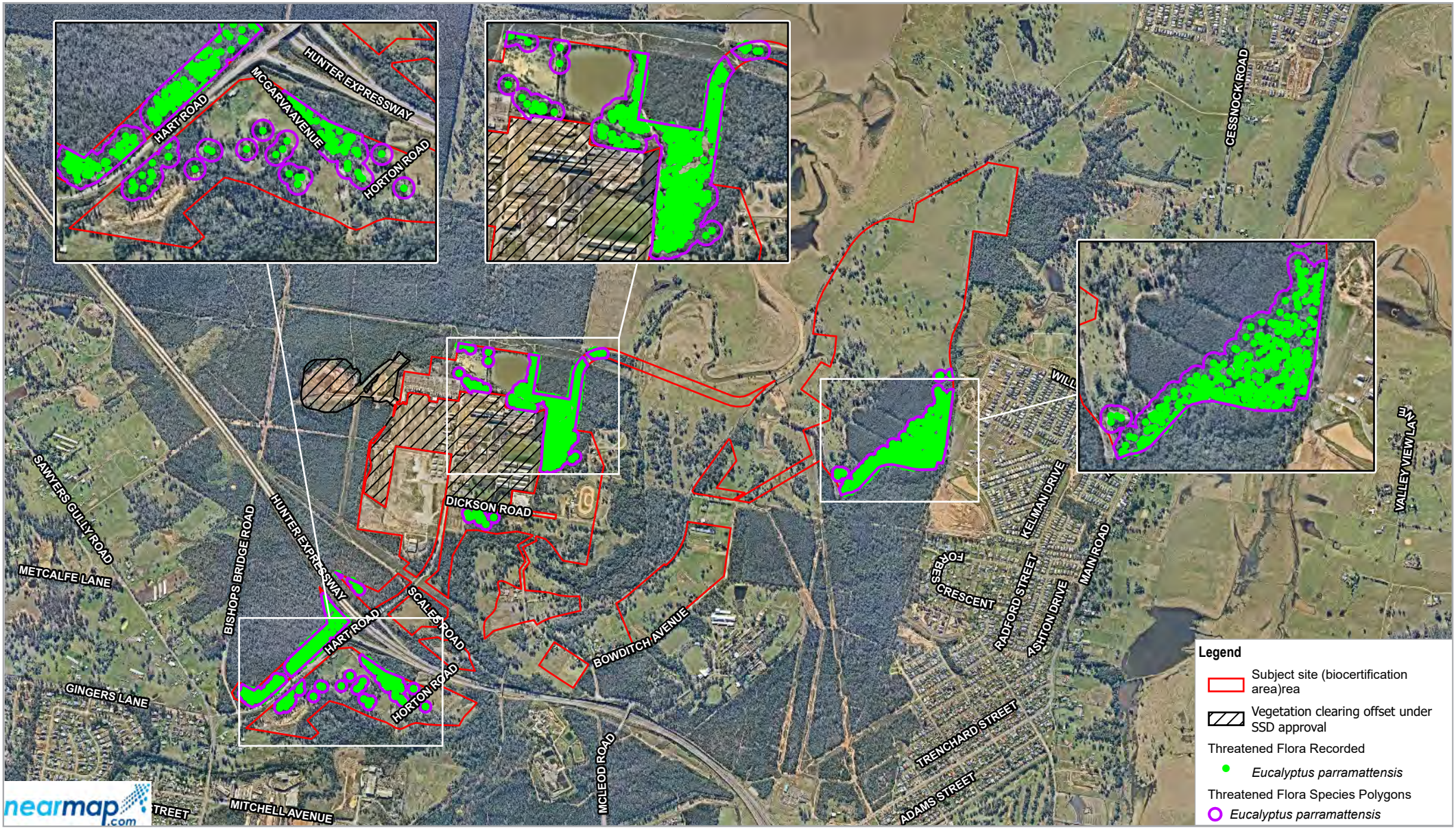
Species credit	Type	Method
Netted Bottlebrush (*Callistemon linearifolius*)	Count	Targeted surveys for the species were undertaken in accordance with the survey guidelines for threatened flora (OEH 2016b). The occurrence and general distributions of the species through the subject site was confirmed during surveys completed in October and November 2019. Individual stem counts for the species were completed in October and November 2020. A total of 400 Netted Bottlebrush individuals were recorded within the subject site (refer to Figure 8-2).
Parramatta Red Gum (*Eucalyptus parramattensis* subsp *decadens)*	Count	Targeted surveys for the species were undertaken in accordance with the survey guidelines for threatened flora (OEH 2016b). The occurrence and general distributions of the species through the subject site was confirmed during surveys completed in October and November 2019. Individual stem counts for the species were completed in October and November 2020. A total of 3224 (including 1069 adults, 1604 juveniles and 548 seedlings) Parramatta Red Gum individuals were recorded within the subject site (refer to Figure 8-1). This species occurs as a co-dominant species within PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area.
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	Area	Area of habitat is used as the unit of measurement to calculate species credits for this species in the BAM Calculator. Species polygons for Small-flowered Grevillea are shown on Figure 8-3. In accordance with the BAM species polygon areas for these species was calculated based on the GHD accredited assessor's assessment of the area of occupied suitable habitat. A total of approximately 1495 Small-flower Grevillea individuals was recorded across the development site. All these records occur within or immediately adjacent to areas of intact PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area. The individuals recorded occur in five distinct separate patches throughout PCT 1633 within the subject site. The species polygon developed for Small-flowered Grevillea comprise a minimum buffer area of 30 meters from the point locations of individual stems, expanded to encompass continuous areas of suitable habitat between groups of stems. It is assumed that the area of suitable habitat ends 30 meters from the outermost recorded stems as environmental gradients change away from the core areas of occupied habitat. For this species within the development site, this is probably due to changing soil texture and chemical properties and/or local changes in relief or topography. The total size of the areas of habitat for Small-flower Grevillea within the development site was calculated to be 10.87 ha.
Bynoe's Wattle (*Acacia bynoeana*)	Area	Six Bynoe's Wattle individuals have been previously recorded within the subject site within PCT 1633 (ELA 2016). None of these individuals were relocated during targeted surveys completed at an appropriate time of year to detect this species, nor were any other individuals recorded within the subject site. As this species is inconspicuous when not in flower and is known to remain viable within the soil seedbank, it has been assumed present. The species polygon was determined by applying a 30 metre diameter buffer area around each of the previously recorded points and also including the area between points (refer to Figure 8-4). As described above the area of habitat ends 30 meters from the outermost recorded stems as environmental gradients change away from the core areas of occupied habitat. The species polygon for this species was calculated to be 2.72 ha.

Species credit	Type	Method
Southern Myotis (*Myotis macropus*)	Area	Approximately ten Southern Myotis individuals were recorded roosting within a culvert that runs beneath the train line adjacent to the subject site. The species polygon for this species was calculated in accordance with the requirements specified in Table 1 of the "'*species credit threatened bats and their habitats: NSW survey guide for the BAM* (OEH 2018). Aerial imagery was used to map waterbodies with pools/stretches 3 m or wider or within 200 m of the subject land. All habitat within 200 m of mapped waterbodies was then mapped as the species polygon, with habitat defined as any PCTs on the subject land with which this species is associated (as listed in the TBDC) (refer to Figure 8-5). PCTs that have been identified in the TBDC as being associated with the Southern Myotis include PCT 1600, PCT 1633 and PCT 1737. There is 26.97 ha of potential habitat for the Southern Myotis within the species polygon.
Squirrel Glider (*Petaurus norfolcensis*)	Area	All woodland and forest PCTs within the subject site contain suitable foraging and nesting habitat for the Squirrel Glider. The species polygon for this species was mapped to include all areas of intact PCTs within the subject site which are associated with this species (as listed in the TBDC). The polygon also includes underscrubbed vegetation that adjoins areas of higher quality of habitat and that is separated by less than 100 m (refer to Figure 8-5). There is 84.49 ha of potential habitat for the Squirrel Glider within the species polygon.
Swift Parrot (*Lathamus discolor*)	Area	DPIE has produced a map important habitat for Swift Parrot (DPIE 2022f). Important habitat maps identify areas that are considered essential to support critical life stages of the species, e.g. breeding areas or locations important for foraging/over-wintering for migratory species. These species are dual credit species assessed for species (important habitat map) and ecosystem credits (all other areas the species is likely to occur). The BAM-C states that to produce the Swift Parrot important habitat map "sighting records from 1990-2020 were extracted from BioNet and BirdLife Australia Atlas. Records were checked and cleaned and a 2km radial buffer was applied. Areas with sightings of five or more birds recorded over any two or more years, or single sightings of 40 or more birds, were identified as important for the species. The NSW State Vegetation Type Map (SVTM), including draft Eastern NSW classification SVTM v1.1.0 (Eastern NSW), was used to select PCTs associated with the Swift Parrot within the buffers. Any areas of vegetation less than one hectare were excluded". A species expert has reviewed the Swift Parrot important habitat mapping and produced an expert report that discusses the quality of habitat within the Hydro site (development and proposed stewardship site) (Crates 2022). This report determined that a significant portion of the land mapped on the important habitat map for this species is not likely to provide habitat or would only provide marginal habitat for this species and would therefore not be considered essential to support critical life stages for this species. Results of Dr Crates assessment determined that 47.55 ha of the land mapped important habitat for Swift Parrot within the subject site is likely to provide habitat for this species. The remaining 18.6 ha were recommended for removal. BAM support have been consulted to determine whether based on the results of the expert report the important habitat mapping could be altered in order to create the species polygon for the project. The BCD response however was that the important habitat mapping could not be altered through an expert report and that the species polygon must be mapped to the extent of the important habitat map provided on BOAMS. BCD has acknowledged that areas of cleared land, exotic vegetation and wetland do not need to be include in the species polygon for Swift Parrot. The species polygon for the Swift Parrot has therefore been created based on the Swift Parrot Important Area mapped within the subject site with areas of areas of exotic vegetation, cleared areas and areas of Typha rushland excluded (Figure 8-7). There is 66.55 ha of mapped important habitat for the Swift Parrot within the species polygon (DPIE 2022f).

Species credit	Type	Method
Regent Honeyeater (*Anthochaera phrygia*)	Area	DPIE has produced a map important habitat for Regent Honeyeater (DPIE 2022f). Areas identified in The Regent Honeyeater National Recovery Plan (2016) as critical to the survival of the species formed the basis of the mapping for use in the BAM. These were refined to only include areas of suitable habitat based on expert opinion and Plant Community Types (PCTs) associated with the species. BOAMS states that to develop the Regent Honeyeater Important habitat mal "A dataset of occurrence records was generated from BioNet, BirdLife Australia, Australian National University Difficult Bird Research Group and expert opinion of historic, unrecorded breeding. Records were overlayed on the refined areas. All woodland vegetation within 200m of a record was added. Records of known breeding events that occurred outside of the polygons created above were identified. Radial buffers of 1km were applied to single breeding events (once off breeding at a location) and 5km buffers applied to multiple breeding events (multiple events in the same year or over multiple years at one location). All woodland vegetation was selected within 1km buffers. Within 5km buffers, PCTs associated with the species were selected, along with all woodland vegetation within 200m of a record" A species expert has reviewed the Regent Honeyeater important habitat mapping and produced an expert report that discusses the quality of habitat within the Hydro site (development and proposed stewardship site) (Crates 2022). This report determined that a significant portion of the land mapped on the important habitat map for this species is not likely to provide habitat or would only provide marginal habitat for this species and would therefore not be considered essential to support critical life stages for this species. Results of Dr Crates assessment determined that 34.63 ha of the land mapped important habitat for Regent Honeyeater within the subject site is likely to provide habitat for this species and that the site is not likely to provide any breeding habitat for this species. As noted above BAM support was consulted to determine whether based on the results of the expert report the important habitat mapping could be altered in order to create the species polygon for the project. The BCD response was that the important habitat mapping could not be altered through an expert report and that the species polygon must be mapped to the extent of the important habitat map provided on BOAMS. The species polygon for the Regent Honeyeater has therefore been created based on the Regent Honeyeater Important Area mapped by DPIE within the subject site (Figure 8-8). There is 50.27 ha of mapped important habitat for the Regent Honeyeater (excluding cleared areas and exotic vegetation) within the species polygon.

Table 8-3 Species credits required to offset impacts of the proposal

Species		Area of habitat impacted (ha)	Stem Count	Species Credits Required
Acacia bynoeana	*Bynoe's Wattle*	2.72	-	87
Callistemon linearifolius	Netted Bottlebrush	-	400	601
Eucalyptus parramattensis subsp. *decadens*	Parramatta Red Gum	-	3224 (including 1064 adults, 1612 juveniles and 548 seedlings)	6448
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	10.87	-	348
Myotis macropus	Southern Myotis	26.97	-	699
Petaurus norfolcensis	Squirrel Glider	84.49	-	2420
Lathamus discolor	Swift Parrot	66.6	-	2899
Anthochaera phrygia	Regent Honeyeater	50.27		2383



Paper Size ISO A4

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Threatened species polygon
Eucalyptus parramattensis

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Figure 8-1

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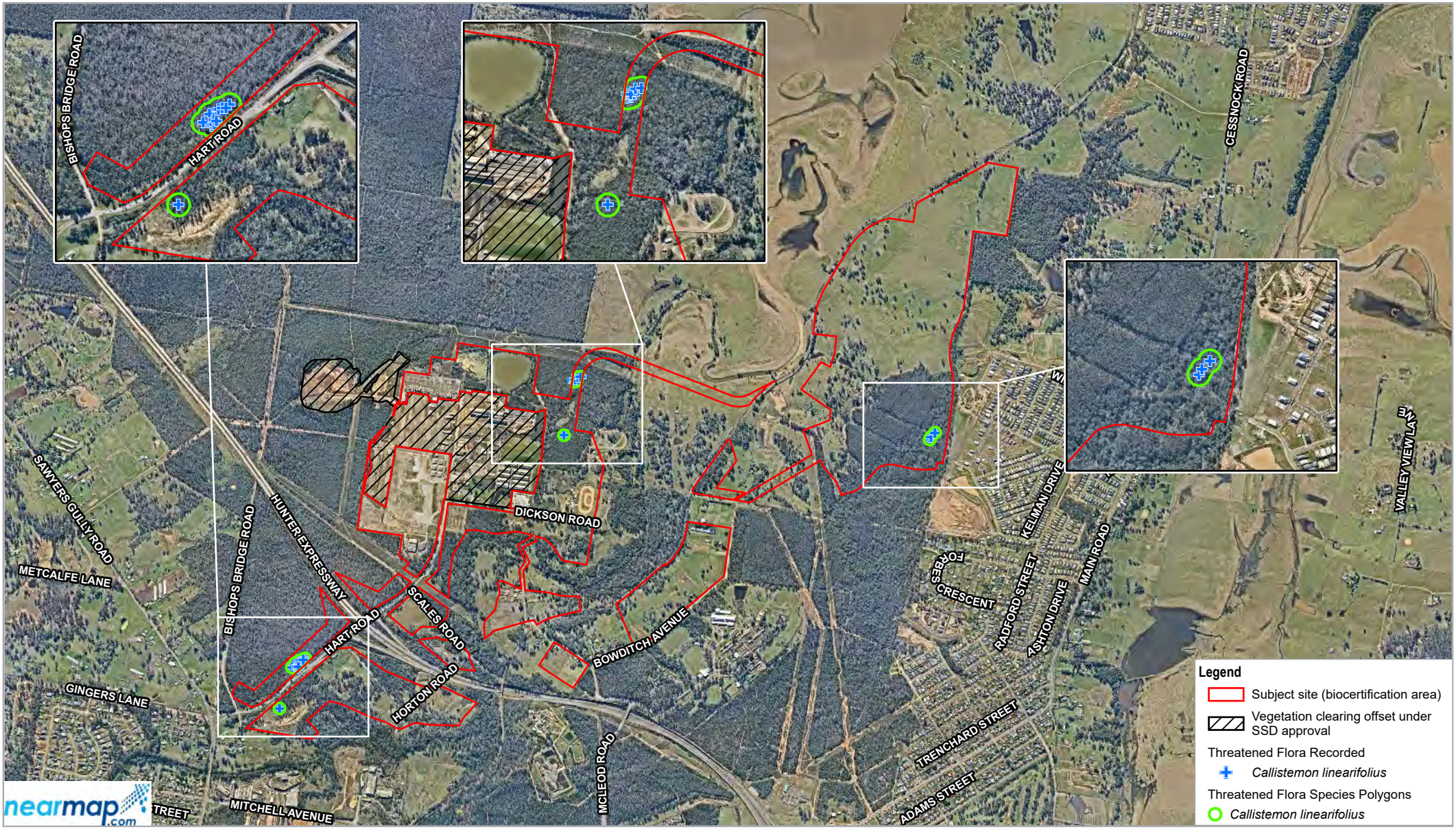
Print date: 01 Jun 2022 - 14:34

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; ELA: Threat Flora, 2019; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay



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Kilometres

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Threatened species polygon *Callistemon linearifolius*

Figure 8-2

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR007a_ThreatFlora_CL_1
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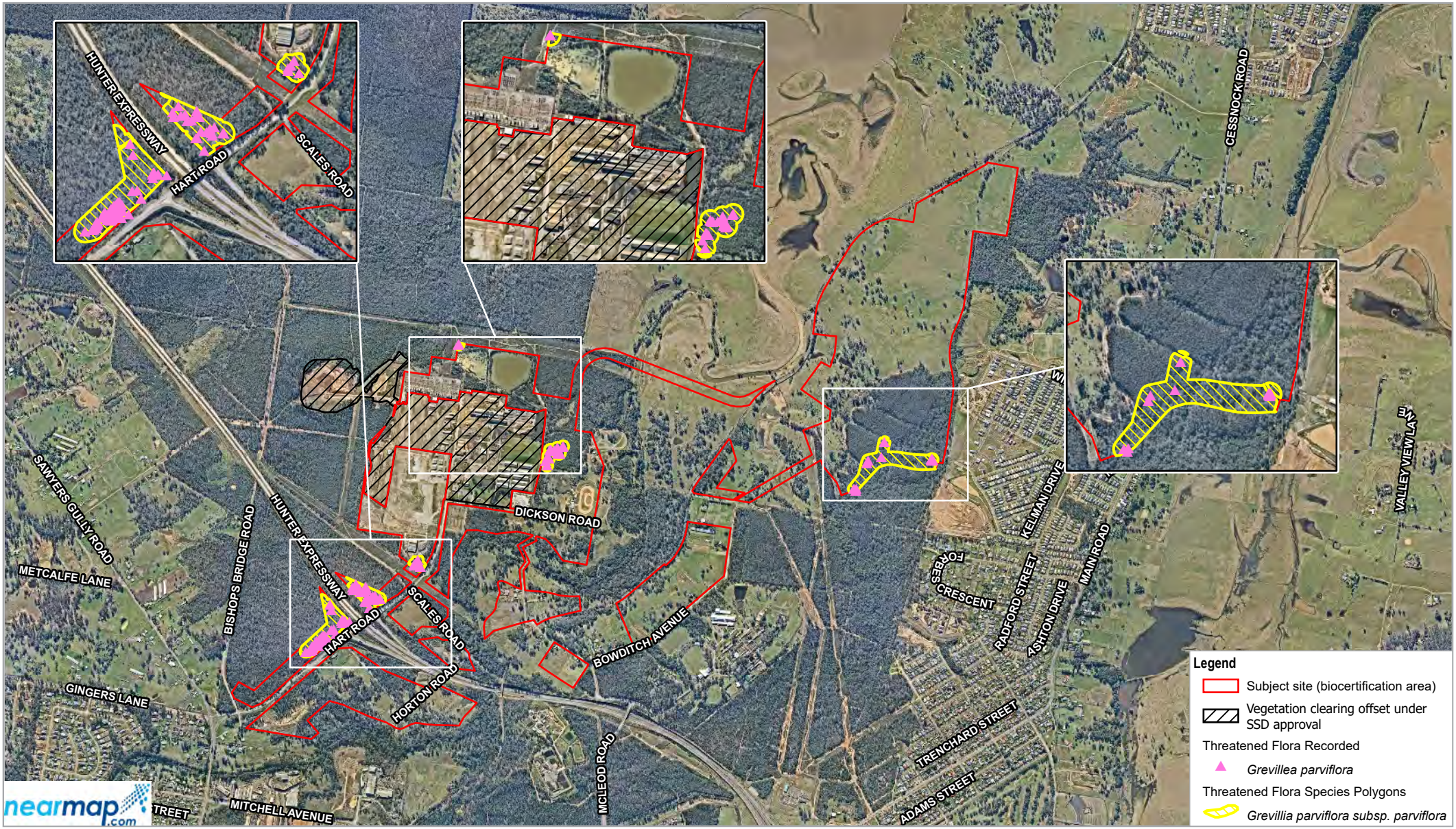

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Threatened species polygon
Grevillia parviflora subsp. parviflora

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Figure 8-3

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR008a_ThreatFlora_GP_1
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Data source: Nearmap: Imagery dated June 2020, extracted 20200825; ELA: Threat Flora, 2019; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

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Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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Threatened species polygon
Acacia bynoeana

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Figure 8-4

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR008b_ThreatFlora_AB_1
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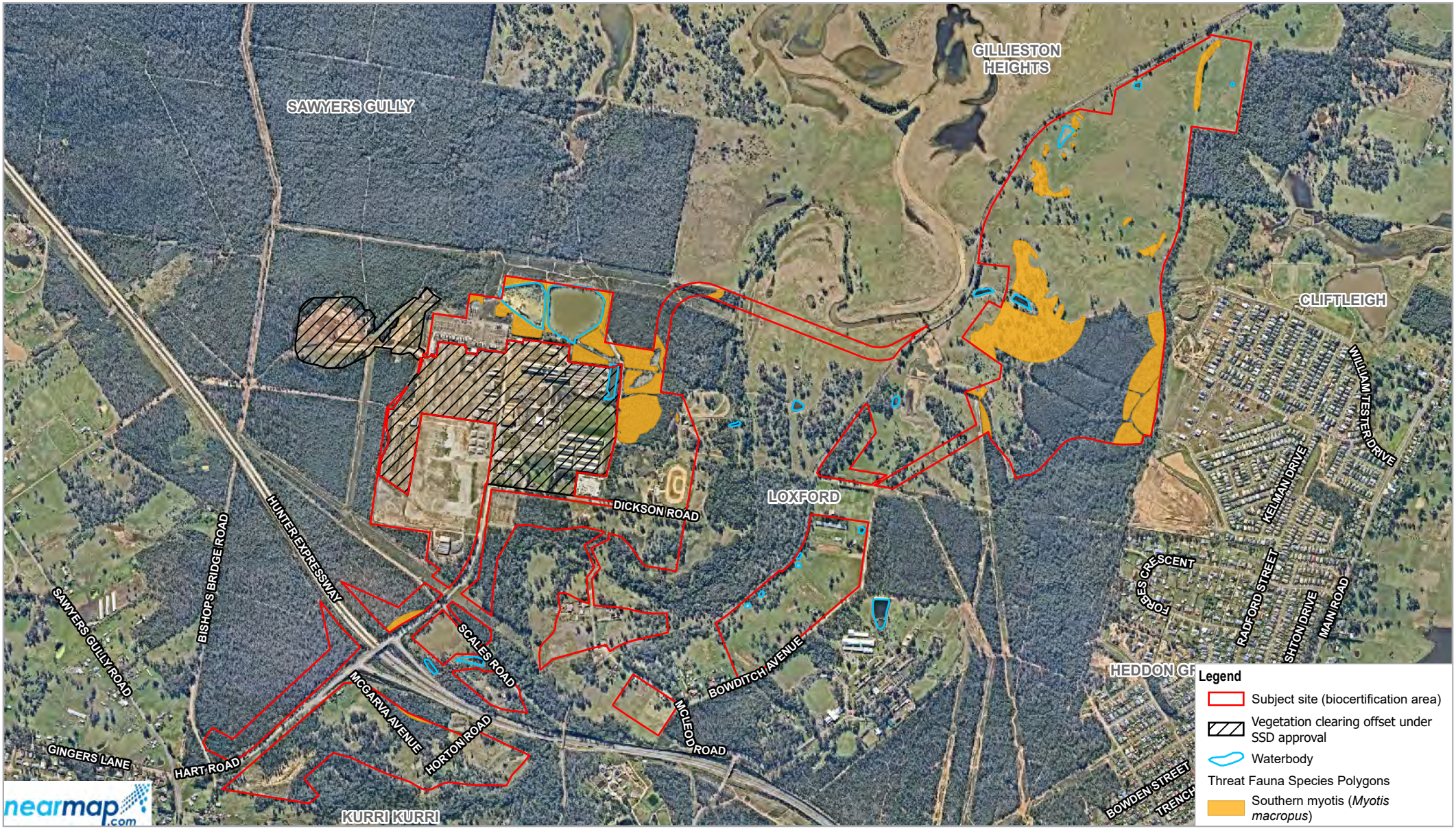

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Grid: GDA 1994 MGA Zone 56

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Threatened fauna species polygons
Southern myotis

Figure 8-5

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR009a_ThreatFauna_SouthernMyotis_1
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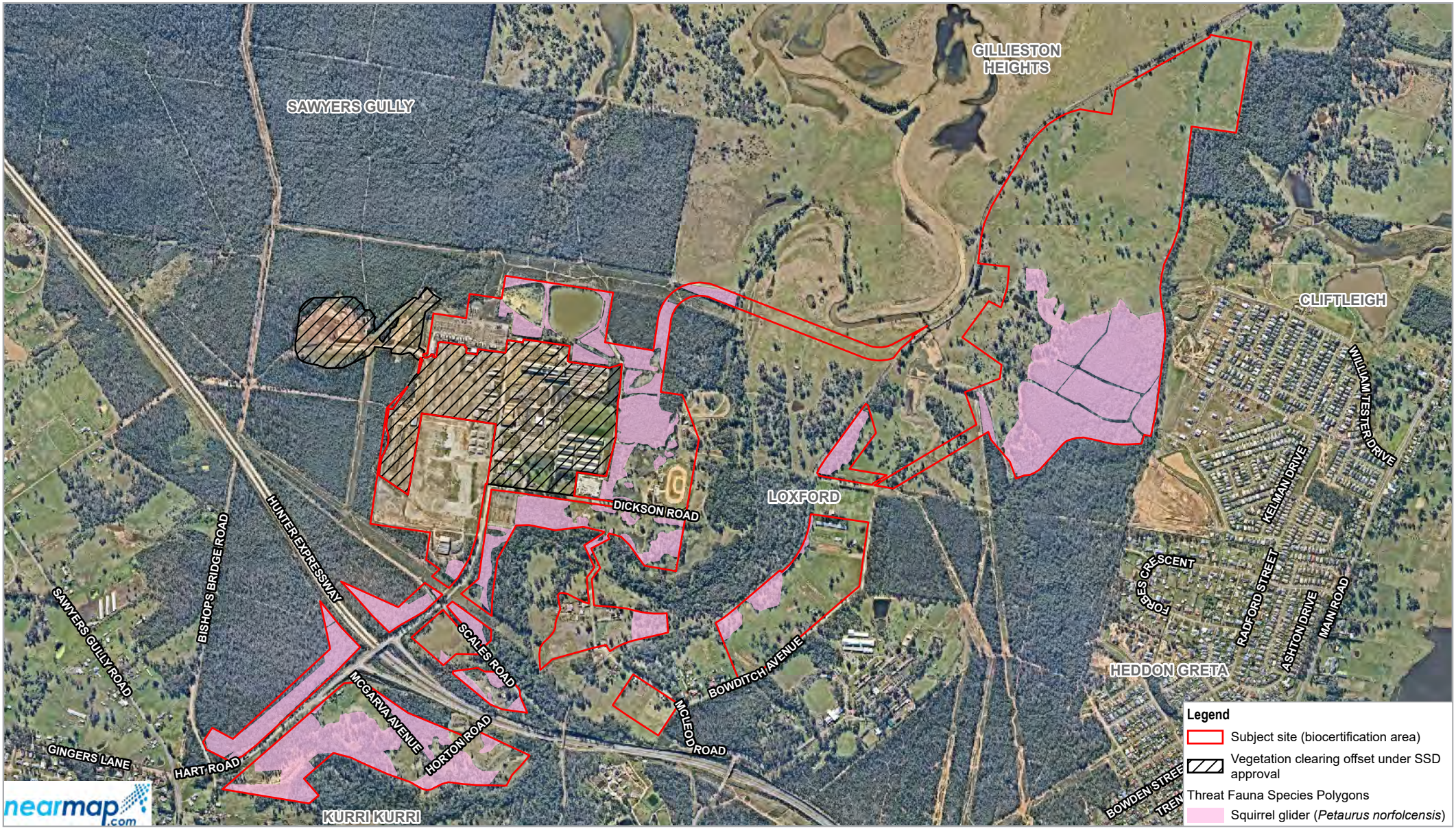

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Kilometres

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Threatened fauna species polygons
Squirrel glider

Figure 8-6

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR009b_ThreatFauna_SquirrelGlider_1
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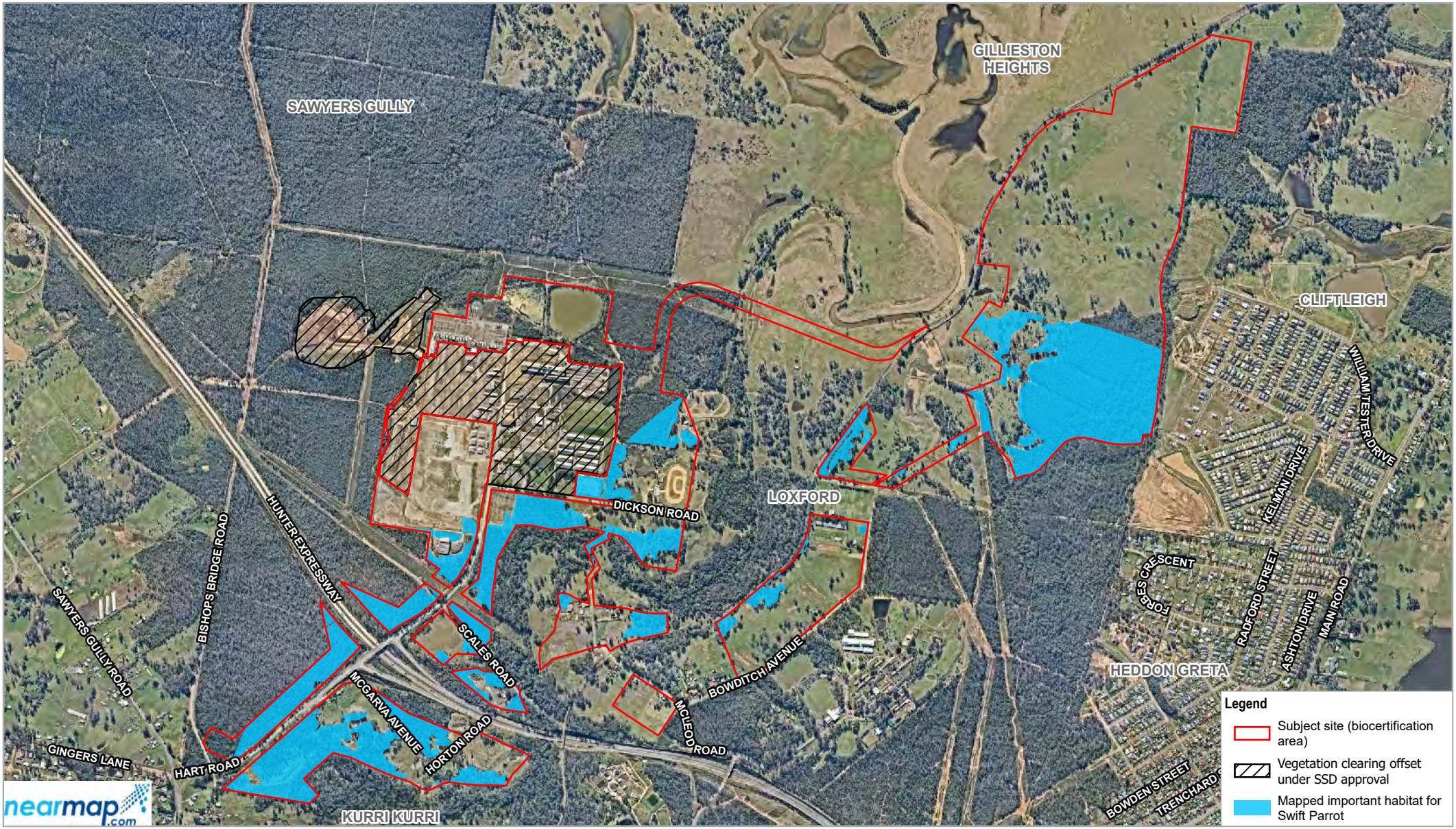

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Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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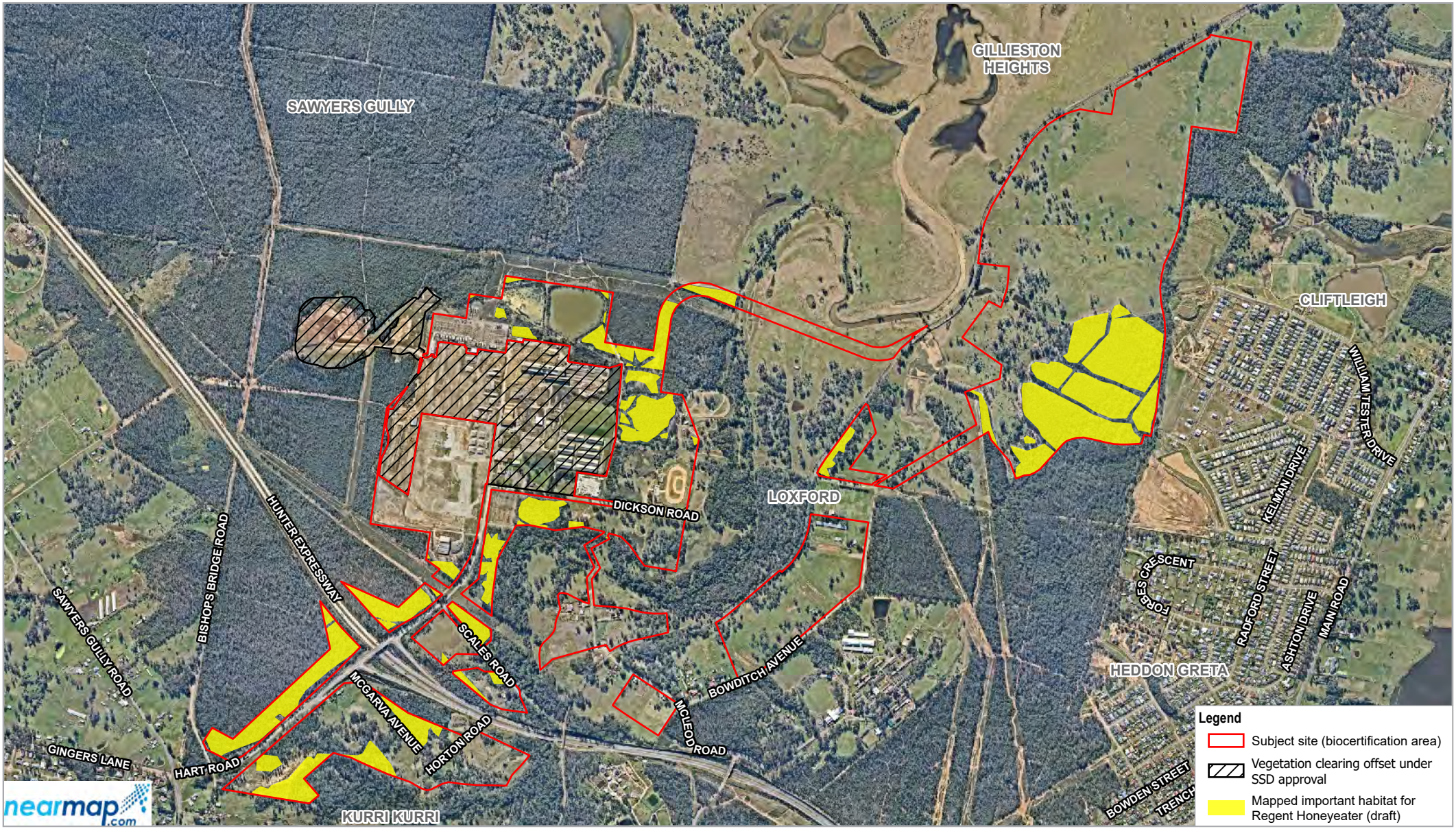
Date **01/06/2022**

Swift Parrot important habitat

Figure 8-7

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR010_ThreatFauna_SwiftParrot_1
Print date: 01 Jun 2022 - 14:34

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; BCD: Swift Parrot polygon, 2020; LPI: DTDB / DCDB, 2017. Created by: fmackay



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Date **01/06/2022**

Regent Honeyeater important habitat

Figure 8-8

G:\22\20284\GIS\Maps\Deliverables\2220284_ProjectData\2220284_BCAR_1.aprx\2220284_BCAR013_ThreatFauna_HoneyEater_1
Print date: 01 Jun 2022 - 14:35

Data source: Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site,2019; BCD: Regent Honey Eater polygon, 2020; LPI: DTDB / DCDB, 2017. Created by: fmackay

8.1.4 Indirect and prescribed impacts

Potential indirect impacts associated with the Project are discussed in detail in Section 7.2 and prescribed impacts are assessed in Section 7.5. The BAM does not have a set methodology to calculate biodiversity credits to offset indirect or prescribed impacts, however under section 7.13(4) BC Act and clause 6.1.2 (b) BC Regulation the consent authority has the discretion to increase the number of biodiversity credits to be retired (or other conservation measures to be undertaken) to account for the environmental impacts of the proposed development. Given there is no set method for determining a suitable quantum of credits to offset indirect or prescribed impacts, a justification for calculating additional credits is provided below.

The BSS will be actively managed and as such several of the identified potential indirect impacts (i.e. weed encroachment, erosion and sedimentation, introduction and spread of pest species) will be managed as part of the adopted site managed plan for the BSS. Indirect and prescribed impacts would be further managed through requirements set out in the project CEMP (refer to Section 6.3).

To compensate for potential residual indirect and prescribed impacts associated with loss of connectivity, a five-metre buffer has been applied to all areas of the subject site that adjoin native vegetation including areas within the proposed BSS that adjoin the subject site (see Figure 7-2). A BAM calculator case has been set up for the buffer area including vegetation zones and BAM vegetation integrity plot data derived from the BAM calculations for the subject site (BAM calculator Case 00016379/BAAS17098/19/00016384 / Revision: 10). The credit calculations for the five-meter buffer that has been applied to the perimeter of the subject site assume a total vegetation loss within these areas (i.e. VI scores have been reduced to zero). In reality there may be a partial reduction in VI scores within these areas due to residual impacts associated with edge effects described in Section 7.1 and on habitat connectivity described in Section 7.5. As these edge effects would be significantly less that the impacts associated with total removal of vegetation assumed for the five-meter buffer, the additional ecosystem credits that have been calculated would adequately compensate for any potential indirect and prescribed impacts associated with the proposal that may affect a broader area at a lower intensity.

An additional 183 ecosystem credits would be retired to account for potential indirect and prescribed impacts associated with the proposal. The additional credits proposed to be retired to compensate for potential indirect and prescribed impacts are outlined in Table 8-4.

Given that potential indirect and prescribed impacts associated with loss of connectivity would to a large extent be mitigated through required management at the BSS, including specific requirements for managing threatened biota within the BSS and that residual indirect impacts including light and noise are not likely to result in significant degradation of habitat for threatened species it is considered appropriate that additional offsets would be made for ecosystem credits only and that additional species credits would not be required to be retired to offset for potential indirect or prescribed impacts.

Table 8-4 Additional credits required to offset indirect and prescribed impacts

Plant community type	PCT ID	Indirect impact area (ha)	VI Score loss	BC Act status[1]	Ecosystem credits required to offset indirect impacts	HBT Credits
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	1633	2.36	63.6	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	75	75
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	1633	0.20	45.2	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	5	5
3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)	1633	0.06	34.3	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	1	0
4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)	1594	0.72	79.6	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and south-east Corner bioregions EEC	29	29
5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (underscrubbed)	1594	1.64	58.9	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and south-east Corner bioregions EEC	48	0
6 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact)	1591	0.34	45.7	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	8	8
7 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (underscrubbed)	1591	0.31	30	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	5	0
10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)	1600	0.37	65.3	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC	12	12

Note: HBT – hollow-bearing tree.

8.2 Impacts not requiring offset

Areas of exotic grassland, open water and cleared land have been identified within the subject site (Figure 7-2). The total area of exotic grassland, open water and cleared land within the subject site is 158.72 ha (refer to Table 8-5). Open water and cleared land is non-native vegetation and as discussed in Section 7.5 Do not comprise habitat for threatened biodiversity that would require calculation of offsets. BAM plots were placed in areas of exotic/mixed grassland to provide additional certainty that these areas do not comprise habitat for threatened biodiversity that would require calculation of offsets. BAM credit calculations based on these plots confirmed that these areas have an integrity score of 4.4. In accordance with Section 9.2.1 of the BAM impacts on vegetation with a VI score of 15 or less (where the PCT may be representative of a TEC) is not required to be offset.

Table 8-5 Impacts not requiring offsetting

Impacts not requiring offsetting	Area (ha)
Mixed grassland	104.11
Cleared land	48.57
Open water/swamp	6.04
Total	**158.72**

8.3 Offsets for impacts on MNES

Offsets would be required for any significant residual impacts on MNES, according to the requirements of the *Environment Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy* (EPBC Act Offsets Policy) (DSEWPaC 2012). Potentially significant impacts on MNES arising from the proposal include:

- Removal of approximately 7.6 ha of River-flat eucalypt forest of coastal floodplains of southern NSW and eastern Victoria CEEC.
- Removal of approximately 1495 Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*) stems within approximately 10.9 ha of occupied habitat.
- Removal of approximately 3224 Parramatta Red Gum individuals (*Eucalyptus parramattensis* subsp. *decadens*) (including 1064 adults, 1612 juveniles and 548 seedlings) within the subject site.
- Removal of up to 84.1 ha of potential foraging habitat for the Swift Parrot (*Lathamus discolor*). Of this potential foraging habitat 66.6 ha is mapped as important habitat by DPIE and has therefore been used to create a species polygon for the purpose of species credit calculations (noting that impacts to the remaining 17.5 ha of foraging habitat would be offset through the retirement of ecosystem credits). An assessment by a species expert has identified 47.55 ha of important habitat within the site and as such this smaller area has been used to assess the significance of impacts (Crates 2022).
- Removal of up to 36.4 ha of potential foraging habitat for the Regent Honeyeater (*Anthochaera phrygia*) Of this potential foraging habitat 50.27 ha is mapped as important habitat by DPIE and has therefore been used to create a species polygon for the purpose of species credit calculations. An assessment by a species expert has identified 34.6 ha of important habitat within the site and as such this smaller area has been used to assess the significance of impacts (Crates 2022).

- Removal of approximately 84.1 ha of potential foraging habitat for the Grey Headed Flying Fox (*Pteropus poliocephalus*).
- Removal of approximately 2.72 ha of habitat for Bynoe's Wattle (*Acacia bynoeana*).

Assessments of significance for MNES likely to be impacted by the proposal are included in Appendix H. This BCAR will be submitted as part of the documentation required to support a EPBC referral to the Commonwealth for consideration. Should the Commonwealth determine the proposal is a 'Controlled Activity' and that offsets for impacted MNES these would need to be delivered in accordance with the offset requirements outlined in this BCAR for MNES. The recently amended bilateral agreement between State and Federal government enables proponents to secure offsets for MNES via securing and retiring biodiversity credits on a 'like for like' basis for MNES (i.e. the variation to trading rules associated with the BOS do not apply) and/or via payment into the BCF administered by the BCT. Should the proponent choose to utilise the BCF, then the BCT would be responsible for securing and retiring credits on a 'like for like' basis on behalf of the proposal.

9. Proposed conservation measures

9.1 Options to meet offset obligations

Biodiversity offsets would be required for impacts associated with development on the land proposed for biodiversity certification (Section 8). In accordance with the offset rules associated with the BOS and established under the *Biodiversity Conservation Regulation 2017,* there are various means by which offset obligations described in Sections 8.1.1 and 8.1.2 can be met. These include:

- Retiring the appropriate credits from an established stewardship site.
- Monetary payment directly into the Biodiversity Conservation Fund (BCF).
- Funding an approved biodiversity action (note this mechanism is only available to actions listed in the ancillary rules for biodiversity conservation actions (OEH, 2017a) and therefore is not relevant to this site).

The Biodiversity Conservation Strategy that accompanies the application for biocertification is included as Appendix K and summarised below.

9.2 Conservation measures proposed to offset impacts of development

9.2.1 Preferred offset approach

Onsite stewardship site establishment

Hydro's preferred approach to offset the residual impacts of the proposed development is to secure and retire appropriate credits from a proposed 770 ha Biodiversity Stewardship Site (BSS), located adjacent to the subject site (referred to as the Regrowth stewardship site)(refer to Figure 1-1). The assessment of the proposed stewardship site has commenced and vegetation mapping at the site has confirmed that the proposed stewardship site contains similar PCTs to those that would be impacted by the proposals. Threatened biota including Parramatta Red Gum, Small Flowered Grevillia, Netted Bottlebrush, Squirrel Gliders, Southern Myotis as well as important mapped habitat for the Regent Honeyeater and Swift Parrot are also known to be present within the proposed BSS.

The proposed stewardship site will be assessed in accordance with the BAM and a separate Biodiversity Stewardship Site Assessment Report (BSSAR) would be prepared that will describe the ecosystem and species credits generated at the site. A Site Management Plan (SMP) will be prepared to describe the restoration and management actions required to be undertaken at the site to improve biodiversity values. The SMP would be accompanied by a Total Fund Deposit (TFD) amount which will determine the funds that would be required to implement the restoration and management program in perpetuity. An application for a BSA will then be lodged with the Biodiversity Conservation Trust (BCT). Vegetation types at the proposed stewardship site are commensurate with those within the subject site and it is anticipated that the stewardship site will provide suitable habitat for a similar suite of threatened species and contain the appropriate credits to substantially meet offset obligations for the proposal.

As required under Section 12 of the BAM a biodiversity certification strategy has been prepared that outlines the conservation measures proposed to offset the impacts of the proposal and details how credits will be retired to offset the development (refer to Appendix K).

Biodiversity credit market

Any residual credit shortfalls would be secured from other stewardship site/s that provide biodiversity credits that comply with the trading rules of the BOS. These credits may be available on the existing credit market for purchase or could be generated from land acquisition and subsequent BAM assessment and registration as a BSA.

The 'like for like' trading rules for the ecosystem credits required for the proposal are shown in Table 9-1, Table 9-2 and Appendix D. The 'like for like rules' for species credits require matching credits for each individual species, though these credits could be generated anywhere in NSW. An application to apply the 'variation to trading rules' is not preferred and would only be considered after all reasonable steps to seek like-for-like credits were undertaken and suitable credits still could not be sourced. As explained in Section 7.5, offsetting by applying a variation to the credit trading rules is also not accepted by DAWE for offsetting significant impacts on MNES and so any use of the variation to trading rules would be applied to NSW listed threatened biota only.

The like for like rules for candidate species credits require matching credits for each individual species, although these credits could be generated anywhere in NSW. If such credits are unavailable, credits would be sourced in accordance with the 'variation report' generated by the BAM calculator and also included in Appendix D.

Biodiversity Conservation Fund Payment

A payment to the BCF could be considered to meet the residual credit requirements if a suitable number and type of biodiversity credits could not be secured from third parties.

The like for like rules for species credits require matching credits for each individual species, though these credits could be generated anywhere in NSW (Table 9-2).

Table 9-1 'Like for like' ecosystem credits required to offset impacts

Name of Plant Community Type/ID	Class	Trading groups	Hollow-bearing trees	IBRA subregions
PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Kurri Sand Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.
PCT 1594 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions This includes PCTs 686, 828, 835, 839, 941, 1064, 1108, 1109, 1212, 1228, 1232, 1293, 1318, 1326, 1386, 1522, 1556, 1594, 1618, 1646, 1648, 1720, 1794	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.

Name of Plant Community Type/ID	Class	Trading groups	Hollow-bearing trees	IBRA subregions
PCT 1591 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	Hunter Lowland Redgum Forest and NSW North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.
PCT 1600 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	Central Hunter Ironbark – Spotted Gum – Grey Box Forest in the NSW North Coast and Sydney Basin Bioregions[1] This includes PCTs 1590, 1592, 1593, 1600, 1602	-	Yes	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.
PCT 1747 Typha Rushland	Coastal Freshwater Lagoons This includes PCTs 781, 783, 1071, 1735, 1736, 1737, 1740, 1741, 1742	Coastal Freshwater Lagoons >=70% and <90%	No	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo Any IBRA subregion that is within 100 kilometres of the outer edge of the impacted site.

Table 9-2 'Like for like' species credits required to offset impacts of the project

Species	Like-for-like retirement options species	Like-for-like retirement options IBRA region
Netted Bottlebrush (*Callistemon linearifolius*)	Netted Bottlebrush (*Callistemon linearifolius*)	Any in NSW
Parramatta Red Gum (*Eucalyptus parramattensis* subsp *decadens)*	Parramatta Red Gum (*Eucalyptus parramattensis* subsp *decadens)*	Any in NSW
Bynoe's Wattle (Acacia bynoeana)	*Bynoe's Wattle (Acacia bynoeana)*	Any in NSW
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	Any in NSW
Southern Myotis (*Myotis macropus*)	Southern Myotis (*Myotis macropus*)	Any in NSW
Squirrel Glider (*Petaurus norfolcensis*)	Squirrel Glider (*Petaurus norfolcensis*)	Any in NSW
Swift Parrot (*Lathamus discolour*)	Swift Parrot (*Lathamus discolour*)	Any in NSW

9.2.2 Staged offsetting

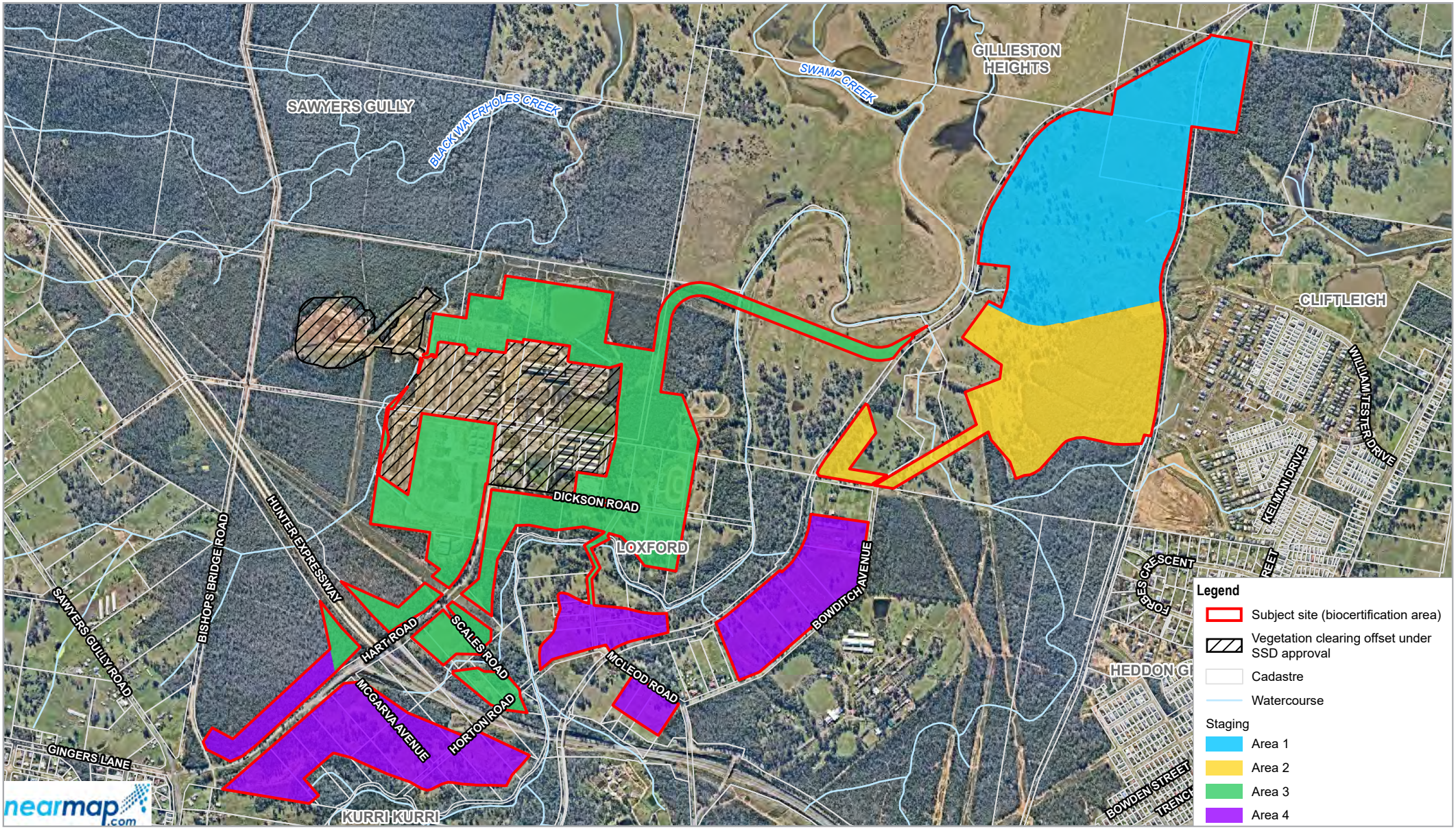
The proposal will be developed in four separate stages as shown on Figure 9-1. The approach to the provision of offsets will be to purchase and retire the biodiversity credits associated with residual impacts of development of each stage before construction of each separate stage commences.

The quantum of biodiversity credits that should be retired before development of each stage has been calculated as follows:

- Data from the fieldwork and mapping was entered into version 1.4.0.00 of the BAM credit calculator as a 'biocertification' assessment to determine the total number and type of biodiversity credits that would be required to offset impacts from the proposal (see Section 8 above).
- The area of vegetation zones in each development stage was calculated in GIS and the proportion of the total vegetation zone area was used to calculate the proportion of the total number of ecosystem credits associated with each development stage.
- The area of species polygons for each area-type species credit entity in each development stage was calculated in GIS and the proportion of the total species polygon area was used to calculate the proportion of the total number of species credits associated with each development stage.
- The number of stems of each individual count-type species credit entity in each development stage was calculated in GIS and the proportion of the total number of stems was used to calculate the proportion of the total number of species credits associated with each development stage.
- The additional credits proposed to be retired to offset indirect and prescribed impacts associated with the development will be retired along with the stage 1 credits, prior to the commencement of stage 1 of the proposal.

A summary of the ecosystem credits to be retired along with staged development and offsetting of the area proposed for biocertification is presented in Table 9-3. Detailed ecosystem credit calculations supporting the staged delivery of offsets, including a breakdown of areas and credits per vegetation zone, are included in Appendix J.

A summary of the species credits to be retired along with staged development and offsetting of the area proposed for biocertification is presented in Table 9-4.



Paper Size ISO A4

0 0.15 0.3 0.45 0.6

Kilometres

Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
Grid: GDA 1994 MGA Zone 56

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GHD

Hydro Aluminium Kurri Kurri Pty Ltd
Biodiversity Certification Assessment Report

Project No. **22-20284**
Revision No. **1**
Date **01/06/2022**

Development staging plan

Figure 9-1

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Print date: 01 Jun 2022 - 14:31

Data source: ESS: Staging,2021; Nearmap: Imagery dated June 2020, extracted 20200825; Hydro Aluminium Pty Ltd: Subject Site, 2019; LPI: DTDB / DCDB, 2017. Created by: fmackay

Table 9-3 Ecosystem credits to be retired along with staged offsetting of development

Vegetation zone	Total direct impact area (ha)	Total credits (direct impacts)	Stage 1 area (ha)	Stage 1 credits	Indirect impact area (ha)	Indirect impact credits	Stage 2 area (ha)	Stage 2 credits	Stage 3 area (ha)	Stage 3 credits	Stage 4 area (ha)	Stage 4 credits
PCT1633, Parramatta Red Gum – Narrow-leaved Apple – Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	47.72	1432	0	0	2.61	81	12.74	406	14.12	434	20.86	593
PCT1594, Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	10.84	363	1.38	42	2.39	77	1.04	31	7.19	242	1.22	49
PCT1591, Grey Gum – Rough-barked Apple shrubby open forest of the lower Hunter	14.99	263	0.00	0	0.65	13	2.86	43	5.55	119	6.57	101
PCT1600, Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter	36.39	926	8.91	157	0.37	12	23.48	647	3.45	104	0.54	18
PCT1737, Typha rushland	0.90	35	0	0	0	0	0	0	0.90	35	0	0
TOTAL	**110.84**	**3019**	**10.29**	**199**	**6.02**	**183**	**40.12**	**1127**	**31.21**	**934**	**29.19**	**761**

Table 9-4 Species credits to be retired along with staged offsetting of development

Species	Impact unit	Total impact	Total credits	Stage 2 area (ha)	Stage 2 credits	Stage 3 area (ha)	Stage 3 credits	Stage 4 area (ha)	Stage 4 credits	Stage 5 area (ha)	Stage 5 credits
Bynoe's Wattle (*Acacia bynoeana*)	area (ha)	2.7	87	0	0	2.7	87	0	0	0	0
Netted Bottlebrush (*Callistemon linearifolius*)	stems (count)	400	601	0	0	7.0	11	214.0	322	179.0	269
Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)	stems (count)	3224	6448	0	0	491.0	982	1763.0	3526	970.0	1940
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	area (ha)	10.9	348	0	0	4.4	140	5.1	163	1.4	45
Southern Myotis (*Myotis macropus*)	area (ha)	27.0	699	6.3	163	11.0	285	9.5	246	0.2	4
Squirrel Glider (*Petaurus norfolcensis*)	area (ha)	84.5	2420	1.9	54	30.2	865	27.4	785	25.0	716
Swift Parrot (*Lathamus discolor*)	area (ha)	66.6	2899	0.5	20	28.4	1236	17.1	734	20.6	898
Regent Honeyeater (*Anthochaera phygia*)	area (ha)	50.3	2383	0.1	5	23.4	1108	17.1	811	9.7	460

10. Conclusion

GHD Pty Ltd (GHD) has been engaged by Hydro Aluminium to prepare a Biodiversity Certification Assessment Report (BCAR) to address the potential biodiversity impacts associated with the proposed biocertification of 270 ha of land at Loxford NSW (the proposal). This BCAR has been prepared as a supporting document to a Planning Proposal that has been prepared in accordance with section 3.33 of the *Environmental Planning and Assessment Act 1979*. The BCAR has been issued to Cessnock City Council for review as part of the approval process undertaken by the BCD on behalf of the Minister.

This assessment has been completed in accordance with the BAM and includes:

- Desktop assessment to describe the existing environment and landscape features of the subject site and to identify the suite of threatened biota potentially affected by the proposal.
- Field survey to describe the biodiversity values of the subject site to determine the likelihood of threatened biota and their habitats occurring in the subject site or being affected by the proposal.
- BAM calculations using the credit calculator version 1.4.0.00 to quantify the biodiversity impacts of the proposal following implementation of measures to avoid and minimise impacts and to determine the biodiversity credits that would be required to be retired to offset the residual impacts of the proposal.

The masterplan for the proposal has undergone several iterations to specifically avoid impacts on areas of high conservation to the maximum extent practicable while still achieving a viable development outcome from the site. To further minimise potential impacts of the proposal on biodiversity values, a series of mitigation and management measures have been identified in this BCAR, which would be implemented as part of the construction environmental management plan/s for the site as well as future management during the operational stage of the proposal.

Despite these measures to avoid and mitigate impacts, the conferral of biodiversity certification would result in the following impacts.

Vegetation

The proposal would removal of up to 110.84 ha of native vegetation. This would include:

- Removal of 47.7 ha of Parramatta Red Gum – Narrow-leaved Apple – Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (PCT 1633). This community is listed under the BC Act as Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC.
- Removal of 10.8 ha of Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (PCT 1594). This community is listed under the BC Act as River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner Bioregions EEC and approximately 7.6 ha is also commensurate with the CEEC listed under the EPBC Act as River-flat eucalypt forest on coastal floodplains of southern NSW and eastern Victoria.

- Removal of 15 ha of Grey-Gum –Rough-barked Apple shrubby open forest of the lower Hunter (PCT 1591). This community is listed under the BC Act as Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC.
- Removal of 36.4 ha of Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub grass open forest of the lower Hunter (PCT 1600). This community is listed under the BC Act as Lower Hunter Spotted Gum –Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC.
- Removal of 0.9 ha of Typha rushland (PCT 1737).

Ecosystem Credit Species

- Removal of up to 84.1 ha of foraging and roosting habitat for the threatened woodland bird species including the Grey-crowned babbler (*Pomatostomus temporalis*) and Varied Sitella (*Daphoenositta chrysoptera*).
- Removal of up to 84.1 ha of foraging and breeding habitat for the Little Lorikeet (*Glossopsitta pusilla*), Grey Headed Flying Fox (*Pteropus poliocephalus*) and White Bellied Sea Eagle (*Haliaeetus leucoglaster)*.
- Removal of up to 84.1 ha of foraging habitat for the following threatened bat species; Large Bent-winged Bat (*Miniopterus orianae oceanensis*), Eastern False Pipistrelle (*Falsistrellus tasmaniensis*), Eastern Coastal Free-tailed Bat (*Micronomus norfolkensis*), and Little Bentwing-bat (*Miniopterus australis*).
- Removal of up to 110.84 ha of potential foraging and breeding habitat for a range of other threatened fauna species predicted to occur by the BAM credit calculator. Although none of these species were recorded within the site, they have included in the list of predicted species due to the presence of associated PCTs which are known to provide habitat for these species. These species are ecosystem credit species for which impacts have been calculated within ecosystem credit requirements for the proposal.

Species credit species

- Removal of approximately 10.9 ha of suitable habitat for the Small-flower Grevillea (*Grevillea parviflora* subsp*. parviflora*).
- Removal of approximately 400 Netted Bottle Brush (*Callistemon linearifolia*) individuals.
- Removal of approximately 3224 (including 1064 adults, 1612 juveniles and 548 seedlings) Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*).
- Removal of approximately of 2.72 ha of habitat for Bynoe's Wattle (*Acacia bynoeana*).
- Removal of up to 84.49 ha of suitable habitat for Squirrel Glider (*Petaurus norfolcensis*) (listed as a vulnerable species under the BC Act).
- Removal of up to 26.97 ha of Southern Myotis (*Myotis macropus*) habitat (listed as a vulnerable species under the BC Act).
- Removal of 66.6 ha of mapped important habitat for the Swift Parrot (*Lathamus discolor*)
- Removal of 50.27 ha of mapped important habitat for the Regent Honeyeater (*Anthochaera phrygia*).

The proposal would not impact any key fish habitat or any threatened biota listed under the *Fisheries Management Act 1994*.

The BAM calculator was used to calculate the credits required to be retired to offset the impacts of the proposal. Impacts on 'predicted threatened species' recorded at the subject site and/or that may be affected by the proposal would be offset through the retirement of the following ecosystem credits in accordance with the BAM and BOS.

- 1432 ecosystem credits to offset impacts on 47.7 ha of PCT 1633 – Parramatta Red Gum-Narrow-leaved Apple –Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri Area.
- 363 ecosystem credits to offset impacts on 10.8 ha of PCT 1594 – Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter.
- 263 ecosystem credits to offset impacts on 15 ha of PCT 1591 – Grey Gum – Rough-barked Apple shrubby open forest of the lower Hunter.
- 926 ecosystem credits to offset impacts on 36.4 ha of PCT 1600 – Spotted Gum – Red Ironbark – Narrow-leaved Ironbark – Grey Box shrub-grass open forest of the lower Hunter.
- 35 ecosystem credits to offset impacts on 0.9 ha of PCT 1737 – Typha rushland.

Impacts on candidate threatened species will be offset by securing the number and type of species listed below in accordance with the BAM and BOS:

- 87 Bynoe's Wattle (*Acacia bynoeana*) species credits.
- 601 Netted Bottle Brush (*Callistemon linearifolia*) species credits.
- 348 Small-flower Grevillea *(Grevillea parviflora* subsp*. parviflora)* species credits.
- 6448 Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*) species credits.
- 699 Southern Myotis (*Myotis macropus*) species credits.
- 2420 Squirrel Glider (*Petaurus norfolcensis*) species credits.
- 2899 Swift Parrot (*Lathamus discolor*) species credits.
- 2383 Regent Honeyeater (*Anthochaera phrygia*) species credits.

Other threatened species identified as potentially being impacted by the proposal are ecosystem credit species, which are predicted species and therefore would be offset through the retirement of the above listed ecosystem credits for PCT 1633, PCT 1594, PCT 1591, PCT 1600 and PCT 1737.

Additional credits are also proposed to be retired to offset potential indirect and prescribed impacts associated with the proposal.

The preferred approach to offset the residual impacts of the proposal is to secure and retire appropriate credits from a proposed stewardship site that will be established within Hydro lands surrounding the subject site. If there are any shortfalls in credits, then these would be sourced from other stewardship site/s from the 'open market' that fit within the trading rules of the BOS. If such credits are unavailable, credits would be sourced in accordance with the 'variation report' generated by the BAM calculator. A payment to the BCF could be considered if a suitable number and type of biodiversity credits cannot be practically secured from third parties.

The proposal will be developed in four separate stages. The approach to the provision of offsets will be to purchase and retire the biodiversity credits associated with residual impacts of development of each stage before construction of each separate stage commences.

The Swift Parrot and Regent Honeyeater are both listed as threatened species entities at risk of SAII. Therefore, additional impact assessments for the Swift Parrot and Regent Honeyeater have been prepared in accordance with section 9.1 of the BAM. As the approval authority DPIE are required to consider if the proposal's residual impacts on Swift Parrot or Regent Honeyeater comprises a SAII and determine if there are any additional and appropriate mitigation measures that will minimise those impacts if approval is to be granted.

Assessment of significance have been prepared in accordance with the '*Matters of National Environmental Significance Significant impact guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999'* (DotE 2013) for the following impacts on MNES:

- Removal of approximately 1495 Small-flower Grevillea individuals, which occur within 10.9 ha of occupied habitat. Small-flower Grevillea is listed as a vulnerable species under the EPBC Act.
- Removal of approximately 3224 (including 1064 adults, 1612 juveniles and 548 seedlings) Parramatta Red Gum individuals and 49.5 ha of occupied habitat. Parramatta Red Gum is listed as a vulnerable species under the EPBC Act.
- Removal of up to 84.1 ha of potential foraging habitat for the Swift Parrot (*Lathamus discolor*) (of which 47.6 ha is considered by a species expert as being important habitat (Crates 2022) (listed as a critically endangered species under the EPBC Act).
- Removal of 36.4 ha of potential foraging habitat for the Regent Honeyeater (*Anthochaera phrygia*), of which 34.6 ha is described as important habitat by a species expert (Crates 2022) (listed as a critically endangered species under the EPBC Act).
- Removal of up to 84.1 ha of potential foraging habitat for the Grey Headed Flying Fox (listed as a vulnerable species under the EPBC Act).
- Removal of up to 84.1 ha of potential foraging habitat for Large-eared-Pied Bat (*Chalinolobus dwyeri*) (listed as a vulnerable species under the BC Act and EPBC Act).
- Removal of up to 84.1 ha of potential foraging habitat for the White-bellied Sea-eagle (*Haliaeetus leucogaster*) (listed as a migratory species under the EPBC Act).

This BCAR, including the assessments of significance completed for MNES, will be included in a referral of the project to the Commonwealth Minister for the Environment. If biodiversity offsets are required for significant residual impacts on threatened biota listed under the EPBC Act then they would need to be delivered in accordance with the Commonwealth *EPBC Act Environmental Offsets Policy* (DSEWPaC 2012). It is noted that under the Amending Agreement to the existing Assessment Bilateral Agreement between the Commonwealth of Australia and the State of New South Wales, offsetting can be undertaken in accordance with the NSW BOS like-for-like credit trading rules. Use of the 'variation to trading rules' is not permitted. A payment into the NSW BCF is also an accepted option for offsetting impacts to MNES.

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Appendices

Appendix A – Threatened species assessment table

Threatened Biota Habitat Table

Databases Searched

- BioNet Atlas – threatened species results within a 10 km buffer
- *Biodiversity Assessment Method Calculator Version 1.4.0.00* – predicted and candidate
- EPBC PMST Online Search – predicted threatened species within a 10 km buffer

Note: Marine species which are restricted to marine environments only (such as whales, dolphins, sharks and seabirds) are excluded from the Likelihood of Occurrence Table as there is no marine habitat in immediately adjacent to the subject site.

Likelihood of Occurrence

Matters considered in determining the likelihood of occurrence include:

- Known natural distributions including prior records (database searches) and site survey results
- Geological/soil preferences
- Specific habitat requirements (e.g. aquatic environs, seasonal nectar resources, tree hollows etc.)
- Climatic considerations (e.g. wet summers; snow fall)
- Home range size and habitat dependence
- Topographical preferences (e.g. coastal headlands, ridgetops, midslopes, gilgai, wetlands)

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Acacia bynoeana	Bynoe's Wattle	E	V	Habitat known to occur within area	Y	-	183	0	Found in central eastern NSW, from the Hunter to the Southern Highlands to west of the Blue Mountains. Occurs in dry sclerophyll forest or heathlands on sandy soils. Associated with Red Bloodwood *Corymbia gummifera,* Scribbly Gum *Eucalyptus haemastoma* and Parramatta Red Gum *Eucalyptus parramattensis.*	Known	Species previously recorded within the subject site.
Actitis hypoleucos	Common Sandpiper	-	Mi	Habitat likely to occur within area	-	-	-	-	Found along all coastlines of Australia and in many areas inland, the Common Sandpiper is widespread in small numbers. The species utilises a wide range of coastal wetlands and some inland wetlands, with varying levels of salinity, and is mostly found around muddy margins or rocky shores and rarely on mudflats.	Unlikely	Species generally confined to the coast. Despite wetland habitat present within the subject site, it is not sizeable enough for the species to occur. The species is more likely to inhabit the wetland areas adjacent to the subject site. No previous records within the locality.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Angophora inopina	Charmhaven Apple	V	V	Habitat may occur within area	-	-	-	-	Endemic to the Central Coast of NSW. The known northern limit is near Karuah where a disjunct population occurs; to the south populations extend from Toronto to Charmhaven with the main population occurring between Charmhaven and Morisset. Occurs in four main vegetation communities: *Eucalyptus haemastoma - Corymbia gummifera - Angophora inopina* woodland/forest; *Hakea teretifolia–Banksia oblongifolia* wet heath; *Eucalyptus resinifera–Melaleuca sieberi–Angophora inopina* sedge woodland; and *Eucalyptus capitellata–Corymbia gummifera–Angophora inopina* woodland/forest.	Unlikely	No previous records within the subject site. Vegetation communities within the subject site do not correspond with known habitat for this species.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Anseranas semipalmata	Magpie Goose	V	-	-	-	Y	1	4092	Occurs in the tropics, increasing numbers in central and northern NSW and vagrants to south-east NSW. Inhabits shallow wetlands containing dense rushes or sedges, and nearby dry land used for grazing. It feeds on grasses, bulbs and rhizomes and roosts in tall vegetation within wetland areas. Breeding occurs predominately in monsoonal areas and is unlikely in SE NSW. Nests are formed in trees over deep water.	Unlikely	Breeding very unlikely within the subject site due to its location. Marginal foraging wetland habitat occurs within the subject site. The species is more likely to utilise the wetland habitat adjacent to the subject site. Only one previous record within the locality approximately 4 km from the subject site.
Anthochaera phrygia	Regent Honeyeater	CE	CE	Habitat known to occur within area	Y (parts of the site mapped as important habitat)	Y	92	1202	The Regent Honeyeater mainly inhabits temperate woodlands and open forests of the inland slopes of south-east Australia. Birds are also found in drier coastal woodlands and forests in some years. In NSW breeding is known from the Capertee Valley and Bundarra-Barraba region. More recently breeding pairs have also been observed in the Tomalpin Woodlands located to the west of the development site. Non-breeding flocks occasionally seen in coastal areas foraging in flowering Spotted Gum and Swamp Mahogany forests, presumably in response to drought. The species typically inhabits dry open forest and woodlands, particularly Box-Ironbark woodland and riparian forests of River Sheoak, with an abundance of mature trees, high canopy cover and abundance of mistletoes.	Possible	The subject site occurs in close proximity to known breeding area. Expert report completed for the site however determined that the site contains low to moderate quality habitat for the species and determined that the site contains low abundance of mistletoe and other key habitat components required by this species.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Apus pacificus	Fork-tailed Swift	-	Mi	Habitat likely to occur within area	-	-	-	-	Recorded in all regions of NSW. Non- breeding, and almost exclusively aerial while in Australia. Occurs over urban and rural areas as well as areas of native vegetation.	Likely	Species likely to utilise the project are for fly-overs only. The open woodland and grassland areas within the subject site provide foraging habitat.
Ardea ibis	Cattle Egret	-	Mi	-	-	-	36	0	Occurs across NSW. Principal breeding sites are the central east coast from Newcastle to Bundaberg. Also breeds in major inland wetlands in north NSW (notably the Macquarie Marshes). Occurs in tropical and temperate grasslands, wooded lands and terrestrial wetlands. Uses predominately shallow, open and fresh wetlands with low emergent vegetation and abundant aquatic flora. Sometimes observed in swamps with tall emergent vegetation and commonly use areas of tall pasture in moist, low-lying areas.	Known	Suitable wetland and grassland habitat within the subject site. The species was observed during site surveys.
Ardenna pacificus	Wedge-tailed Shearwater	-	Mi	-	-	-	13	583	The Wedge-tailed Shearwater breeds on the east and west coasts of Australia and on off-shore islands. The species is common in the Indian Ocean, the Coral Sea and the Tasman Sea. In Australia, Wedge-tailed Shearwaters have been observed feeding along the junction between inshore and offshore water masses.	None	No suitable habitat within the subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Ardenna tenuirostris	Short-tailed Shearwater	-	Mi	-	-	-	3	4092	This species breeds on Tasmania and off the coast of south Australia, with the bulk of the population in the south-east. Breeding occurs mainly on coastal islands, typically in areas of grassland or other vegetation, but sometimes cliffs or bare ground.	None	No suitable habitat within the subject site.
Arenaria interpres	Ruddy Turnstone	-	Mi	Habitat known to occur within area	-	-	-	-	Breeds in northern Hemisphere. In non-breeding season, widespread in most coastal regions of Australia with occasional inland records. Strongly prefers rocky shores or beaches with large seaweed deposits.	None	No suitable habitat within the subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Artamus cyanopterus cyanopterus	Dusky Woodswallow	V	-	-	-	-	29	2143	The Dusky Woodswallow is widespread from the coast to inland, including the western slopes of the Great Dividing Range and farther west. It is often recorded in woodlands and dry open sclerophyll forests, and has also been recorded in shrublands, heathlands regenerating forests and very occasionally in moist forests or rainforests. The understorey is typically open with sparse eucalypt saplings, acacias and other shrubs, often with coarse woody debris. It is also recorded in farmland, usually at the edges of forest or woodland or in roadside remnants or wind breaks with dead timber. The nest is an open shallow untidy cup frequently built in an open hollow, crevice or stump. Although Dusky Woodswallows have large home ranges, individuals may spend most of their time in about a 2 ha range and defend an area about 50 m around the nest. Dusky Woodswallows prefer larger remnants over smaller remnants. Competitive exclusion by Noisy Miners (Manorina melanocephala) is a significant threat to this species.	Likely	The species has a high number of records within the locality. Suitable dry sclerophyll forests occur within the subject site for both foraging and breeding.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Asperula asthenes	Trailing Woodruff	V	V	-	Y	-	-	-	This herb occurs in scattered locations from Bulahdelah to Kempsey. Some records from Port Stephens/Wallis Lakes area. Occurs in damp sites, often along riverbanks (OEH 2012).	Unlikely	No suitable habitat within subject site, no records within locality.
Botaurus poiciloptilus	Australasian Bittern	E	E	Habitat known to occur within area	-	Y	-	-	Widespread but uncommon over most NSW except the northwest. Favours permanent freshwater wetlands with tall dense reedbeds particularly Typha spp. and Eleocharis spp., with adjacent shallow, open water for foraging. Roosts during the day amongst dense reeds or rushes and feeds mainly at night on frogs, fish, yabbies, spiders, insects and snails.	Unlikely	Marginal wetland habitat with retention basins. No previous records within the locality of the subject site.
Burhinus grallarius	Bush Stone-curlew	E	-	-	Y	-	-	-	The Bush Stone-curlew is found throughout Australia except for the central southern coast and inland, the far south-east corner, and Tasmania. Only in northern Australia is it still common however and, in the south-east, it is rare throughout its former range. Inhabits open forests and woodlands with a sparse grassy ground layer and fallen timber. Nest on the ground in a scrape or small bare patch.	Unlikely	Suitable habitat occurs within the subject site, however due to not found during targeted surveys and no previous records within the locality, the species is unlikely to occur.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Caladenia tessellata	Thick-lipped Spider-orchid	E	V	Habitat may occur within area	-	-	-	-	Known to exist within the Sydney and Central Coast area of NSW. It is found in grassy sclerophyll woodland. Found on clay loam or sandy soils. Flowers from September to November (this is reduced from late September to early October for southern populations).	Unlikely	The subject site is located north of the Central Coast. Most of the sclerophyll woodland within the subject site is shrubby. Not previously recorded in locality or known to occur within any of the PCTs that occur within the subject site.
Calidris acuminata	Sharp-tailed Sandpiper	-	Mi	Habitat known to occur within area	-	-	2	9909	Spends the non-breeding season in Australia with small numbers occurring regularly in New Zealand. Most of the population migrates to Australia, mostly to the south-east and are widespread in both inland and coastal locations and in both freshwater and saline habitats. Many inland records are of birds on passage. In Australasia, prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation. Breeds in northern Siberia.	None	The wetland habitat within the subject site does not provide suitable muddy edges and saltmarsh for this species.
Calidris ferruginea	Curlew Sandpiper	E	CE, Mi	Habitat known to occur within area	Y	Y (not mapped as important habitat)	-	-	Breeds in northern hemisphere. In Australia generally occupies littoral and estuarine habitats. In NSW mainly found in intertidal mudflats on sheltered coasts. Roosts on beaches, spits or islands on the coast/in wetlands, or in saltmarsh on rocky shores.	None	No suitable habitat within the subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Calidris melanotos	Pectoral Sandpiper	-	Mi	Habitat known to occur within area	-	-	3	1120	Widespread but scattered records across NSW, east of the divide and in the Riverina and Lower Western regions. Breeds in the northern hemisphere. In Australasia, prefers shallow fresh to saline wetlands and is found at coastal lagoons, estuaries, bays, swamps, lakes, inundated grasslands, saltmarshes, river pools, creeks, floodplains and artificial wetlands. Usually in coastal or near-coastal habitats and prefers wetlands with open mudflats and low emergent or fringing vegetation such as grass or samphire.	Unlikely	Marginal foraging wetland habitat occurs within the subject site. It does not provide the open mudflats and fringing vegetation habitat for which the species prefers. The species is more likely to utilise the wetland habitat adjacent to the subject site. This is due to the three previous records within the locality, the nearest being approximately 1 km from the subject site.
Calidris ruficollis	Red-necked Stint	-	Mi	Habitat known to occur within area	-	-	1	9925	Distributed along most of the Australian coastline with large densities on the Victorian and Tasmanian coasts. Breeds in Siberia and sporadically in north and west Alaska. In Australasia, mostly found in coastal areas, including in sheltered inlets, bays, lagoons and estuaries with intertidal mudflats, often near spits, islets and banks and, sometimes, on protected sandy or coralline shores. Occasionally they have been recorded on exposed or ocean beaches, and sometimes on stony or rocky shores, reefs or shoals.	None	No intertidal mudflats occur within the subject site. No spits, islets, rocky shores or reefs.

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Calidris tenuirostris	Great Knot	V	CE, Mi	Habitat known to occur within area	Y	Y (not mapped as important habitat)	-	-	Breeds in northern hemisphere. In Australia, prefers sheltered coastal habitats with large intertidal mud or sandflats, including inlets, bays, harbours, estuaries and lagoons. Occasionally found on exposed reefs or rock platforms, mangroves, saltwork ponds, near-coastal swamps, salt lakes and non-tidal lagoons. Rarely occurs on inland lakes and swamps. Roosts in large groups in open areas, often at the water's edge or in shallow water close to feeding areas.	None	No suitable habitat within the subject site.
Callistemon linearifolius	Netted Bottle Brush	V	-	-	Y	-	1598	160	Recorded from the Georges to Hawkesbury Rivers in Sydney, and north to Nelson Bay. There is also a recent record from the northern Illawarra. Grows in dry sclerophyll forest on the coast and adjacent ranges.	Known	The species was found within subject site during targeted surveys.

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Callocephalon fimbriatum	Gang-gang Cockatoo	V	-	-	Y (Breeding)	Y	15	2815	Restricted to the south-eastern coast and highlands, from the lower Hunter and northern Blue Mountains to the Southwestern Slopes, south to and contiguous with the Victorian population. Inhabits eucalypt open forests and woodlands with an acacia understorey. In summer it lives in moist highland forest types, and in winter it moves to more open types at lower elevations. The Gang-Gang Cockatoo nests in hollows in the trunks, limbs or dead spouts of tall living trees, especially eucalypts, often near water. The Gang-gang Cockatoo feeds on seeds obtained in trees and shrubs, mostly from eucalypts and wattles.	Possible	An abundance of hollow-bearing trees indicates potential for nesting habitat. The nearest previous record was 2.5 km away from the subject site. The species was not found during targeted surveys.
Calyptorhynchus lathami	Glossy Black-Cockatoo	V	-	-	Y (Breeding)	Y	16	2544	Widespread but uncommon from coast to southern tablelands and central western plains. Feeds almost exclusively on the seeds of *Allocasuarina* species. Prefers woodland and open forests, rarely away from *Allocasuarina.* Roost in leafy canopy trees, preferably eucalypts, usually <1 km from feeding site. Nests in large (approx. 20 cm) hollows in trees, stumps or limbs, usually in Eucalypts (Higgins 1999).	Possible	Potential foraging habitat present within vegetation that contains low abundance of casuarina individuals. A moderate number of records have previously been recorded within close proximity to the subject site. Species however not found during targeted surveys.

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Cercartetus nanus	Eastern Pygmy-possum	V	-	-	Y	-	-	-	The Eastern Pygmy-possum is found in south-eastern Australia, from southern Queensland to eastern South Australia and in Tasmania. In NSW it extends from the coast inland as far as the Pilliga, Dubbo, Parkes and Wagga Wagga on the western slopes. Found in a broad range of habitats from rainforest through sclerophyll (including Box-Ironbark) forest and woodland to heath, but in most areas woodlands and heath appear to be preferred, except in north-eastern NSW where they are most frequently encountered in rainforest. Feeds largely on nectar and pollen collected from banksias, eucalypts and bottlebrushes; an important pollinator of heathland plants such as banksias; soft fruits are eaten when flowers are unavailable. Shelters in tree hollows, rotten stumps, holes in the ground, abandoned bird-nests, Ringtail Possum (*Pseudocheirus peregrinus*) dreys or thickets of vegetation, (e.g. grass-tree skirts); nest-building appears to be restricted to breeding females; tree hollows are favoured but spherical nests have been found under the bark of eucalypts and in shredded bark in tree forks.	Possible	Despite suitable heathland habitat occurring within the subject site, this species was not found during targeted surveys. No previous records occur within the locality.

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Chalinolobus dwyeri	Large-eared Pied Bat	V	V	Habitat known to occur within area	Y	-	14	0	Occurs from the coast to the western slopes of the divide. Largest numbers of records from sandstone escarpment country in the Sydney Basin and Hunter Valley (Hoye and Schulz 2008). Roosts in caves and mines and most commonly recorded from dry sclerophyll forests and woodlands. An insectivorous species that flies over the canopy or along creek beds (Churchill 2008). In southern Sydney appears to be largely restricted to the interface between sandstone escarpments and fertile valleys.	Known	The species is likely to utilise the vegetation and wetland areas within and adjacent to the subject site for foraging. Recorded during targeted surveys. No breeding or roosting habitat present within or adjacent (within 2 km) of the subject site.
Charadrius bicinctus	Double-banded Plover	-	Mi	Habitat known to occur within area	-	-	-	-	Found in both coastal and inland areas. During the non-breeding season, it is common in eastern and southern Australia. Breeds only in New Zealand. Found on littoral, estuarine and fresh or saline terrestrial wetlands and also saltmarsh, grasslands and pasture. It occurs on muddy, sandy, shingled or sometimes rocky beaches, bays and inlets, harbours and margins of fresh or saline terrestrial wetlands such as lakes, lagoons and swamps, shallow estuaries and rivers.	Unlikely	Despite wetland habitat present within the subject site, it is not sizeable enough for the species to occur. The species is more likely to inhabit the wetland areas adjacent to the subject site. No previous records within the locality.

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Charadrius leschenaultii	Greater Sand Plover	V	V, Mi	Habitat known to occur within area	-	-	-	-	Does not breed in Australia. In NSW, recorded between the northern rivers and the Illawarra, with most records coming from the Clarence and Richmond estuaries. Occurs mainly on sheltered sandy, shelly or muddy beaches or estuaries with large intertidal mudflats or sandbanks. Roosts during high tide on sandy beaches and rocky shores; forage on wet ground at low tide.	None	No beaches within or in close proximity to the subject site in addition to estuaries with mudflats or sandbanks.
Charadrius mongolus	Lesser Sand Plover	V	E, Mi	Habitat known to occur within area	-	-	-	-	Does not breed in Australia. Found along the entire coast of Australia, most common in northern NSW, QLD and the Gulf of Carpentaria. Rarely recorded south of the Shoalhaven. In NSW almost entirely coastal, on beaches of sheltered bays, harbours and estuaries with large intertidal sand or mudflats, occasionally on sandy beaches, coral reefs and rock platforms.	None	Subject site is located 30 km from the coast. No beaches or intertidal estuaries with mudflats or sandflats occur within the subject site.

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Chlidonias leucopterus	White-winged Black Tern	-	Mi	-	-	-	1	9909	Breeds in northern hemisphere, and one breeding record in New Zealand. In NSW, widespread east of the Great Divide, mainly north from Wollongong but with scattered records further south. Mostly inhabits a wide range of fresh, brackish or saline wetlands, which may be open or with floating emergent or marginal vegetation. Rarely occur on inland wetlands. Mainly forages aerially over water or muddy/ sandy wetland edges and adjacent habitats.	Unlikely	Subject site occurs approximately 30 km from the coast. Only one previous record approximately 10 km away from the subject site.
Chthonicola sagittata	Speckled Warbler	V	-	-	-	Y	19	107	Within NSW most frequently reported from the hills and tablelands of the Great Dividing Range, rarely from the coast. Inhabits a wide range of Eucalyptus-dominated communities with a grassy understorey, a sparse shrub layer, often on rocky ridges or in gullies. Sedentary and requires large, relatively undisturbed remnants to persist in an area. Forages on the ground for seeds and insects, and nests in a slight hollow in the ground or at the base of a low dense plant.	Possible	Suitable nesting and foraging habitat occur within the subject site Although no rocky ridges or significant gullies occur within the site. Eucalypt spp. communities with grassy understoreys and hollow-bearing trees allow for the species potential occurrence. A high number of records with the nearest record approximately 100 m from the subject site indicates that this species may occur.

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Circus assimilis	Spotted Harrier	V	-	-	-	Y	2	4130	Occurs throughout Australian mainland, except in densely forested or wooded habitats of the coast, escarpment and ranges, and rarely in Tasmania. Individuals disperse widely in NSW and comprise a single population. Inhabits grassy open woodland including acacia and mallee remnants, inland riparian woodland, grassland and shrub steppe (e.g. chenopods). Most commonly in native grassland, but also in agricultural land, foraging over open habitats including edges of inland wetlands. Builds a stick nest in a tree and lays eggs in spring (or sometimes autumn).	Possible	A low number of previous records within the locality. Potential foraging and breeding habitat within the subject site. Known presence of other raptor species may discourage the Spotted Harrier from inhabiting the subject site.
Climacteris picumnus victoriae	Brown Treecreeper (eastern subspecies)	V	-	-	-	Y	60	3026	Occurs from Corowa, Wagga Wagga, Temora, Forbes, Dubbo and Inverell to the east coast, in areas such as the Snowy River Valley, Cumberland Plain, Hunter Valley and parts of the Richmond and Clarence Valleys. Most common on the inland slopes and plains. Inhabits eucalypt woodlands and dry open forest, usually dominated by stringybarks or rough-barked species with open grassy understorey. Fallen timber is important foraging habitat. Nests in hollows in standing trees or stumps.	Likely	The subject site has suitable foraging and breeding habitat, which is characteristic of Eucalypt woodlands and dry open forest. A high number of hollows also occur within the subject site. A large number of records occur within 4 km of the subject site.

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Cryptostylis hunteriana	Leafless Tongue-orchid	V	V	Habitat likely to occur within area	Y	-	-	-	Occurs in coastal areas from East Gippsland to southern Queensland. Habitat preferences not well defined. Grows mostly in coastal heathlands, margins of coastal swamps and sedgelands, coastal forest, dry woodland, and lowland forest. Prefers open areas in the understorey and is often found in association with Large Tongue Orchid and the Bonnet Orchid. Soils include moist sands, moist to dry clay loam and occasionally in accumulated eucalypt leaves. Flowers November-February.	Unlikely	Small amount of marginal habitat within the subject site. Not found during targeted surveys and no previous records within locality. No other Cryptostylis species recorded during surveys.
Cuculus optatus	Oriental Cuckoo	-	Mi	Habitat may occur within area	-	-	-	-	This species migrates to northern and eastern Australia in the warmer months. Occurs south to the Shoalhaven area. Occurs in a range of habitats, including monsoon forest, rainforest edges, leafy trees in paddocks, river flats, roadsides and mangroves. It will forage from the ground but requires shrubs or trees from which it sallies and returns to consume prey items.	Unlikely	Marginal habitat occurs on site including remnant trees in paddocks and floodplain vegetation. No previous records within the locality.
Cymbidium canaliculatum	Cymbidium canaliculatum population in the Hunter Catchment	EP	-	-	-	-	5	1913	The endangered population of this species occurs in the Hunter region, centred in the Upper Hunter north of Singleton but extending south to Weston and Pokolbin. Grows in hollows and forks of eucalypts and acacias, in dry sclerophyll forest or woodland. In the Hunter catchment most commonly found in White Box dominated communities.	Possible	Suitable habitat present, although no White Box occurs within the subject site. Not recorded during surveys.

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Cynanchum elegans	White-flowered Wax Plant	E	E	Habitat likely to occur within area	Y	-	-	-	Occurs from Gerroa (Illawarra) to Brunswick Heads and west to Merriwa in the upper Hunter. Most common near Kempsey. Usually occurs on the edge of dry rainforest or littoral rainforest, but also occurs in Coastal Banksia Scrub, open forest and woodland, and Melaleuca scrub. Soil and geology types are not limiting.	Unlikely	No rainforest vegetation, banksia scrub or Melaleuca scrub within the subject site. This species was not found during targeted surveys and no previous records of the species occur within the locality.
Daphoenositta chrysoptera	Varied Sittella	V	-	-	-	Y	30	0	Sedentary, occurs across NSW from the coast to the far west. Inhabits eucalypt forests and woodlands, especially rough-barked species and mature smooth-barked gums with dead branches, mallee and Acacia woodland. Sensitive to habitat isolation and loss of structural complexity, and adversely affected by dominance of Noisy Miners. Cleared agricultural land is potentially a barrier to movement. Builds a cup-shaped nest of plant fibres and cobwebs in an upright tree fork high in the living tree canopy, and often re-uses the same fork or tree in successive years.	Known	Observed on site during targeted surveys. A high number of previous records within close proximity to the subject site. Potential breeding and foraging habitat present.

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Dasyornis brachypterus	Eastern Bristlebird	E	E	Habitat likely to occur within area	-	-	-	-	Occurs in three disjunct areas of south-eastern Australia: southern Queensland/northern NSW, the Illawarra Region and in the vicinity of the NSW/Victorian border. Illawarra population comprises an estimated 1600 birds, mainly from Barren Grounds Nature Reserve, Budderoo National Park and the Jervis Bay area. Habitat characterised by dense, low vegetation including heath and open woodland with a heathy understorey. The fire history of habitat is important, and the Illawarra and southern populations reach maximum densities in habitat that have not been burnt for over 15 years.	Unlikely	The subject site is not located within the three disjunct areas of known populations. No previous records within the locality. Recent fire within some areas of the subject site may discourage the species from inhabiting the site.
Dasyurus maculatus	Spotted-tailed Quoll	V	E	Habitat known to occur within area	-	Y	5	5412	Inhabits a range of environments including rainforest, open forest, woodland, coastal heath and inland riparian forest, from the sub-alpine zone to the coastline. Den sites are in hollow-bearing trees, fallen logs, small caves, rock crevices, boulder fields and rocky-cliff faces. Females occupy home ranges of up to 750 ha and males up to 3,500 ha, usually traversed along densely vegetated creek lines.	Unlikely	No breeding habitat within the subject site, as it lacks small caves, rock crevices, boulder fields and rocky-cliff faces. Foraging habitat may occur, however is marginal and has been subject to previous disturbance. A low number of records occur with the nearest record occurring approximately 5.5 km from the subject site.

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Delma impar	Striped Legless Lizard	V	V	Habitat may occur within area	Y	-	-	-	Occurs in the Southern Tablelands, South-west Slopes and possibly the Riverina. Found in natural or secondary grassland or open areas in grassy eucalypt woodland. May occur in modified grasslands with high exotic grass cover. Shelters in base of grass tussocks, under rocks or logs or in soil cracks (Smith and Robertson 1999).	Unlikely	Despite small amount of habitat present within the subject site, this species was not observed during targeted surveys. The subject site lacks high abundance of rocks and logs due to the disturbed nature of the site.
Dichanthium setosum	Bluegrass	V	V	Habitat likely to occur within area	-	-	-	-	Occurs on the New England Tablelands, North-west Slopes and Plains and the Central-west Slopes. Associated with heavy basaltic black soils and red-brown loams with clay subsoil. Often found in moderately disturbed areas and appears to have wide environmental tolerances.	None	No suitable habitat within the subject site due to the underlying soils predominantly sandstone influence.
Diuris pedunculata	Small Snake Orchid	E	E	-	-	-	3	1913	Originally found scattered from Tenterfield south to the Hawkesbury River but is now mainly found on the New England Tablelands, around Armidale, Uralla, Guyra and Ebor. Grows on grassy slopes or flats, preferring moist areas between 50-900 m asl. Soils well-structured red-brown clay loams and stony loams, or occasionally on peaty soils, from shale and fine granite.	Unlikely	Three previous records within the locality the most recent from 1933. Soil landscape within the subject site unlikely to provide for suitable habitat.
Diuris tricolor	Long-tailed Donkey Orchid	V	-	-	-	-	-	-	Sporadically distributed on the western slopes of NSW, extending from south of Narrandera all the way to the north of NSW. Localities in the south include Red Hill north of Narrandera, Coolamon, and several sites west of Wagga Wagga. Condobolin-Nymagee road, Wattamondara towards Cowra,	Unlikely	No previous records in locality, marginal habitat present

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									Eugowra, Girilambone, Dubbo and Cooyal, in the Central West. Pilliga SCA, Pilliga National Park and Bibblewindi State Forest in the north (and extending into Queensland) and Muswellbrook in the east. In 2016 a small population was recorded growing in North Rothbury. • Disturbance regimes are not known, although the species is usually recorded from disturbed habitats. • Associated species include *Callitris glaucophylla, Eucalyptus populnea, Eucalyptus intertexta*, Ironbark and *Acacia* shrubland. The understorey is often grassy with herbaceous plants such as *Bulbine* species. • Usually flowers between early September to late October. The species is a tuberous, deciduous terrestrial orchid and the flowers have a pleasant, light sweet scent. • The Pine Donkey Orchid grows in sclerophyll forest among grass, often with native Cypress Pine (*Callitris* spp.). It is found in sandy soils, either on flats or small rises. Also recorded from a red earth soil in a Bimble Box community in western NSW.		

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Ephippiorhynchus asiaticus	Black-necked Stork	E	-	-	-	Y	14	639	In NSW, becomes increasingly uncommon south of the Northern Rivers region, and rarely occurs south of Sydney. Breeding recorded as far south as Newcastle, though most breeding in NSW occurs in the north-east. Primarily inhabits permanent freshwater wetlands and surrounding vegetation including swamps, floodplains, watercourses and billabongs, freshwater meadows, wet heathland, farm dams and shallow floodwaters. Will also forage in inter-tidal shorelines, mangrove margins and estuaries. Feeds in shallow, still water. Breeds during summer, nesting in or near a freshwater swamp.	Unlikely	Marginal foraging wetland habitat occurs within the subject site. If present in locality the species is more likely to utilise the wetland habitat within Wentworth located adjacent to the subject site.
Epthianura albifrons	White-fronted Chat	V	-	-	-	Y	1	8060	This species occurs from southern Queensland to Western Australia and down to Tasmania, mostly in temperate to arid climates and very rarely in sub-tropical areas. It is found in damp open habitats, particularly wetlands containing saltmarsh areas that are bordered by open grasslands. Along the coast they are found in estuarine and marshy habitats with vegetation <1 m tall, and in open grasslands and areas bordering wetlands. Inland, they are often observed in grassy plains, saltlakes and saltpans along waterway margins.	Unlikely	No suitable habitat within subject site. Only one previous record within the locality.

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Erythrotriorchis radiatus	Red Goshawk	CE	V	Habitat likely to occur within area	-	-	-	-	Very rare in NSW, generally confined to the Northern Rivers bioregion with most records in the Clarence River catchment with few around the lower Richmond and Tweed Rivers. Inhabits open woodland and forest, preferring mixed subtropical rainforest, Melaleuca swamp forest and riparian Eucalyptus forest of coastal rivers. Preferred habitats include a mosaic of vegetation types, a large population of birds (prey) and permanent water. Adults have large home ranges (up to 120 km^2 in NT), and in NSW appear to move from nesting areas in the ranges to coastal areas to coastal plains. Generally breed in tall trees within 1 km of a river or wetland.	Unlikely	No rainforest, melaleuca swamp or coastal eucalyptus forest within the site. Species has not been previously recorded in locality.
Eucalyptus camaldulensis	Eucalyptus camaldulensis population in the Hunter catchment	EP	-	-	-	-	6	8458	Population occurs on the major floodplains of the Hunter and Goulburn Rivers. Grows in forested wetlands and grassy woodlands, especially in areas where water impoundment occurs after flood. Associated species include Forest Red Gum, Yellow Box, River Oak and Rough-barked Apple.	Unlikely	Nearest record is approximately 8.5 km from the subject site. Suitable wetland and woodland habitat occurs within the subject site. Not recorded during surveys

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Eucalyptus glaucina	Slaty Red Gum	V	V	Habitat known to occur within area	Y	-	24	80	Distributed along the North coast of NSW. Occurs in grassy woodland and dry eucalypt forest. Prefers deep, moderately fertile and well-watered soils. Flowers from August to December.	Unlikely	The species has an occurrence within the locality. Suitable habitat occurs within the subject site however not detected during targeted surveys. The sandy soils may indicate lack of optimal fertile soils.
Eucalyptus parramattensis subsp. decadens	Earp's Gum	V	V	Habitat known to occur within area	Y	-	1701	0	Endemic to the Hunter Region of NSW. Occurs in low-lying, swampy areas. Found with Narrow-leaved Scribbly Gum Eucalyptus racemosa, Narrow-leaved Apple Angophora bakeri and White Stringybark Eucalyptus globoidea. Prefers deep low-nutrient sands.	Known	The species recorded within the subject site during surveys. Species forms dominant canopy within PCT 1633.
Eucalyptus pumila	Pokolbin Mallee	V	V	-	Y	-	-	-	Currently known only from a single population west of Pokolbin in the Hunter Valley. Historical records also exist for Wyong and Sandy Hollow, however, has not been recorded recently in these areas. The single known population occupies north-west-facing slopes derived from sandstone. Present as a mid-canopy species to a height of 6 m within dry sclerophyll woodland which has a canopy comprising *Eucalyptus fibrosa, Callitris endlicheri* and, to a lesser extent, *Corymbia maculata*. Very little is known about the biology or ecology of this species.	Unlikely	Subject site is located east of Pokolbin and does not occur near the known current population. Marginal habitat occurs within the subject site. Species not found during targeted surveys and no previous records of this species occur within the locality.

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Euphrasia arguta	-	CE	CE	Habitat may occur within area	-	-	-	-	Recently rediscovered near Nundle on the north-western slopes and tablelands, once known from scattered locations between Sydney, Bathurst and Walcha. Known populations occur in eucalypt forest with a mixed grass/shrub understorey, while previous records are described as occurring in open forest, grassy country and river meadows. Annual and dies back over winter. Dense stands observed in cleared firebreak areas, suggesting it may respond well to disturbance.	Unlikely	Suitable Eucalypt habitat with a grassy/shrubby understorey occurs within the subject site. Previous fire disturbance has also occurred, however, this has resulted in dense thickets of Acacia and Melaleuca spp and is unlikely to provide preferred growing conditions. The species has not been previously recorded within the locality.
Falco subniger	Black Falcon	V	-	-	-	-	1	4622	The Black Falcon is widely, but sparsely, distributed in New South Wales, mostly occurring in inland regions. Some reports of 'Black Falcons' on the tablelands and coast of New South Wales are likely to be referable to the Brown Falcon. Occurs in plains, grasslands, foothills, timbered watercourses, wetland environs, crops, and occasionally over towns and cities. Breeding occurs along timbered waterways in in land areas.	Unlikely	No plains, grasslands or foothill environs or timbered water courses within the site. Known presence of other raptor species may discourage the Black Falcon from inhabiting the subject site.

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Falsistrellus tasmaniensis	Eastern False Pipistrelle	V	-	-	-	Y	45	3915	Occurs on southeast coast and ranges. Prefers tall (>20 m) and wet forest with dense understorey. Absent from small remnants, preferring continuous forest but can move through cleared landscapes and may forage in open areas. Roosts in hollow trunks of Eucalypts, underneath bark or in buildings. Forages in gaps and spaces within forest, with large foraging range (12 km foraging movements recorded) (Churchill 2008, Law et al 2008).	Known	Recorded during surveys, suitable foraging and roosting habitat present.
Gallinago hardwickii	Latham's Snipe	-	Mi	Habitat known to occur within area	-	-	7	3658	Occurs along the coast and west of the Great Dividing Range. Nonbreeding visitor to Australia. Inhabit permanent and ephemeral wetlands up to 2000 m asl. Typically in open, freshwater wetlands with low, dense vegetation (incl. swamps, flooded grasslands and heathlands). Can also occur in saline/brackish habitats and in modified or artificial habitats close to human activity.	Unlikely	No suitable wetland habitat within subject site.

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Glossopsitta pusilla	Little Lorikeet	V	-	-	-	Y	109	0	Occurs from coast to western slopes of the Great Dividing Range. Inhabits dry, open eucalypt forests and woodlands. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Feed primarily on profusely-flowering eucalypts and a variety of other species including melaleucas and mistletoes. On the western slopes and tablelands *Eucalyptus albens* and *E. melliodora* are particularly important food sources for pollen and nectar respectively. Mostly nests in small (opening approx. 3 cm) hollows in living, smooth-barked eucalypts, especially *Eucalyptus viminalis, E. blakelyi and E. dealbata*. Most breeding records are from the western slopes.	Known	Observed on site during targeted surveys.
Grantiella picta	Painted Honeyeater	V	V	Habitat likely to occur within area	-	Y	-	-	Nomadic, occurring in low densities across most of NSW. Highest concentrations and almost all breeding occur on inland slopes of the Great Dividing Range. Inhabits Boree, Brigalow and Box Gum woodlands and Box-Ironbark forests. Specialist forager on the fruits of mistletoes, preferably of the *Amyema* genus. Nests in outer tree canopy.	Unlikely	No breeding habitat within the subject site, as it is not located on the inland sloped of the Great Dividing Range. Despite Box Gum woodlands and Box-Ironbark woodlands being present, mistletoe's are rare throughout the site. No previous records within the locality.

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Grevillea parviflora subsp. parviflora	Small-flower Grevillea	V	V	Habitat known to occur within area	Y	-	416	0	Occurs between Moss Vale/Bargo and lower Hunter Valley, with most occurrences in Appin, Wedderburn, Picton and Bargo. Broad habitat range including heath, shrubby woodland and open forest on light clay or sandy soils, and often in disturbed areas such as on the fringes of tracks.	Known	Species recorded during targeted surveys.
Haliaeetus leucogaster	White-bellied Sea-Eagle	V	Ma	-	Y (Breeding)	Y (foraging)	25 to 28	0	Primarily coastal but may extend inland over major river systems. Breeds close to water, mainly in tall open forest/woodland but also in dense forest, rainforest, closed scrub or remnant trees. Usually forages over large expanses of open water, but also over open terrestrial habitats (e.g. grasslands).	Known	Observed foraging within the site during site surveys. A high number of previous records within the locality within very close proximity. Suitable foraging habitat within the site. No active nests were recorded on site.
Hamirostra melanosternon	Black-breasted Buzzard	V	-	-	-	-	3	4084	Sparsely distributed in areas of less than 500 mm rainfall, north from north-western NSW. Inhabits a range of inland habitats, especially along timbered watercourses which is the preferred breeding habitat. Also hunts over grasslands and sparsely timbered woodlands. Breeds from August to October near water in a tall tree.	Possible	Potential foraging and breeding habitat within the subject site. Known presence of other raptor species may discourage the Black-breasted Buzzard from inhabiting the subject site.

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Heleioporus australiacus	Giant Burrowing Frog	V	V	Habitat may occur within area	-	-	-	-	Occurs along the coast and eastern slopes of the Great Dividing Range south from Wollemi National Park. Appears to exist as 2 populations with a 100 km gap in records between Jervis Bay and Eden. Northern population occurs on sandy soils supporting heath, woodland or open forest. Breeds in ephemeral to intermittent streams with persistent pools. Only infrequently moves to breeding sites, most commonly found on ridges away from creeks, several hundred metres from water.	None	Small section of intermittent creekline occurs on site however subject site is located north-east of Wollemi National Park and therefore outside of this species known range. No ridges occur within the subject site. No previous records of the species have been recorded.
Hieraaetus morphnoides	Little Eagle	V	-	-	Y (Breeding)	Y (foraging)	4	3026	Occurs throughout NSW except most densely forested parts of the Dividing Range escarpment. Occupies habitats rich in prey within open eucalypt forest, woodland or open woodland. Sheoak or acacia woodlands and riparian woodlands of interior NSW are also used. For nest sites it requires a tall living tree within a remnant patch, where pairs build a large stick nest in winter and lay in early spring.	Possible	Potential foraging and breeding habitat within the subject site. Known presence of other raptor species may discourage the Little Eagle from inhabiting the subject site.

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Hirundapus caudacutus	White-throated Needletail	-	V, Mi	Habitat known to occur within area	-	-	10	5114	Recorded along NSW coast to the western slopes and occasionally from the inland plains. Breeds in northern hemisphere. Almost exclusively aerial while in Australia. Occur above most habitat types but are more frequently recorded above more densely vegetated habitats (rainforest, open forest and heathland) than over woodland or treeless areas.	Possible	Species likely to utilise the project are for fly-overs only. The open woodland and grassland areas within the subject site provide lesser preferred habitat than densely vegetated habitats.

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Hoplocephalus bitorquatus	Pale-headed Snake	V	-	-	-	-	-	-	A patchy distribution from north-east Queensland to the north-eastern quarter of NSW. In NSW it has historically been recorded from as far west as Mungindi and Quambone on the Darling Riverine Plains, across the north-west slopes, and from the north coast from Queensland to Sydney. A small number of historical records are known for the New England Tablelands from Glenn Innes and Tenterfield; however, the majority of records appear to be from sites of relatively lower elevation. Although the Pale-headed snake distribution is very cryptic, it now appears to have contracted to a patchy and fragmented distribution. Found mainly in dry eucalypt forests and woodlands, cypress forest and occasionally in rainforest or moist eucalypt forest. In drier environments, it appears to favour habitats close to riparian areas. Shelter during the day between loose bark and tree-trunks, or in hollow trunks and limbs of dead trees. The Pale-headed Snake is a highly cryptic species that can spend weeks at a time hidden in tree hollows.	Possible	Habitat present within dry eucalypt forests and woodlands within the subject site, however most not located near riparian areas. No previous records in locality and species not detected during targeted surveys.

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Hoplocephalus bungaroides	Broad-headed Snake	E	V	Habitat may occur within area	Y	-	-	-	Nocturnal, sheltering in rock crevices and under flat sandstone rocks on exposed cliff edges during autumn, winter, and spring, moving to shelters in hollows of large trees within 200 m of escarpments in summer. Feeds mostly on geckos and small skinks, and occasionally on frogs and small mammals.	None	No suitable habitat within the subject site. There are no sandstone escarpment or flat sandstone rocks within the site.
Irediparra gallinacea	Comb-crested Jacana	V	-	-	-	Y	15	3899	Occurs on freshwater wetlands in northern and eastern Australia, mainly in coastal and subcoastal regions, from the north-eastern Kimberley Division of Western Australia to Cape York Peninsula then south along the east coast to the Hunter region of NSW – some recorded in south-eastern NSW potentially in response to unfavourable conditions (OEH 2012). Inhabit permanent freshwater wetlands, either still or slow-flowing, with a good surface cover of floating vegetation, especially water-lilies, or fringing and aquatic vegetation.	Unlikely	No suitable wetland habitat within subject site.

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Ixobrychus flavicollis	Black Bittern	V	-	-	-	Y	2	668	Occurs from southern NSW to Cape York and the Kimberley, and southwest WA. Inhabits terrestrial and estuarine wetlands, generally in areas of permanent water and dense vegetation. May occur in flooded grassland, forest, woodland, rainforest and mangroves as long as there is permanent water. Roosts by day in trees or within reeds on the ground. Nests in branches overhanging water and breeds from December to March.	Unlikely	No suitable wetland habitat within subject site.
Lathamus discolor	Swift Parrot	E	CE	Habitat known to occur within area	Y (important habitat)	Y (foraging)	73	619	Migratory, travelling to the mainland from March to October. Breeds in Tasmania from September to January. On the mainland, it mostly occurs in the southeast foraging on winter flowering eucalypts and lerps, with records of the species between Adelaide and Brisbane. Principal over-winter habitat is box-ironbark communities on the inland slopes and plains. *Eucalyptus robusta, Corymbia maculata* and *C. gummifer*a dominated coastal forests are also important habitat.	Likely	Large number of previous records within close proximity to the subject site. Suitable foraging habitat present.

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Limicola falcinellus	Broad-billed Sandpiper	V	Mi	Habitat known to occur within area	-	-	-	-	Breeds in the northern hemisphere. In the non-breeding season most common in north and north-west of Australia but is a regular visitor in small numbers to the NSW coast from Ballina to Shoalhaven Heads. Occurs on sheltered parts of the coast, favouring estuarine mudflats but also occasionally in saltmarshes, freshwater lagoons, saltworks and sewerage farms. Forage on exposed mudflats or wet sand.	None	No suitable habitat within the subject site.
Limosa lapponica baueri	Bar-tailed Godwit	-	V, Mi	Habitat known to occur within area	-	-	-	-	Has been recorded in the coastal areas of all Australian states. It is widespread in the Torres Strait and along the east and south-east coasts of Queensland, NSW and Victoria, including the offshore islands. Breeds in the north of Scandinavia, Russia and north-west Alaska. Found mainly in coastal habitats such as large intertidal sandflats, banks, mudflats, estuaries, inlets, harbours, coastal lagoons and bays.	None	No suitable habitat within the subject site.
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	-	CE	Habitat may occur within area	-	-	-	-	The Northern Siberian Bar-tailed Godwit is a large Migratory shorebird which breeds in northern Siberia, Russia between the Khatanga River and the delta of the Kolyma River. During the non-breeding period, the distribution of L. l. menzbieri is predominantly in the north and north-west of Western Australia and in south-eastern Asia.	None	No suitable habitat within the subject site.

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Limosa limosa	Black-tailed Godwit	V	Mi	Habitat known to occur within area	-	-	-	-	The Black-tailed Godwit is a migratory wading bird that breeds in Mongolia and Eastern Siberia and flies to Australia for the southern summer, arriving in August and leaving in March. In NSW, it is most frequently recorded at Kooragang Island (Hunter River estuary), with occasional records elsewhere along the north and south coast, and inland. Records in western NSW indicate that a regular inland passage is used by the species, as it may occur around any of the large lakes in the western areas during summer, when the muddy shores are exposed. It is usually found in sheltered bays, estuaries and lagoons with large intertidal mudflats and/or sandflats. It has also been found around muddy lakes and swamps, wet fields and sewerage treatment works.	None	No previous records within the locality of the subject site. No muddy wetland flats or lakes occur within the subject site. May utilise adjacent wetland habitat which would provide better suited habitat for the species.

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Litoria aurea	Green and Golden Bell Frog	E	V	Habitat known to occur within area	Y	-	8	852	Formerly occurred from Brunswick Heads to Victoria, but >80% populations now extinct. Inhabits marshes, natural and artificial freshwater to brackish wetlands, dams and in stream wetlands. Prefers sites containing cumbungi (Typha spp.) or spike rushes (Eleocharis spp.), which are unshaded and have a grassy area and/or rubble as shelter/refuge habitat nearby. *Gambusia holbrooki* is a key threat as they feed on green and Golden Bell Frog eggs and tadpoles.	Unlikely	Despite suitable habitat on site, species not found during targeted surveys completed in March 2019 and Nov/Dec 2021 The nearest previous record within the locality is approximately 800 m from the subject site. Presence of Gambusia within site ponds further reduces likelihood of this species occurring. Expert report confirmed that species is not likely to occur within the site.

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Litoria brevipalmata	Green-thighed Frog	V	-	-	Y	-	2	4385	Occurs north from Gosford to Qld. Breeding occurs in flooded semi-permanent or ephemeral pools, usually in grassy areas and within 100 m of significant stands of native vegetation (Ehman 1997, Lemckert et al 2006). Can tolerate some disturbance but not found in >50% cleared grazing land or entirely urban areas (Ehmann 1997, Lemckert et al 2006). Usually associated with moist forest (swamp forest, wet sclerophyll or rainforest) but often recorded from dry sclerophyll forests in the northern part of its range (Lemckert et al 2006).	Unlikely	Suitable habitat not present within the subject site. The subject site has historically been disturbed in most areas, particularly in areas which may have suited the Green-thighed Frog. Expert report concludes that this species is not likely to occur within the subject site.
Litoria littlejohni	Littlejohn's Tree Frog	V	V	Habitat likely to occur within area	-	-	1	5875	Occurs on plateaus and eastern slopes of the Great Dividing Range south from Watagan State Forest. Occurs along permanent rocky streams with thick fringing vegetation associated with eucalypt woodlands and heaths among sandstone outcrops, hunting either in shrubs or on the ground.	None	No suitable habitat within the subject site. There are no permanent rocky streams or sandstone outcrops within the site. The subject site is located approximately 28 km north of Watagan State Forest. Only one previous record occurs within the locality.

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Lophoictinia isura	Square-tailed Kite	V	-	-	-	Y	6	3026	Occurs across NSW, resident in North, north-east and along west-flowing rivers. Summer breeding migrant to southeast of state. Inhabits a variety of habitats including woodlands and open forests, with preference for timbered watercourses. Favours productive forests on the coastal plain, box-ironbark-gum woodlands on the inland slopes, and Coolibah/River Red Gum on the inland plains. In Sydney area nests in mature living trees within 100 m of ephemeral/permanent watercourse. Large home range > 100 km^2.	Possible	Potential foraging and breeding habitat within the subject site. Known presence of other raptor species may discourage the Square-tailed Kite from inhabiting the subject site. The species was not found during targeted surveys. No evidence of raptor nests recorded during surveys.
Melaleuca biconvexa	Biconvex Paperbark	V	V	Habitat may occur within area	Y	-	-	-	Scattered, disjunct populations in coastal areas from Jervis Bay to Port Macquarie, with most populations in the Gosford-Wyong areas. Grows in damp places, often near streams or low-lying areas on alluvial soils over shale of low slopes or sheltered aspects	Unlikely	Despite damp habitat occurring within the subject site soils within the site are not derived from shale soils, rather sandstone. No previous records within the locality.

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Melanodryas cucullata cucullata	Hooded Robin (south-eastern form)	V	-	-	-	Y	1	5535	Considered a sedentary species, but local seasonal movements are possible. Prefers lightly wooded country, usually open eucalypt woodland, acacia scrub and mallee, often in or near clearings or open areas. Occurrence is positively associated with patch size, and with components of habitat complexity including canopy cover, shrub cover, ground cover, logs, fallen branches and litter. Nests on low, live or dead forks or branches of trees or stumps, or occasionally on fallen trees or limbs.	Possible	Suitable open woodland habitat within the subject site adjacent to clearings and open areas. Only one previous record within the locality. Potential breeding habitat within the subject site.
Melithreptus gularis gularis	Black-chinned Honeyeater (eastern subspecies)	V	-	-	-	-	88	2696	Widespread in NSW, but rarely recorded east of Great Dividing Range except in Richmond and Clarence River areas and scattered sites in the Hunter, Central Coast and Illawarra regions. Mostly in upper levels of drier open forests /woodlands dominated by box and ironbark eucalypts, or less commonly smooth-barked gums, stringybarks and tea-treas. Forage over home range of >5 ha. Tend to occur within largest woodland patches in the landscape. They forage for insects, nectar and honeydew. The nest is hidden by foliage high in the crown of a tree.	Likely	Suitable box-ironbark vegetation within the subject site for foraging and nesting. The species has previously been recorded in high number within the locality and has been recorded within approximately 2.5 km from the subject site.

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Merops ornatus	Rainbow Bee-eater	-	Mi	-	-	-	33	0	Distributed across much of mainland Australia, and several near-shore islands. Occurs in a range of habitats, including open forests and woodlands, shrublands, and in various cleared or semi-cleared habitats, including farmland and areas of human habitation. It usually occurs in open, cleared or lightly-timbered areas that are often, but not always, located in close proximity to permanent water. It also occurs in inland and coastal sand dune systems, and in mangroves in northern Australia. Nests are made in sandy banks.	Known	Species recorded during site surveys.
Miniopterus australis	Little Bent-winged Bat	V	-	-	Y (Breeding)	Y (foraging)	164	0	Occurs from Cape York to Sydney. Inhabits rainforests, wet and dry sclerophyll forests, paperbark swamps and vine thickets. Only one maternity cave known in NSW, shared with Eastern Bentwing-bats at Willi Willi, near Kempsey. Outside breeding season roosts in caves, tunnels and mines and has been recorded in a tree hollow on one occasion. Forages for insects beneath the canopy of well-timbered habitats (Churchill 2008, Hoye and Hall 2008).	Known	Suitable foraging and roosting habitat present. Species also likely to utilise the waterbodies within and adjacent to the subject site for foraging. Recorded during targeted surveys.

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Miniopterus orianae oceanensis	Large Bent-winged Bat	V	-	-	Y (Breeding)	Y (foraging)	80	0	Generally occurs east of the Great Dividing Range along NSW coast (Churchill 2008). Inhabits various habitats from open grasslands to woodlands, wet and dry sclerophyll forests and rainforest. Essentially a cave bat but may also roost in road culverts, stormwater tunnels and other man-made structures. Only 4 known maternity caves in NSW, near Wee Jasper, Bungonia, Kempsey and Texas. Females may travel hundreds of kilometres to the nearest maternal colony (Churchill 2008).	Known	Suitable foraging and roosting habitat present. Species also likely to utilise the waterbodies within and adjacent to the subject site for foraging. Recorded during targeted surveys.

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Mixophyes balbus	Stuttering Frog	E	V	Habitat likely to occur within area	-	-	-	-	Occurs along the east coast of Australia. Has undergone a massive range reduction particularly in the south of its range: within the Sydney Basin, White (2008a) located only 3 populations south of Sydney (Macquarie Pass and Mt Werong) and Daly et al. (2002, in White 2008a) found only 2 extant populations between Macquarie Pass and Victoria. Inhabits rainforest and wet, tall, open forest. Shelter in deep leaf litter and thick understorey vegetation on the forest floor. Feeds on insects and smaller frogs, breeding in streams during summer after heavy rain. The species does not occur in areas where the riparian vegetation has been disturbed or where there have been significant upstream human impacts (Mahony et al 1997).	None	No previous records within the locality of the subject site. No rainforest habitat occurs within the site. The subject site is also located outside of the known species range.
Mixophyes iteratus	Giant Barred Frog	E	E	Habitat known to occur within area	-	-	-	-	Occurs on the coast and ranges from south-eastern QLD to the Hawkesbury River in NSW, particularly in Coffs Harbour - Dorrigo area. Forage and live amongst deep, damp leaf litter in rainforest, moist eucalypt forest and nearby dry eucalypt forest. Breed in shallow, flowing rocky streams. Within Sydney Basin, confined to small populations in tall, wet forest in the Watagan Mountains north of the Hawkesbury and the lower Blue Mountains (White 2008b).	None	No suitable rainforest habitat occurs within the subject site. Despite some ephemeral streams occurring, these are not flowing rocky streams. The subject site is located approximately 28 km north of the Watagan Mountains. No previous records within the locality.

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Monarcha melanopsis	Black-faced Monarch	-	Mi	Habitat known to occur within area	-	-	-	-	Found along the coast of eastern Australia, becoming less common further south. Found in rainforests, eucalypt woodlands, coastal scrub and damp gullies. It may be found in more open woodland when migrating. Resident in the north of its range but is a summer breeding migrant to coastal south-eastern Australia, arriving in September and returning northwards in March. It may also migrate to Papua New Guinea in autumn and winter.	Unlikely	No rainforest habitat within the subject site. May utilise the open woodland within the subject site for foraging or roosting, however it does not occur within a damp gully. Despite being characteristic of floodplain vegetation, these areas may still remain predominantly dry throughout the year. No previous records within the locality.
Monarcha trivirgatus	Spectacled Monarch	-	Mi	Habitat known to occur within area	-	-	-	-	The Spectacled Monarch is found in coastal north-eastern and eastern Australia, including coastal islands, from Cape York, Queensland to Port Stephens, New South Wales. It is much less common in the south. Prefers thick understorey in rainforest, wet gullies and waterside vegetation as well as mangroves.	None	No suitable rainforest, wet gully or mangrove habitat within the subject site.
Mormopterus norfolkensis	Eastern Coastal Free-tailed Bat	V	-	-	Y (Breeding)	Y	82	0	Occurs in dry sclerophyll forest and woodland east of the Great Dividing Range. Forages in natural and artificial openings in vegetation, typically within a few kilometres of its roost. Roosts primarily in tree hollows but also recorded from man-made structures or under bark (Churchill 2008).	Known	Foraging and roosting habitat present. Recorded during targeted surveys.

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Motacilla flava	Yellow Wagtail	-	Mi	Habitat likely to occur within area	-	-	-	-	This species breeds in temperate Europe and Asia. They occur within Australia in open country habitat with disturbed ground and some water. Recorded in short grass and bare ground, swamp margins, sewage ponds, saltmarshes, playing fields, airfields, ploughed land and town lawns.	Possible	Suitable habitat within the subject site, although no previous records within the locality.
Myiagra cyanoleuca	Satin Flycatcher	-	Mi	Habitat known to occur within area	-	-	-	-	In NSW widespread on and east of the Great Divide, sparsely scattered on the western slopes, very occasional records on the western plains. Inhabit heavily vegetated gullies in eucalypt-dominated forests and taller woodlands, often near wetlands and watercourses. On migration, occur in coastal forests, woodlands, mangroves and drier woodlands and open forests. Generally not in rainforests.	Unlikely	Suitable eucalypt dominated habitat within the subject site in close proximity to adjacent wetland habitat. The subject site is not however located within a heavily vegetated gully and no tall woodland present. No previous records within the locality.

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Myotis macropus	Southern Myotis	V	-	-	Y	-	47	35	Mainly coastal but may occur inland along large river systems. Usually associated with permanent waterways at low elevations in flat/undulating country, usually in vegetated areas. Forages over streams and watercourses feeding on fish and insects from the water surface. Roosts in a variety of habitats including caves, mine shafts, hollow-bearing trees, stormwater channels, buildings, under bridges and in dense foliage, typically in close proximity to water (Campbell 2011). Breeds November or December (Churchill 2008).	Likely	Recorded within a culvert adjacent to the subject site. Species is likely to utilise the waterbodies within and adjacent to the subject site for foraging.
Neophema pulchella	Turquoise Parrot	V	-	-	-	Y	10	2634	Occurs from coast to inland slopes. In coastal area, most common between Hunter and Northern Rivers, and further south in S Coast. Inhabits open eucalypt woodlands and forests, typically with a grassy understorey. Favours edges of woodlands adjoining grasslands or timbered creek lines and ridges. Feeds on the seeds of native and introduced grasses and other herbs. Grasslands and open areas provide important foraging habitat for this species while woodlands provide important roosting and breeding habitat. Nests in tree hollows, logs or posts from August to December.	Possible	Suitable breeding and foraging habitat available within the subject site.

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Ninox connivens	Barking Owl	V	-	-	Y (Breeding)	Y (foraging)	4	4	Occurs from coast to inland slopes and plains, though is rare in dense, wet forests east of the Great Dividing Range and sparse in higher parts of the tablelands and in the arid zone. Inhabits eucalypt woodlands, open forest, swamp woodlands, and, especially in inland areas, timber along watercourses. Roosts along creek lines in dense, tall understorey foliage (e.g. in Acacia and Casuarina), or dense eucalypt canopy. Nests in hollows of large, old eucalypts including *Eucalyptus camaldulensis, Eucalyptus albens, Eucalyptus polyanthemos and Eucalyptus blakelyi*. Birds and mammals important prey during breeding. Territories range from 30 to 200 ha.	Possible	Suitable foraging habitat present within the subject site. Some suitable nesting hollows although no evidence of nesting owls recorded during targeted surveys.
Ninox strenua	Powerful Owl	V	-	-	Y (Breeding)	Y (foraging)	39	0	Occurs from the coast to the western slopes. Solitary and sedentary species. Inhabits a range of habitats from woodland and open sclerophyll forest to tall open wet forest and rainforest. Prefers large tracts of vegetation. Nests in large tree hollows (> 0.5 m deep), in large eucalypts (dbh 80-240 cm) that are at least 150 years old. Pairs have high fidelity to a small number of hollow-bearing nest trees and defend a large home range of 400 - 1,450 ha. Forages within open and closed woodlands as well as open areas.	Known	Recorded during previous surveys within subject site. Suitable foraging habitat present as well as suitable nesting hollows. No evidence of nesting/breeding owls recorded during targeted surveys.

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Numenius madagascariensis	Eastern Curlew	-	CE, Mi	Habitat may occur within area	-	-	-	-	Within Australia, the species has a primarily coastal distribution. The species is found in all states, particularly the north, east, and south-east regions including Tasmania. Breeds in Russia and north-eastern China. Most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. Occasionally, the species occurs on ocean beaches (often near estuaries), and coral reefs, rock platforms, or rocky islets. The birds are often recorded among saltmarsh and on mudflats fringed by mangroves, and sometimes use the mangroves. The birds are also found in saltworks and sewage farms.	None	No suitable habitat within the subject site.

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Numenius minutus	Little Curlew	-	Mi	-	-	-	2	1120	Generally spend the non-breeding season in northern Australia. In NSW, most records are scattered east of the Great Dividing Range, from Casino, south to Greenwell Point with a few scattered records west of the Great Dividing Range. Recorded breeding in Siberia. Most often found feeding in short, dry grassland and sedgeland, including dry floodplains and blacksoil plains, which have scattered, shallow freshwater pools or areas seasonally inundated. Open woodlands with a grassy or burnt understorey, dry saltmarshes, coastal swamps, mudflats or sandflats of estuaries or beaches on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses and verges of roads and airstrips are also used.	Unlikely	No suitable habitat within the subject site.

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Numenius phaeopus	Whimbrel	-	Mi	Habitat known to occur within area	-	-	-	-	A regular migrant to Australia and New Zealand, with a primarily coastal distribution. There are also scattered inland records in all regions. It is found in all states but is more common in the north. It is found along almost the entire coast of Queensland and NSW. Breeds in north and west Alaska, Eurasia and Iceland. Often found on the intertidal mudflats of sheltered coasts. It is also found in harbours, lagoons, estuaries and river deltas, often those with mangroves, but also open, unvegetated mudflats. It is occasionally found on sandy or rocky beaches, on coral or rocky islets, or on intertidal reefs and platforms.	None	No suitable habitat within the subject site.
Oxyura australis	Blue-billed Duck	V	-	-	-	Y	6	6147	Partly migratory, travels short distances between breeding swamps and over-wintering lakes. Young birds disperse in April-May from breeding swamps in inland NSW to Murray River system and coastal lakes. Prefers deep water in large permanent wetlands and swamps with dense aquatic vegetation. Nests in Cumbungi over deep water or in trampled Lignum, sedges or spike-rushes. Completely aquatic, swimming along the edge of dense cover.	Unlikely	No suitable habitat within the subject site.

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Ozothamnus tesselatus	-	V	V	-	Y	-	-	-	Restricted to a few locations in an east-west zone south of Bunnan and between west Bylong and east Ravensworth. Grows in eucalypt woodland.	Unlikely	Suitable habitat within the subject, however the species was not found during targeted surveys. No previous records within the locality.
Pandion cristatus	Eastern Osprey	V	-	-	Y (Breeding)	Y (foraging)	2	6156	Favours coastal areas, especially the mouths of large rivers, lagoons and lakes. They feed on fish over clear, open water. Breeding takes place from July to September in NSW, with nests being built high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea, though there are a handful of records from inland areas.	Unlikely	Only one previous record within the locality approximately 9 km from the subject site. Whilst foraging habitat occurs within the subject site, the subject site is located approximately 30 km from the coast.
Pandion haliaetus	Osprey	V	Mi	Habitat known to occur within area	-	-	-	-	The Osprey is found around the Australian coastline, except for Victoria and Tasmania. They favour coastal areas, especially the mouths of large rivers, lagoons and lakes. Ospreys feed on fish over clear, open water and breed from July to September in NSW. Nests are made high up in dead trees or in dead crowns of live trees, usually within one kilometre of the sea.	Unlikely	The subject site is located within approximately 30 km of the coast. Whilst permanent stands of water occur within the subject site, these would provide only marginal foraging habitat. No previous records within the locality.

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Persicaria elatior	Knotweed	V	V	Habitat likely to occur within area	Y	-	-	-	Tall Knotweed has been recorded in south-eastern NSW (Mt Dromedary (an old record), Moruya State Forest near Turlinjah, the Upper Avon River catchment north of Robertson, Bermagui, and Picton Lakes. In northern NSW it is known from Raymond Terrace (near Newcastle) and the Grafton area (Cherry Tree and Gibberagee State Forests). This species normally grows in damp places, especially beside streams and lakes. Occasionally in swamp forest or associated with disturbance.	Unlikely	Some marginal habitats present within constructed waterbodies present surrounding smelter site however likelihood of occurrence is low as these ponds are not connected to any natural waterways or lakes. Species not previously recorded in locality or during targeted surveys within the site.
Persoonia hirsuta	Hairy Geebung	E	E	Habitat may occur within area	-	-	-	-	Occurs within the Blue Mountains, Southern Highlands and Sydney coastal regions from Hilltop to Glen Davis and Royal NP to Gosford. Population within the Hills Shire particularly important due to high density of plants. Grows on sandy soils in dry sclerophyll open forest, woodland and heath on sandstone up to 600 m above sea level.	Unlikely	Suitable habitat within the subject site. The site is not located within the species known range. No previous records within the locality.

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Persoonia pauciflora	North Rothbury Persoonia	CE	CE	Habitat may occur within area	-	-	1	9043	Extremely restricted distribution: all but one of the plants which make up the only known population occur within a 2.5 km radius of the original specimen at North Rothbury in the Cessnock local government area. Within this range, there are three main sub-populations which comprise approximately 90% of the total population. The other 10% of the population occurs as scattered individuals in what is a relatively disturbed landscape. It is found in dry open forest or woodland dominated by Spotted Gum (*Corymbia maculata*), Broad-leaved Ironbark (*Eucalyptus fibrosa*) and/or Narrow-leaved Ironbark (*E. crebra*) and supporting a moderate to sparse shrub layer and grassy groundcover. The majority of the population is known to occur on silty sandstone soils derived from the Farley Formation. Flowers from January through to May. Its breeding system is unknown, but it is likely that native bees are required for pollination. Seedlings are present in most sub-populations which indicates that the population is capable of reproducing under favourable conditions.	Unlikely	Nearest record is approximately 8.5 km from the subject site. Soil landscape is not derived from the Farley Formation. Its highly restricted distribution indicates likelihood of occurrence is unlikely.

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Petauroides volans	Greater Glider	-	V	Habitat known to occur within area	-	-	8	8309	The greater glider is restricted to eastern Australia, occurring from the Windsor Tableland in north Queensland through to central Victoria (Wombat State Forest), with an elevational range from sea level to 1200 m above sea level. It prefers taller montane, moist eucalypt forest with relatively old trees and abundant hollows.	Unlikely	No tall montane or moist eucalypt forest present within subject site.
Petaurus australis	Yellow-bellied Glider	V	-	-	-	Y	74	2776	Occurs along the east coast to the western slopes of the Great Dividing Range. Inhabits a variety of forest types but prefers tall mature eucalypt forest with high rainfall and rich soils. Relies on large hollow-bearing trees for shelter and nesting, with family groups of 2-6 typically denning together. In southern NSW its preferred habitat at low altitudes is moist gullies and creek flats in mature coastal forests. Mostly feeds on sap, nectar and honeydew.	Unlikely	Soils within site typically sandy and with low fertility. No tall mature forests or moist gullies present.

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Petaurus norfolcensis	Squirrel Glider	V	-	-	Y	-	74	0	Occurs along the drier inland slopes as well as coastal habitats. Inhabits woodland and open forest with a *Eucalyptus, Corymbia* or *Angophora* overstorey and a shrubby understorey of Acacia or Banksia. Key habitat components include reliable winter and early-spring flowering Eucalypts, Banksia or other nectar sources, and hollow-bearing trees for roost and nest sites (van der Ree and Suckling 2008, Quin et al 2004), with social groups moving between multiple hollows. Social groups include one or two adult males and females with offspring and have home ranges of 5-10 ha within NSW (van der Ree and Suckling 2008, Kavanagh 2004).	Known	Despite not found during targeted surveys by GHD, species has been previously recorded within the subject site (ELA 2016). Suitable open forests with shrubby Acacia and Banksia understoreys are present within the subject site.
Petrogale penicillata	Brush-tailed Rock-wallaby	E	V	Habitat likely to occur within area	-	-	-	-	Occurs from the Shoalhaven north to the Queensland border. Now mostly extinct west of the Great Dividing Range, except in the Warrumbungles and Mt Kaputar. Occurs on rocky escarpments, outcrops and cliffs with a preference for complex structures with fissures, caves and ledges facing north. Diet consists of vegetation in adjacent to rocky areas eating grasses and forbs as well as the foliage and fruits of shrubs and trees.	None	No suitable rocky habitat within the subject site including escarpments, outcrops and cliffs. Not found during targeted surveys

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Petroica boodang	Scarlet Robin	V	-	-	-	Y	8	714	In NSW occurs from coast to inland slopes. Breeds in drier eucalypt forests and temperate woodlands, often on ridges and slopes, within open understorey of shrubs and grasses and sometimes in open areas. In autumn and winter it migrates to more open habitats such as grassy open woodland or paddocks with scattered trees. Abundant logs and coarse woody debris are important habitat components.	Possible	Suitable habitat within the subject site. Small number of previous records within the locality with the nearest record being approximately 700 m from the subject site.
Petroica phoenicea	Flame Robin	V	-	-	-	-	2	1251	Breeds in upland moist eucalypt forests and woodlands, often on ridges and slopes, in areas of open understorey. Migrates in winter to more open lowland habitats such as grassland with scattered trees and open woodland on the inland slopes and plains. Forages from low perches, feeding on invertebrates taken from the ground, tree trunks, logs and other coarse woody debris. Fallen logs and coarse woody debris are important habitat components. Open cup nest of plant fibres and cobweb is often built near the ground in a sheltered niche, ledge or shallow cavity in a tree, stump or bank.	Possible	The subject site is located on the lowland habitats from which grasslands and open woodlands within the subject site may provide winter foraging habitat. Two previous records within the locality with the nearest record occurring approximately 1.2 km from the subject site.

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Phaethon lepturus	White-tailed Tropicbird	-	Mi	-	-	-	1	8973	In Australia, the Hwite-tailed Tropicbird breeds in the Cocos-Keeling Islands, Ashmore reef and Rowley Shoals off the northern coast of WA. In Australia, the White-tailed Tropicbird (Indian Ocean) nests in Pisonia trees amongst Pisonia-coconut vegetation, and on sandy ground.	None	No suitable habitat within the subject site.
Phascogale tapoatafa	Brush-tailed Phascogale	V	-	-	Y	-	7	6197	Predominately east of the Great Dividing Range, occasional records to the west. Prefers open forest with sparse groundcover but occurs in habitats ranging from mallees to rainforest. Home ranges span 20-40 ha (females) and >100 ha (males) though may be smaller in optimal habitats. Male ranges overlap with females and other males. May use up to 40 nests/ year in hollow trees, rotted stumps, buildings or bird nests. When breeding females prefer to nest in large tree cavities with small entrances. Forages preferentially in rough barked trees, large logs and dead standing trees (Soderquist and Rhind 2008).	Unlikely	No mallee or rainforest vegetation within the subject site. Large home range suggests the subject site may be a thoroughfare to nearby suitable habitat. Despite being targeted during site surveys, the species was not found. The nearest record to the subject site within the locality is 6 km.
Phascolarctos cinereus	Koala	V	V	Habitat known to occur within area	-	Y	13	178	Occurs from coast to inland slopes and plains. Restricted to areas of preferred feed trees in eucalypt woodlands and forests. Home range varies depending on habitat quality, from < 2 to several hundred ha.	Unlikely	A number of feed trees identified on SEPP present however very few recent records in locality and specie not recorded during targeted surveys, nor were any signs of the species found (scats, scratches etc.).

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Philomachus pugnax	Ruff	-	Mi	Habitat known to occur within area	-	-	-	-	In NSW the species has been recorded at Kurnell, Tomki, Casino, Ballina, Kooragang Island, Broadwater Lagoon and Little Cattai Creek. The species has also found around the Riverina, including Windouran Swamp, Wanganella, Fivebough Swamo and the Tullakool Saltworks. Most NSW records come from the Sydney region. In Australia the Ruff is found on generally fresh, brackish of saline wetlands with exposed mudflats at the edges. It is found in terrestrial wetlands including lakes, swamps, pools, lagoons, tidal rivers, swampy fields and floodlands. They are occasionally seen on sheltered coasts, in harbours, estuaries, seashores and are known to visit sewage farms and saltworks. They are sometimes found on wetlands surrounded by dense vegetation including grass, sedges, saltmarsh and reeds.	Unlikely	Despite wetland habitat present within the subject site, it is not sizeable enough for the species to occur. The species is more likely to inhabit the wetland areas adjacent to the subject site. The wetland habitat within the subject site does not provide exposed mudflats or saltmarsh. No previous records within the locality.

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Planigale maculata	Common Planigale	V	-	-	Y	-	-	-	Occurs in coastal north-eastern NSW, coastal east Queensland and Arnhem Land. The species reaches its confirmed southern distribution limit on the NSW lower north coast however there are reports of its occurrence as far south as the central NSW coast west of Sydney. Common Planigales inhabit rainforest, eucalypt forest, heathland, marshland, grassland and rocky areas where there is surface cover, and usually close to water. They are active at night and during the day shelter in saucer-shaped nests built in crevices, hollow logs, beneath bark or under rocks.	Unlikely	No suitable habitat present within the subject site.
Pluvialis fulva	Pacific Golden Plover	-	Mi	Habitat known to occur within area	-	-	-	-	Widespread in coastal regions, though there are also a number of inland records (in all states), sometimes far inland and usually along major river systems, especially the Murray and Darling Rivers and their tributaries. Most Pacific Golden Plovers occur along the east coast and are especially widespread along the Queensland and NSW coastlines. Breeds mostly in northern Siberia as well as in western Alaska. In Australia this species usually inhabits coastal habitats, though it occasionally occurs around inland wetlands.	Unlikely	No previous records within the locality of the subject site. Subject site is located approximately 30 km from the coast.

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Pluvialis squatarola	Grey Plover	-	Mi	Habitat known to occur within area	-	-	1	5971	Breed in the northern Hemisphere. Widespread on Australian coast in the non-breeding season. Occur almost entirely in coastal areas, usually in sheltered embayments with mud or sandflats and occasionally on rocky coasts or near-coastal lakes and swamps. Very occasionally recorded further inland. Forage on exposed mudflats and beaches.	None	No suitable habitat within the subject site.
Pomaderris queenslandica	Scant Pomaderris	E	-	-	Y	-	-	-	Widely scattered but not common in north-east NSW and in Queensland. It is known from several locations on the NSW north coast and a few locations on the New England Tablelands and North-west Slopes, including near Torrington and Coolata. Found in moist eucalypt forest or sheltered woodlands with a shrubby understorey, and occasionally along creeks.	Unlikely	Marginal habitat within the subject. Species not found during targeted surveys. No previous records within the locality.
Pomatostomus temporalis temporalis	Grey-crowned Babbler (eastern subspecies)	V	-	-	-	Y	127	0	Occurs on western slopes and plains, as well as in the Hunter Valley and several locations on the north coast. Inhabits open Box-Gum Woodlands on the slopes, and Box-Cypress-pine and open Box Woodlands on alluvial plains. Family groups have territories between 1-50 (generally around 10) ha. Nests typically built in shrubs or sapling eucalypts.	Known	Suitable Box-Gum woodlands and alluvial plains occur within the subject site. This species was observed on site during site surveys. A high number of previous records also occur within the locality.

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Potorous tridactylus tridactylus	Long-nosed Potoroo	V	V	Habitat may occur within area	-	-	-	-	Restricted to east of the Great Dividing Range, with annual rainfall >760 mm. Inhabits coastal heath and dry and wet sclerophyll forests. Requires relatively thick ground cover and appears restricted to areas of light and sandy soil (Johnston 2008). Feeds on fungi, roots, tubers, insects and their larvae, and other soft-bodied animals in the soil.	None	No suitable habitat within the subject site due to historical disturbance of the site. The dry sclerophyll forests within the subject site lack dense groundcover to provide for the species. No previous records within the subject site.
Prasophyllum sp. Wybong	a leek-orchid	-	CE	Habitat may occur within area	-	-	-	-	Endemic to NSW, known from seven populations within the Border Rivers, Central Rivers and Central West NRM regions. Known to occur in open eucalypt woodland and grassland.	Unlikely	Despite suitable habitat occurring within the subject site, it is located within predicted habitat only. No previous records within the locality.
Prostanthera cineolifera	Singleton Mint Bush	V	V	Habitat may occur within area	-	-	-	-	Inhabits sclerophyll forests and open woodlands on exposed sandstone ridges, usually on shallow or skeletal sands. Restricted to few areas near Walcha, Scone and St Albans.	Unlikely	No suitable exposed sandstone ridges within subject site. No previous records within the locality.

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Pseudomys novaehollandiae	New Holland Mouse	-	V	Habitat known to occur within area	-	-	7	604	Occurs in disjunct, coastal populations from Tasmania to Queensland. In NSW inhabits a variety of coastal habitats including heathland, woodland, dry sclerophyll forest with a dense shrub layer and vegetated sand dunes (Wilson and Bradtke 1999). Populations may recolonise/ increase in size in regenerating native vegetation after wildfire, clearing and sandmining. Presence strongly correlated with understorey vegetation density, and high floristic diversity in regenerating heath (Lock and Wilson 1999).	Possible	Dry sclerophyll forest present within the subject site, which has also been subject to historical fire and subsequent regeneration of shrub and ground layers. These areas however lack high diversity. Not associated with vegetation types present within subject site (TBDC).
Pteropus poliocephalus	Grey-headed Flying-fox	V	V	Roosting known to occur within area	Y (Breeding)	Y (foraging)	335	0	Roosts in camps within 20 km of a regular food source, typically in gullies, close to water and in vegetation with a dense canopy. Forages in subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths, swamps and street trees, particularly in eucalypts, melaleucas and banksias. Highly mobile with movements largely determined by food availability (Eby and Law 2008). Will also forage in urban gardens and cultivated fruit crops.	Known	Recorded flying over site during targeted surveys. Previous records with a high number of individuals also indicate historical presence. Known foraging Eucalypt species occur within the subject site. No breeding camps present within or within close proximity to the site.

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Pterostylis chaetophora	*Pterostylis chaetophora*	V	-	-	Y	-	-	-	Recorded in Queensland and NSW. In NSW it is currently known from 18 scattered locations in a relatively small area between Taree and Kurri Kurri, extending to the south-east towards Tea Gardens and west into the Upper Hunter, with additional records near Denman and Wingen. There are also isolated records from the Sydney region. The species occurs in two conservation reserves, Columbey National Park and Wingen Maid Nature Reserve. The preferred habitat is seasonally moist, dry sclerophyll forest with a grass and shrub understorey. Flowers from September to November. Vegetative reproduction is not common in this group of Greenhoods, but some species may form more than one dropper annually. Fails to flower in dry seasons.	Unlikely	Some areas of suitable habitat within the subject, however the species was not found during targeted surveys. There have also been no previous records within the locality.

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Pterostylis gibbosa	Illawarra Greenhood	E	E	Habitat may occur within area	-	-	2	1913	Known from a small number of populations in the Illawarra, Nowra and Hunter regions. First collected in western Sydney. Only visible above the ground between late summer and spring, and only when soil moisture levels can sustain its growth. Grows in open forest or woodland, on flat or gently sloping land with poor drainage. In the Illawarra region, the species grows in woodland dominated by Forest Red Gum, Woollybutt and Melaleuca decora. Near Nowra, the species grows in an open forest of Spotted Gum, Forest Red Gum and Grey Ironbark. In the Hunter region, the species grows in open woodland dominated by Narrow-leaved Ironbark, Forest Red Gum and Black Cypress Pine.	Unlikely	No cypress pine present within subject site. Not associated with any of the PCTs present.

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Rhipidura rufifrons	Rufous Fantail	-	Mi	Habitat known to occur within area	-	-	-	-	Occurs in coastal and near coastal districts of northern and eastern Australia. Has breeding populations in NSW. Two subspecies intergrades in a zone between the Queensland-NSW border ranges and the Clarence-Orara rivers in NSW. The species mainly inhabits wet sclerophyll forests, often in gullies dominated by *Eucalyptus microcorys, E. cypellocarpa, E. radiata, E. regnans, E. delegatensis, E. pilularis or E. resinifera*; usually with a dense shrubby understorey, often including ferns. They also occur in subtropical and temperate rainforests. They occasionally occur in secondary regrowth, following logging or disturbance in forests or rainforests. When on passage, they are sometimes recorded in drier sclerophyll forests and woodlands, including *Eucalyptus maculata, E. melliodora, ironbarks or stringybarks,* often with a shrubby or heath understorey.	Unlikely	No previous records within the locality. No wet sclerophyll forest, rainforest or gullies present within subject site and main associated canopy species absent Potential that species may pass through site on occasion.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Rhizanthella slateri	Eastern Underground Orchid	V	E	Habitat may occur within area	-	-	-	-	The species grows in eucalypt forest but no informative assessment of the likely preferred habitat for the species is available (DECC 2005b; c). Currently known only from 10 locations, including near Bulahdelah, the Watagan Mountains, the Blue Mountains, Wiseman's Ferry area, Agnes Banks and near Nowra. Flowers during October and November (Harden 1993).	Unlikely	No previous records within the locality, species not known to occur in Hunter Valley area.
Rhodamnia rubescens	Scrub Turpentine	CE	-	-	-	-	3	8776	Occurs in coastal districts north from Batemans Bay in New South Wales, approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of R. rubescens typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm. Found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest usually on volcanic and sedimentary soils.	None	No suitable rainforest or wet sclerophyll forest habitat present within the subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Rhodomyrtus psidioides	Native Guava	CE	-	-	-	-	4	6948	Occurs from Broken Bay, approximately 90 km north of Sydney, New South Wales, to Maryborough in Queensland. Populations are typically restricted to coastal and sub-coastal areas of low elevation however the species does occur up to c. 120 km inland in the Hunter and Clarence River catchments and along the Border Ranges in NSW. Pioneer species found in littoral, warm temperate and subtropical rainforest and wet sclerophyll forest often near creeks and drainage lines.	None	No suitable rainforest or wet sclerophyll forest habitat present within the subject site.
Rostratula australis	Australian Painted Snipe	E	E	Habitat known to occur within area	-	Y	1	693	Normally found in permanent or ephemeral shallow inland wetlands, either freshwater or brackish. Nests on the ground amongst tall reed-like vegetation near water. Feeds on mudflats and the water's edge taking insects, worm and seeds. Prefers fringes of swamps, dams and nearby marshy areas with cover of grasses, lignum, low scrub or open timber.	Possible	No suitable wetland habitat within subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Rutidosis heterogama	Heath Wrinklewort	V	V	Habitat known to occur within area	Y	-	957	1892	This species has been recorded in several patches from near Cessnock to Kurri Kurri with an outlying occurrence at Howes Valley. On the Central Coast it is located north from Wyong to Newcastle. There are north coast populations between Wooli and Evans Head in Yuraygir and Bundjalung National Parks. It also occurs on the New England Tablelands from Torrington and Ashford south to Wandsworth south-west of Glen Innes. Grows in heath on sandy soils and moist areas in open forest. Has also been recorded along disturbed roadsides.	Possible	A high number of previous records within the locality. The nearest record occurs approximately 2 km from the subject site. The species was not found during targeted surveys.
Saccolaimus flaviventris	Yellow-bellied Sheathtail-bat	V	-	-	-	Y	9	5660	Migrates from tropics to SE Aus in summer. Forages across a range of habitats including those with and without trees, from wet and dry sclerophyll forest, open woodland, Acacia shrubland, mallee, grasslands and desert. Roosts communally in large tree hollows and buildings (Churchill 2008).	Possible	Suitable foraging and roosting habitat present. Despite not being recorded during site surveys, a moderate number of previous records within approximately 5.5 km to the subject site suggests a possible occurrence of the species.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Scoteanax rueppellii	Greater Broad-nosed Bat	V	-	-	-	Y	46	66	Occurs on the east coast and Great Dividing Range. Inhabits a variety of habitats from woodland to wet and dry sclerophyll forests and rainforest, also remnant paddock trees and timber-lined creeks, typically below 500 m asl. Forages in relatively uncluttered areas, using natural or man-made openings in denser habitats. Usually roosts in tree hollows or fissures but also under exfoliating bark or in the roofs of old buildings. Females congregate in maternal roosts in suitable hollow trees (Hoye and Richards 2008, Churchill 2008).	Possible	Despite not being recorded during site surveys, a high number of previous records within close proximity to the subject site suggests it may occur.
Sternula albifrons	Little Tern	E	Mi	-	-	-	1	1120	In eastern Australia, many breeding colonies lie within conservation reserves, or within Ramsar-listed wetlands, or both. Little Terns occur in two Ramsar listed sites in NSW, Towra Point Nature Reserve and Hunter Estuary Wetlands (including Kooragang Nature Reserve). Inhabit sheltered coastal environments, including lagoons, estuaries, river mouths and deltas, lakes, bays, harbours and inlets, especially those with exposed sandbanks or sand-spits, and also on exposed ocean beaches.	Unlikely	No suitable wetland habitat within subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Stictonetta naevosa	Freckled Duck	V	-	-	-	Y	4	9925	Breeds in large, ephemeral swamps in the Murray-Darling, particularly along the Paroo and Lachlan Rivers and other Riverina rivers. In drier times moves to more permanent waters. Disperses during extensive inland droughts and may be found in coastal areas during such times. Prefers freshwater swamps/creeks with dense Cumbungi, Lignum or tea-tree. Nests in dense vegetation at or near water level.	Unlikely	Suitable habitat occurs within the subject site, however closest previous record occurred approximately 10 km from the subject site with only four records within the locality. The subject appears to be located on the edge of the species range.
Synemon plana	Golden Sun Moth	E	CE	Habitat may occur within area	-	-	-	-	In NSW, this species is now found between Queanbeyan, Gunning, Young and Tumut. It occurs in Natural Temperate Grasslands and grassy Box-Gum Woodlands in which groundlayer is dominated by wallaby grasses Austrodanthonia spp.	Unlikely	No natural temperate grasslands or grassy box-gum woodland habitat present.
Syzygium paniculatum	Magenta Lilly Pilly	E	V	Habitat known to occur within area	-	-	3	5275	Occurs in narrow coastal strip from Bulahdelah to Conjola State Forest. Grows in rainforest on sandy soils or stabilised Quaternary sand dunes at low altitudes in coastal areas, often in remnant littoral or gallery rainforests.	None	No suitable rainforest habitat present within the subject site

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Tetratheca juncea	Black-eyed Susan	V	V	Habitat known to occur within area	-	-	57	6701	Regarded as extinct within the Sydney area, current range from Wyong north to Bulahdelah and inland 50 km to edge of Sugarloaf Range. Occurs predominately in areas of over 1000 mm annual rainfall, within dry sclerophyll forest, and sometimes heath and moist forest, with a preference for Coastal Plains Smooth-barked Apple Woodland and Coastal Plains Scribbly Gum Woodland.	Unlikely	The subject site receives lower than 1000 mm annual rainfall. Despite potential habitat for the species preferred vegetation types are not present within the site. A number of previous records occur within the locality, however these are located approximately 7 km from the subject site. Species not associated with any of the PCTs that occur within subject site.
Thesium australe	Austral Toadflax	V	V	Habitat may occur within area	-	-	-	-	Found in small, scattered populations along the east coast, northern and southern tablelands. Occurs in grassland or grassy woodland and is often found in association with Kangaroo Grass.	Unlikely	No suitable habitat present. Historical grazing of grassland vegetation within the subject site indicates that this species is unlikely to occur.

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Thinornis rubricollis rubricollis	Hooded Plover	CE	V	Habitat may occur within area	-	-	-	-	The Hooded Plover is endemic to southern Australia and is nowadays found mainly along the coast from south of Jervis Bay. In the late 1920s and early 1930s the species was recorded from Port Stephens but are now considered locally extinct. It has not been seen in the Sydney area since the 1940s. Occasionally, individual birds are sighted slightly further north to the Shoalhaven River and Comerong Beach and one bird was sighted at Lake Illawarra in March 2001. Hooded Plovers prefer sandy ocean beaches backed by sparsely vegetated sand-dunes for shelter and nesting. Hooded Plovers display high nest site fidelity and nest solitarily. Occasionally Hooded Plovers are found on tidal bays and estuaries, rock platforms and rocky or sand-covered reefs near sandy beaches, and small beaches in lines of cliffs. They regularly use near-coastal saline and freshwater lakes and lagoons, often with saltmarsh.	None	No suitable habitat within the subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Threskiornis spinicollis	Straw-necked Ibis	-	Ma	-	-	-	-	-	The Straw-necked Ibis is widespread across much of the Australian mainland except the harshest deserts, and they often fly hundreds or thousands of kilometres between temperate locations in the south and tropical areas, and between inland sites and the coasts, possibly as regular seasonal movements, and sometimes in response to local environmental conditions. The Straw-necked Ibis prefers wet and dry grasslands, pastures, croplands and swamp or lagoon margins. It is rarely found on coastal shores, mudflats or mangroves and is generally less adaptable than the Australian White Ibis. It forages by probing or takes prey from the surface of water bodies. The low nests are large trampled platforms of reeds, rushes and sticks over water, often blending together to form one continuous platform, and are re-used over many years.	Known	Swamp, wetland and grassland habitat suitable for foraging within the subject site. Observed foraging during targeted surveys.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Tringa brevipes	Grey-tailed Tattler	-	Mi	Habitat known to occur within area	-	-	-	-	Non-breeding visitor to Australia. In NSW occurs along the coast from the Queensland border south to Tilba Lake, and has been recorded as far south as Gippsland. In NSW it is recorded more frequently north of Sydney. Found on sheltered coasts with reefs and rock platforms or with intertidal mudflats. Inland records are rare. Forages in shallow water in intertidal areas. Usually roosts in the branches of mangroves or rocks which may be partly submerged. Also rarely recorded in dense shrubs, on driftwood or sand dunes.	None	No suitable habitat within the subject site.
Tringa glareola	Wood Sandpiper	-	Mi	-	-	-	2	9925	Breeds in N Hemisphere. Occurs in largest numbers in NW Australia, with all sites of national importance within WA. In NSW there are records east of the Divide north from Nowra, and inland from the upper and lower Western regions. Uses well-vegetated, shallow, freshwater wetlands and are typically associated with wetlands supporting emergent aquatic plants or grass and taller fringing vegetation such as dense reeds/rushes, shrubs or trees. Also frequent flooded grasslands and irrigated crops. Rarely in brackish wetlands or saltmarsh. Known from artificial wetlands.	Unlikely	No suitable wetland habitat within subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Tringa nebularia	Common Greenshank	-	Mi	Habitat known to occur within area	-	-	1	9909	Does not breed in Australia but occurs in all types of wetlands. In NSW has been recorded in most coastal regions and is widespread west of the Great Dividing Range, particularly in the north-west, Macquarie Marshes and areas between the Lachlan and Murray Rivers and Darling River drainage basin. The Hunter River estuary is an internationally important site for the species. In coastal areas typically occurs in sheltered habitats with large mudflats and saltmarsh, mangroves or seagrass.	Unlikely	No suitable habitat within the subject site.
Tringa stagnatilis	Marsh Sandpiper	-	Mi	Habitat known to occur within area	-	-	2	693	Breeds in N Hemisphere. Occurs in coastal and inland wetlands, including freshwater and estuarine habitats, throughout Australia. All regions of NSW but particularly central and south coasts and western slopes and plains. Sites of national importance in NSW include Parkes wetlands, Macquarie Marshes and Tullakool Evaporation Ponds.	Unlikely	No suitable wetland habitat within subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Tyto novaehollandiae	Masked Owl	V	-	-	Y (Breeding)	Y (foraging)	21	3026	Occurs across NSW except NW corner. Most common on the coast. Inhabits dry eucalypt woodlands from sea level to 1100 m. Roosts and breeds in large (>40 cm) hollows and sometime caves in moist eucalypt forested gullies. Hunts along the edges of forests and roadsides. Home range between 500 ha and 1000 ha. Prey mostly terrestrial mammals but arboreal species may also be taken.	Unlikely	No suitable moist eucalypt forested gullies within subject site.
Tyto tenebricosa	Sooty Owl	V	-	-	-	-	5	1961	Occurs in the coastal, escarpment and tablelands regions of NSW. More common in the north and absent from the western tablelands and further west. Inhabits tall, moist eucalypt forests and rainforests, and are strongly associated with sheltered gullies, particularly those with tall rainforest understorey. Roosts in tree hollows, amongst dense foliage in gullies or in caves, recesses or ledges of cliffs or banks. Nest in large (>40 cm wide, 100 cm deep) tree hollows in unlogged/unburnt gullies within 100 m of streams or in caves.	Unlikely	No tall moist eucalypt forest, rainforest or sheltered gullies present within subject site.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Vespadelus troughtoni	Eastern Cave Bat	V	-	-	Y (Breeding)	Y	31	66	Occurs in NE NSW south to Kempsey and west to the Warrumbungles. Inhabits rainforest margins, wet and dry sclerophyll forests through to drier forests and woodlands in semi-arid environments. All records are within close proximity to sandstone or volcanic escarpments. Roosts in overhangs and caves, mines, boulder piles, abandoned Fairy Martin nests and occasionally in buildings, and regularly switches between alternate roost colonies. Forages over a small area but are capable of flying 500 m over clear paddocks (Churchill 2008, Parnaby et al 2008).	Unlikely	Marginal foraging habitat occurs on site however no sheltered gullies, tall, moist eucalypt forests or rainforests present. Site not in close proximity to sandstone or volcanic escarpments and not caves, mines or boulder piles present.
Xenus cinereus	Terek Sandpiper	V	Mi	Habitat known to occur within area	Y	Y (not mapped as important habitat)	-	-	The two main sites for this species in NSW are the Richmond River and Hunter River estuaries. Inhabits coastal mudflats, lagoons, creeks and estuaries. Favours mudbanks and sandbanks near mangroves, also observed on rocky pools and reefs and up to 10 km inland around brackish pools. Roost communally in mangroves or dead trees. Forages in open intertidal mudflats.	None	No suitable habitat within subject site. No previous records within the locality.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Tyto longimembris	Eastern Grass Owl	V	-	-	-	Y	-	-	Most common in N and NE Australia but recorded in all mainland states. In NSW most likely to be resident in the NE. Inhabit areas of tall grass, including grass tussocks, in swampy areas, grassy plains, swampy heath, and in cane grass or sedges on flood plains. Nests on the ground in trodden grass and are often accessed by tunnels through vegetation.	Unlikely	No suitable grassland habitat within subject site
Asperula asthenes	Trailing Woodruff	V	V	-	Y	-	-	-	This herb occurs in scattered locations from Bulahdelah to Kempsey. Some records from Port Stephens/Wallis Lakes area. Occurs in damp sites, often along riverbanks (OEH 2012).	Unlikely	No suitable riverbank habitat within the subject site.
Maundia triglochinoides	-	V	-	-	Y	-	-	-	Coastal NSW: current southern limit at Wyong, former populations near Sydney now extinct. Grows on heavy clay, low nutrient soil in swamps, lagoons, dams, channels, creeks or shallow freshwater 30-60 cm depth.	Unlikely	Marginal habitat present within vegetation surrounding detention ponds however heavy clay soils not present. Not recorded during targeted surveys.

Scientific Name	Common Name	BC Act status	EPBC Act status	PMST (DAWE, 2020)	Candidate species (BAM-C)	Predicted species (BAM-C)	Number of records (OEH, 2020)	Nearest Record (m)	Habitat Association	Likelihood of Occurrence	Justification
Uperoleia mahonyi	Mahoney's toadlet	E	-	-	Y	-	-	-	Mahony's Toadlet is endemic to the mid-north coast of New South Wales (NSW) between Kangy Angy and Seal Rocks. Mahony's Toadlet inhabits ephemeral and semi-permanent swamps and swales on the coastal fringe of its range occurring in heath or wallum habitats almost exclusively associated with leached (highly nutrient impoverished) white sand. Commonly associated with acid paperbark swamps wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland and Sydney red gum woodland. Records are associated with shallow ephemeral/semi-permanent water bodies with limited flow of water. Aquatic vegetation at breeding sites includes sedges (Shoenoplectus spp., Baumea spp. and Lepironia articulata) and Broadleaf Cumbungi (Typha orientalis).	Unlikely	No acid paperbark swamps wallum heath, swamp mahogany-paperbark swamp forest, heath shrubland or Sydney red gum woodland habitat within subject site.
Zannichellia palustris	-	E	-	-	Y	-	-	-	Known from the Lower Hunter and Sydney Olympic Park. A submerged aquatic plant that grows in fresh or slightly saline water.	Unlikely	No suitable habitat present within subject site. Manmade wetland areas not connected to natural waterways. Not previously recorded in locality.

CE= critically endangered, E=endangered, V= vulnerable, Y = Yes

Appendix B – Property lots within Biocertification area

Lot_DP	Note	Lot_DP	Note
Lot 1 DP71130	Whole	Lot 463 DP755231	Whole
Lot 1 DP543057	Part	Lot 456 DP755231	Part
Lot 1 DP998540	Part	Lot 424 DP755231	Part
Lot 2 DP62332	Whole	Lot 425 DP755231	Part
Lot 427 DP755231	Part	Lot 423 DP755231	Part
Lot 420 DP755231	Part	Lot 536 DP755231	Whole
Lot 435 DP755231	Part	Lot 682 DP755231	Whole
Lot 438 DP755231	Part	Lot 2 DP502196	Part
Lot 449 DP755231	Part	Lot 453 DP755231	Part
Lot 439 DP755231	Whole	Lot 1 DP502196	Part
Lot 1 DP589169	Part	Lot 10 DP553542	Part
Lot 429 DP755231	Part	Lot 416 DP755231	Whole
Lot 448 DP755231	Part	Lot 417 DP755231	Whole
Lot 447 DP755231	Part	Lot 2 DP233125	Part
Lot 436 DP755231	Part	Lot 3 DP233125	Part
Lot 769 DP755231	Part	Lot 458 DP755231	Whole
Lot 318 DP755231	Part	Lot 418 DP755231	Part
Lot 1 DP456769	Part	Lot 414 DP755231	Part
Lot 428 DP755231	Part	Lot 415 DP755231	Part
Lot 434 DP755231	Whole	Lot 421 DP755231	Part
Lot 437 DP755231	Part	Lot 422 DP755231	Part
Lot 460 DP755231	Whole	Lot 3 DP456769	Part
Lot 459 DP755231	Whole	Lot 3 DP62332	Whole
Lot 461 DP755231	Whole	Lot 5 DP62332	Whole
Lot 462 DP755231	Whole	Lot 454 DP755231	Part
Lot 18 DP1082569	Part	Lot 451 DP755231	Part
Lot 21 DP1082569	Whole	Lot 16 DP1082775	Part
Lot 17 DP1082569	Part	Lot 12 DP1082569	Part
Lot 19 DP1082569	Whole	Lot 16 DP1082569	Part
Lot 11 DP1082569	Part	Lot 10 DP1082569	Part
Lot 20 DP1082569	Whole	Lot 14 DP1082569	Part
Lot 319 DP755231	Part	Lot 15 DP1082569	Part
Lot 22 DP1082569	Whole		

Appendix C – PCT and vegetation integrity plot data

Vegetation Integrity Plot Data

Veg Zone	PCT	Condition	Plot	Composition (species richness)							Structure (% cover)						Function														
				TG	SG	GG	FG	EG	OG	Total	TG	SG	GG	FG	EG	OG	Large trees	Hollow trees	Litter cover (%)	Fallen logs (m)	Tree DBH 5-10 cm	Tree DBH 10-20 cm	Tree DBH 20-30 cm	Tree DBH 30-50 cm	Tree DBH 50-80 cm	Tree regen	HTE cover (total)	Zone	Easting	Northing	Bearing
	1633	**Benchmark**		**4**	**20**	**11**	**9**	**1**	**3**	**48**	**28**	**74**	**58**	**5**	**0**	**1**	**3**		**65**	**45**						Y					
1	1633	Intact	1a_8_GHD	4	11	5	1	0	1	22	19	45.2	26.3	0.1	0	0.1	0	1	82	38	1	1	1	1	0	Y	0	56	360043.8	6371049	325
	1633	Intact	1a_9_GHD	3	12	5	2	0	1	23	28	46.7	40.9	0.2	0	35	1	2	80	42	1	1	1	1	1	Y	0	56	360307.3	6371249	310
	1633	Intact	1a_10_GHD	2	5	6	9	1	0	23	19	66.5	21.2	2.7	2	0	1	0	34	41	0	1	1	1	1	Y	0.1	56	356980.8	6369753	143
	1633	Intact	1a_11_GHD	2	12	3	0	2	1	20	22	108.9	28.5	0	1.5	0.1	0	1	89	11	1	1	1	0	0	Y	0	56	358289.9	6371090	172
2	1633	Underscrubbed	1b_3_GHD	2	1	6	1	1	0	11	7	1	69.5	0.1	1	0	0	0	38	3	1	1	1	0	0	Y	0.8	56	357564.7	6369648	172
	1633	Underscrubbed	1b_4_GHD	2	9	7	4	1	0	23	18	40	2.1	3.1	0.5	0	1	2	77	21	1	1	1	1	1	Y	0	56	357312.2	6369786	82
	1633	Underscrubbed	1b_5_GHD	4	7	6	3	0	1	21	10.5	59.7	7.9	0.4	0	2	2	0	46	15	0	0	1	1	1	Y	0	56	356661	6369671	64
3	1633	Regrowth	1e_1_GHD	4	4	3	2	2	1	16	10.9	16.2	73.8	1.1	0.5	0.3	0	0	39	7	1	1	1	0	0	Y	6	56	357913.4	6371475	3
	1594	**Benchmark**		**4**	**8**	**8**	**7**	**2**	**3**	**32**	**28**	**15**	**102**	**3**	**1**	**2**	**1**		**40**	**12**						Y					
4	1594	Intact	2a_1_GHD	2	6	8	5	1	0	22	22	46.3	12	1.4	0.8	0	1	1	95	29	1	1	1	1	1	Y	0	56	358356	6371019	238
	1594	Intact	RFEF_3	3	4	4	3	2	2	18	12.8	67.1	0.5	0.7	0.2	3	0	1	39.0	6.0	1	1	1	1	0	Y	15.1	56	357697	6370405	355
5	1594	Underscrubbed	2c_3_GHD	3	6	5	2	1	0	17	9	60.9	23.3	1.4	1	0	0	0	77	22	1	1	1	0	0	Y	0.9	56	358232.1	6370858	128
	1594	Underscrubbed	2c_4_GHD	2	2	5	3	2	1	15	17	1.6	5.8	0.7	85.2	0.1	2	0	45	53	1	1	1	1	1	Y	7.3	56	358373	6370593	267
	1594	Underscrubbed	2c_5_GHD	2	5	3	2	1	0	13	23	8.6	5	0.3	75	0	3	0	53	48	1	1	1	1	1	Y	3.1	56	358338.4	6370539	240
	1591	**Benchmark**		**7**	**10**	**12**	**12**	**2**	**6**	**49**	**66**	**22**	**102**	**8**	**1**	**6**	**3**		**70**	**45**						Y					
6	1591	Intact	2a_2_GHD	2	6	5	2	0	3	18	21	95.8	5.7	0.2	0	0.7	1	1	59	53	0	1	1	1	1	N	0.4	56	357708.8	6370523	26
	1591	Intact	2a_3_GHD	3	9	5	3	2	1	23	25.1	37.4	27.3	1.4	3.5	0.1	0	1	69	32	0	1	1	1	0	N	0.9	56	357621.7	6370251	135
	1591	Intact	3a_2_GHD	3	6	4	5	0	1	19	24	65.9	37.4	0.6	0	0.3	3	0	89	22	0	1	1	1	1	N	0.9	56	361395.1	6372813	51
7	1591	Underscrubbed	3b_3_GHD	2	1	2	1	0	1	7	15	0.2	80.1	0.1	0	0.1	0	0	9	40	0	1	1	1	0	N	0.2	56	358828.9	6370391	180
	1591	Underscrubbed	3b_4_GHD	1	0	4	0	0	0	5	15	0	26.2	0	0	0	0	0	23	32	0	1	1	1	0	N	5.6	56	358808.3	6370162	140
	1591	Underscrubbed	3b_5_GHD	2	0	9	5	0	2	18	19	0	41.4	4.7	0	1.1	0	0	50	2	1	1	1	1	0	Y	3	56	359075.7	6370933	20
	1600	**Benchmark**		**7**	**10**	**12**	**12**	**2**	**6**	**49**	**66**	**22**	**102**	**8**	**1**	**6**	**3**		**70**	**45**						Y					
8	1600	Underscrubbed	5b_9_GHD	3	3	6	1	0	0	13	13	1.4	82.8	0.1	0	0	0	0	14	22	0	0	0	1	0	Y	0.5	56	360046.3	6371932	120
	1600	Underscrubbed	5b_7_GHD	0	0	1	1	0	0	2	0	0	20	0.1	0	0	0	0	27	0	0	0	0	0	0	N	8	56	360239.7	6371682	308
9	1600	Regrowth	5d_1_GHD	0	5	7	2	1	0	15	0.0	3.8	68.3	0.2	3.0	0.0	0	0	3.0	0.0	0	0	0	0	0	1	2.6	56	359778	6371129.3	0
	1600	Regrowth	5b_5_GHD	3	8	8	1	1	2	23	12.1	6.8	97.7	0.5	0.1	0.2	2	0	30.0	14.0	1	1	1	0	1	1	0.7	56	359937	6371375.1	15
	1600	Regrowth	5b_6_GHD	3	5	10	1	1	1	21	24.5	45.5	40.1	0.1	0.2	0.5	1	1	10.4	2.0	1	0	0	0	1	1	0.2	56	359756.9	6371435.2	60
10	1600	Intact	5a_3_GHD	3	7	5	6	1	3	25	27.2	36.4	9.1	0.7	0.2	0.5	0	0	93	84	1	1	1	1	0	Y	0	56	360111.2	6371215	147
	1600	Intact	5a_4_GHD	3	9	6	6	2	3	29	24.1	56	51	0.8	0.3	1	0	1	92	86	1	1	1	1	0	N	0.2	56	360283.7	6371406	166
	1600	Intact	5a_8_GHD	4	7	10	3	0	2	26	23	73.4	55.8	0.7	0	0.3	1	0	79	72	1	1	1	1	1	Y	1	56	360124.7	6371421	50
11	**1737**	**Benchmark**		**1**	**2**	**5**	**4**	**1**	**1**	**14**	**0**	**0**	**122**	**2**	**0**	**0**	**0**		N/A	N/A											
	1737	Intact	7a_1_GHD	0	0	5	5	0	0	10	0	0	94.7	8.4	0	0	0	0	1	0	0	0	0	0	0	N	2.2	56	358339.4	6370955	180

Cover-An estimate of Projected Foliage Cover for each species present with a 20x20m plot. Foliage cover estimates are recorded using the following number series: 0.1, 0.2, 0.3…1,2,3…10,15,20,25…100%.

Growth form - *TG=Tree; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other)

Appendix D – Species lists

Fauna species

V = Listed as vulnerable species, E = Endangered, CE = Critically endangered

BC Act = Biodiversity Conservation Act 2017

EPBC Act = Environment Protection and Biodiversity Conservation Act 1999

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Aves	*Acanthiza lineata*	Striated Thornbill	-	-	Observed
Aves	*Acanthiza nana*	Yellow Thornbill	-	-	Observed
Aves	*Acanthiza pusilla*	Brown Thornbill	-	-	Observed
Aves	*Acanthiza reguloides*	Buff-rumped Thornbill	-	-	Observed
Aves	*Acanthorhynchus tenuirostris*	Eastern Spinebill	-	-	Observed
Aves	*Accipiter cirrocephalus*	Collared Sparrowhawk	-	-	Observed
Aves	*Accipiter novaehollandiae*	Grey Goshawk	-	-	Observed
Aves	*Acridotheres tristis*	Common Myna	-	-	Observed
Aves	*Alisterus scapularis*	Australian King-Parrot	-	-	Observed
Aves	*Amblyornis newtonianus*	Superb Fairy-wren	-	-	Heard
Aves	*Anas castanea*	Chestnut Teal	-	-	Observed
Aves	*Anas gracilis*	Grey Teal	-	-	Observed
Aves	*Anas superciliosa*	Pacific Black Duck	-	-	Observed
Aves	*Anthochaera carunculata*	Red Wattlebird	-	-	Observed
Aves	*Aquila audax*	Wedge-tailed Eagle	-	-	Observed
Aves	*Ardea ibis*	Cattle Egret	-	-	Observed
Aves	*Ardea intermedia*	Intermediate Egret	-	-	Observed
Aves	*Ardea pacifica*	White-necked Heron	-	-	Observed
Aves	*Cacatua galerita*	Sulphur-crested Cockatoo	-	-	Observed
Aves	*Cacatua sanguinea*	Little Corella	-	-	Observed
Aves	*Calyptorhynchus funereus*	Yellow-tailed Black-Cockatoo	-	-	Observed
Aves	*Cacomantis flabelliformis*	Fan-tailed Cuckoo	-	-	Observed
Aves	*Chenonetta jubata*	Australian wood duck	-	-	Observed
Aves	*Colluricincla harmonica*	Grey Shrike-thrush	-	-	Observed
Aves	*Coracina novaehollandiae*	Black-faced Cuckoo-shrike	-	-	Observed
Aves	*Corcorax melanorhamphos*	White-winged Chough	-	-	Observed
Aves	*Cormobates leucophaeus*	White-throated Treecreeper	-	-	Observed
Aves	*Corvus coronoides*	Australian Raven	-	-	Observed
Aves	*Corvus orru*	Torresian Crow	-	-	Observed
Aves	*Cracticus nigrogularis*	Pied Butcherbird	-	-	Observed
Aves	*Cracticus torquatus*	Grey Butcherbird	-	-	Observed
Aves	*Cracticus tibicen*	Australian Magpie	-	-	Observed
Aves	*Cygnus atratus*	Black Swan	-	-	Observed
Aves	*Dacelo novaeguineae*	Laughing Kookaburra	-	-	Observed
Aves	*Daphoenositta chrysoptera*	Varied Sittella	V	-	Observed
Aves	*Dendrocygna eytoni*	Plumed Whistling-Duck	-	-	Observed
Aves	*Dicaeum hirundinaceum*	Mistletoebird	-	-	Observed
Aves	*Elseyornis melanops*	Black-fronted Dotterel	-	-	Observed
Aves	*Entomyzon cyanotis*	Blue-faced Honeyeater	-	-	Observed
Aves	*Eolophus roseicapilla*	Galah	-	-	Observed

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Aves	*Eopsaltria australis*	Eastern Yellow Robin	-	-	Observed
Aves	*Eudnamys orientalis*	Eastern Koel	-	-	Observed
Aves	*Eurystomus orientalis*	Dollarbird	-	-	Observed
Aves	*Falco cenchroides*	Nankeen Kestrel	-	-	Observed
Aves	*Falco longipennis*	Australian hobby	-	-	Observed
Aves	*Fulica atra*	Eurasian Coot	-	-	Observed
Aves	*Geopelia humeralis*	Bar-shouldered Dove	-	-	Observed
Aves	*Geopelia placida (striata)*	Peaceful Dove	-	-	Observed
Aves	*Gerygone albogularis*	White-throated Gerygone	-	-	Observed
Aves	*Glossopsitta concinna*	Musk Lorikeet	-	-	Observed
Aves	*Glossopsitta pusilla*	Little Lorikeet	V	-	Observed
Aves	*Grallina cyanoleuca*	Magpie-lark	-	-	Observed
Aves	*Gymnorhina tibicen*	Australian Magpie	-	-	Observed
Aves	*Haliaeetus leucogaster*	White-bellied Sea-Eagle	V	-	Observed
Aves	*Haliastur sphenurus*	Whistling Kite	-	-	Observed
Aves	*Hirundo neoxena*	Welcome Swallow	-	-	Observed
Aves	*Lalage tricolor*	White-winged Triller	-	-	Observed
Aves	*Lichenostomus chrysops*	Yellow-faced Honeyeater	-	-	Observed
Aves	*Lichenostomus fuscus*	Fuscous Honeyeater	-	-	Observed
Aves	*Lichenostomus leucotis*	White-eared Honeyeater	-	-	Observed
Aves	*Lichenostomus melanops*	Yellow-tufted Honeyeater	-	-	Observed
Aves	*Malurus cyaneus*	Superb Fairy-wren	-	-	Observed
Aves	*Malurus lamberti*	Variegated Fairy-wren	-	-	Observed
Aves	*Manorina melanocephala*	Noisy Miner	-	-	Observed
Aves	*Manorina melanophrys*	Bell Miner	-	-	Observed
Aves	*Melithreptus brevirostris*	Brown-headed Honeyeater	-	-	Observed
Aves	*Merops ornatus*	Rainbow Bee-eater	-	-	Observed
Aves	*Myzomela sanguinolenta*	Scarlet Honeyeater	-	-	Observed
Aves	*Neochmia temporalis*	Red-browed Finch	-	-	Observed
Aves	*Ocyphaps lophotes*	Crested Pigeon	-	-	Observed
Aves	*Oriolus sagittatus*	Olive-backed Oriole	-	-	Observed
Aves	*Pachycephala pectoralis*	Golden whistler	-	-	Observed
Aves	*Pachycephala rufiventris*	Rufous Whistler	-	-	Observed
Aves	*Pardalotus punctatus*	Spotted Pardalote	-	-	Observed
Aves	*Pardalotus striatus*	Striated Pardalote	-	-	Observed
Aves	*Pelecanus conspicillatus*	Australian Pelican	-	-	Observed
Aves	*Phalacrocorax carbo*	Great Cormorant	-	-	Observed
Aves	*Phalacrocorax melanoleucos*	Little Pied Cormorant	-	-	Observed
Aves	*Phalacrocorax sulcirostris*	Little Black Cormorant	-	-	Observed
Aves	*Phaps chalcoptera*	Common Bronzewing	-	-	Observed
Aves	*Philemon corniculatus*	Noisy Friarbird	-	-	Observed
Aves	*Phylidonyris niger*	White-cheeked Honeyeater	-	-	Observed
Aves	*Phylidonyris novaehollandiae*	New Holland Honeyeater	-	-	Observed
Aves	*Platycercus eximius*	Eastern Rosella	-	-	Observed
Aves	*Podargus strigoides*	Tawny Frogmouth	-	-	Observed
Aves	*Platycercus elegans*	Crimson Rosella	-	-	Observed
Aves	*Platycercus eximius*	Eastern Rosella	-	-	Observed

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Aves	*Pomatostomus temporalis*	Grey-crowned Babbler (eastern subspecies)	V	-	Observed
Aves	*Porphyrio porphyrio*	Purple Swamphen	-	-	Observed
Aves	*Psophodes olivaceus*	Eastern whipbird	-	-	Observed
Aves	*Rhipidura albiscapa*	Grey Fantail	-	-	Observed
Aves	*Rhipidura leucophrys*	Willie Wagtail	-	-	Observed
Aves	*Sericornis frontalis*	White-browed Scrubwren	-	-	Heard
Aves	*Threskiornis spinicollis*	Straw-necked Ibis	-	-	Observed
Aves	*Todiramphus sanctus*	Sacred Kingfisher	-	-	Observed
Aves	*Trichoglossus chlorolepidotus*	Scaly-breasted Lorikeet	-	-	Observed
Aves	*Trichoglossus haematodus*	Rainbow Lorikeet	-	-	Observed
Aves	*Tyto javanica*	Eastern Barn owl	-	-	Observed
Aves	*Vanellus miles*	Masked lapwing	-	-	Observed
Aves	*Zosterops lateralis*	Silvereye	-	-	Observed
Amphibians	*Litoria dentata*	Bleating tree frog	-	-	Heard
Amphibians	*Crinia signifera*	Common Eastern Froglet	-	-	Observed
Amphibians	*Litoria caerulea*	Green Tree Frog	-	-	Observed
Amphibians	*Limnodynastes dumerilii*	Eastern Banjo Frog	-	-	Observed
Amphibians	*Litoria fallax*	Eastern Dwarf Tree Frog	-	-	Observed
Amphibians	*Platyplectrum ornatum*	Ornate Burrowing Frog	-	-	Observed
Amphibians	*Litoria peronii*	Peron's Tree Frog	-	-	Observed
Amphibians	*Uperoleia laevigata*	Smooth Toadlet	-	-	Trapped and heard
Amphibians	*Limnodynastes peroni*	Brown-striped Frog	-	-	Observed
Amphibians	*Litoria tyleri*	Tyler's Tree Frog	-	-	Heard
Reptilia	*Pogona barbata*	Bearded Dragon	-	-	Observed
Reptilia	*Chelodina longicollis*	Eastern Snake-necked Turtle	-	-	Observed
Reptilia	*Ctenotus robustus*	Robust Ctenotus	-	-	Trapped
Reptilia	*Eulamprus quoyii*	Eastern Water-skink	-	-	Observed
Reptilia	*Lampropholis delicata*	Dark-flecked Garden Sunskink	-	-	Trapped
Reptilia	*Amphibolurus muricatus*	Jacky Lizard	-	-	Observed
Reptilia	*Varanus varius*	Lace Monitor	-	-	Observed
Reptilia	*Pseudechis porphyriacus*	Red-bellied Black Snake	-	-	Observed
Reptilia	*Furina diadema*	Red-naped snake	-	-	Observed
Mammalia	*Antechinus stuartii*	Brown Antechinus	-	-	Observed
Mammalia	*Rattus rattus*	Black Rat	-	-	Observed
Mammalia	*Trichosurus vulpecula*	Common Brushtail Possum	-	-	Observed
Mammalia	*Sminthopsis murina*	Common Dunnart	-	-	Trapped
Mammalia	*Pseudocheirus peregrinus*	Common Ringtail Possum	-	-	Observed
Mammalia	*Vombatus ursinus*	Common Wombat	-	-	Observed
Mammalia	*Macropus giganteus*	Eastern grey kangaroo	-	-	Observed
Mammalia	*Lepus europaeus*	Brown Hare	-	-	Observed
Mammalia	*Oryctolagus cuniculus*	Rabbit	-	-	Observed
Mammalia	*Vulpes vulpes*	Fox	-	-	Observed
Mammalia	*Macropus rufogriseus*	Red-necked Wallaby	-	-	Observed
Mammalia	*Tachyglossus aculeatus*	Short-beaked Echidna	-	-	Observed
Mammalia	*Petaurus breviceps*	Sugar Glider	-	-	Trapped
Mammalia	*Wallabia bicolor*	Swamp Wallaby	-	-	Observed

Class	Scientific name	Common name	Status		Observation type
			BC Act	EPBC Act	
Mammalia	*Chalinolobus morio*	Chocolate Wattled Bat	-	-	Acoustic Recording
Mammalia	*Micronomus norfolkensis*	Eastern Coastal Free-tailed Bat	V	-	Acoustic Recording
Mammalia	*Vespadelus pumilus*	Eastern Forest Bat	-	-	Acoustic Recording
Mammalia	*Mormopterus norfolkensis*	Eastern Freetail-bat	V	-	Acoustic Recording
Mammalia	*Chalinolobus gouldii*	Gould's Wattled Bat	-	-	Acoustic Recording
Mammalia	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	V	Observed
Mammalia	*Chalinolobus dwyeri*	Large-eared Pied Bat	V	V	Acoustic Recording
Mammalia	*Nyctophilus geoffroyi*	Lesser Long-eared Bat	-	-	Acoustic Recording
Mammalia	*Miniopterus australis*	Little Bentwing-bat	V	-	Acoustic Recording
Mammalia	*Myotis macropus*	Southern Myotis	V	-	Observed
Mammalia	*Austronomus australis*	White-striped Freetail-bat	-	-	Acoustic Recording and observed

Flora species

Growth Form	Family	Exotic	Scientific name	Common Name	BC status	EPBC status
FG	Acanthaceae	-	*Brunoniella australis*	Blue Trumpet	-	-
EG	Adiantaceae	-	*Adiantum aethiopicum*	Common Maidenhair	-	-
EG	Adiantaceae	-	*Cheilanthes sieberi*	Rock Fern	-	-
FG	Amaranthaceae		*Alternanthera nana*	Hairy Joyweed	-	-
FG	Anthericaceae	-	*Laxmannia gracilis*	Slender Wire Lily	-	-
FG	Apiaceae	-1	*Centella asiatica*	Indian Pennywort	-	-
EX	Apiaceae	*	*Foeniculum vulgare*	Fennel	-	-
OG	Apocynaceae	-	*Parsonsia spp.*	-	-	-
OG	Apocynaceae	-	*Parsonsia straminea*	Common Silkpod	-	-
EX	Asteraceae	*	*Ambrosia artemisiifolia*	Annual Ragweed	-	-
EX	Asteraceae	*	*Arctotheca calendula*	Capeweed	-	-
EX	Asteraceae	*	*Aster spp.*	-	-	-
HT	Asteraceae	*	*Bidens pilosa*	Cobbler's Pegs	-	-
EX	Asteraceae	*	*Conyza bonariensis*	Flaxleaf Fleabane	-	-
EX	Asteraceae	*	*Coreopsis lanceolata*	Coreopsis	-	-
FG	Asteraceae	-	*Euchiton spp.*	-	-	-
EX	Asteraceae		*Facilis retusa*	Annual Trampweed		
EX	Asteraceae	*	*Gamochaeta calviceps*	Cudweed	-	-
EX	Asteraceae	*	*Gamochaeta purpurea*	Purple Cudweed	-	-
EX	Asteraceae	*	*Hypochaeris radicata*	Catsear	-	-
EX	Asteraceae	*	*Scorzonera laciniata*	-	-	-
HT	Asteraceae	*	*Senecio madagascariensis*	Fireweed	-	-
EX	Asteraceae	*	*Sonchus asper*	Prickly Sowthistle	-	-
EX	Asteraceae	*	*Taraxacum officinale*	Dandelion		
FG	Asteraceae	-	*Vernonia cinerea*	-	-	-
FG	Asteraceae	-	*Vittadinia spp.*	-	-	-
OG	Bignoniaceae	-	*Pandorea jasminoides*	Bower Vine	-	-
EG	Blechnaceae	-	*Blechnum spp.*	-	-	-
EX	Boraginaceae	*	*Echium vulgare*	Viper's Bugloss	-	-
EX	Brassicaceae	*	*Lepidium africanum*	Common Peppercress	-	-
FG	Campanulaceae	-	*Wahlenbergia gracilis*	Sprawling Bluebell	-	-
EX	Caryophyllaceae	*	*Cerastium glomeratum*	Mouse-ear Chickweed	-	-
EX	Caryophyllaceae	*	*Petrorhagia dubia*	-	-	-
EX	Caryophyllaceae	*	*Silene apetala*	-	-	-
EX	Caryophyllaceae	*	*Silene gallica*	French Catchfly	-	-
TG	Casuarinaceae	-	*Allocasuarina torulosa*	Forest Oak	-	-
TG	Casuarinaceae	-	*Casuarina glauca*	Swamp Oak	-	-
SG	Celastraceae	-	*Denhamia silvestris*	Narrow-leaved Orangebark	-	-
FG	Chenopodiaceae	-	*Einadia hastata*	Berry Saltbush	-	-
FG	Chenopodiaceae	-	*Einadia nutans*	Climbing Saltbush	-	-
FG	Commelinaceae	-	*Commelina cyanea*	Native Wandering Jew	-	-

Growth Form	Family	Exotic	Scientific name	Common Name	BC status	EPBC status
FG	Convolvulaceae	-	*Dichondra repens*	Kidney Weed	-	-
FG	Crassulaceae	-	*Crassula sieberiana*	Australian Stonecrop	-	-
EX	Cucurbitaceae	*	*Citrullus amarus*	Wild Melon	-	-
GG	Cyperaceae	-	*Baumea articulata*	Jointed Twig-rush	-	-
GG	Cyperaceae	-	*Eleocharis sphacelata*	Tall Spike Rush	-	-
GG	Cyperaceae	-	*Lepidosperma laterale*	Variable Sword-sedge	-	-
EG	Dennstaedtiaceae	-	*Pteridium esculentum*	Bracken	-	-
SG	Dilleniaceae	-	*Hibbertia linearis*	-	-	-
SG	Dilleniaceae	-	*Hibbertia vestita*	-	-	-
SG	Ericaceae	-	*Epacris longiflora*	Fuchsia Heath	-	-
SG	Ericaceae	-	*Leucopogon juniperinus*	Prickly Beard-heath	-	-
SG	Ericaceae	-	*Leucopogon spp.*	-	-	-
SG	Ericaceae	-	*Monotoca elliptica*	Tree Broom-heath	-	-
SG	Ericaceae	-	*Styphelia triflora*	Pink Five-Corners	-	-
SG	Fabaceae (Faboideae)	-	*Bossiaea rhombifolia*	-	-	-
SG	Fabaceae (Faboideae)	-	*Daviesia ulicifolia*	Gorse Bitter Pea	-	-
SG	Fabaceae (Faboideae)	-	*Dillwynia retorta*	-	-	-
OG	Fabaceae (Faboideae)	-	*Glycine clandestina*	Twining Glycine	-	-
OG	Fabaceae (Faboideae)	-	*Glycine microphylla*	Small-leaf Glycine	-	-
OG	Fabaceae (Faboideae)	-	*Glycine tabacina*	Variable Glycine	-	-
OG	Fabaceae (Faboideae)	-	*Hardenbergia violacea*	False Sarsaparilla	-	-
FG	Fabaceae (Faboideae)	-	*Hovea linearis*	-	-	-
SG	Fabaceae (Faboideae)	-	*Hovea purpurea*	-	-	-
SG	Fabaceae (Faboideae)	-	*Hovea spp.*	-	-	-
SG	Fabaceae (Faboideae)	-	*Indigofera australis*	Australian Indigo	-	-
SG	Fabaceae (Faboideae)	-	*Jacksonia scoparia*	Dogwood	-	-
EX	Fabaceae (Faboideae)	*	*Lotus angustissimus*	Slender Birds-foot Trefoil	-	-
EX	Fabaceae (Faboideae)	*	*Lotus subbiflorus*	Hairy Birds-foot Trefoil	-	-
EX	Fabaceae (Faboideae)	*	*Medicago sativa*	Lucerne	-	-
SG	Fabaceae (Faboideae)	-	*Oxylobium cordifolium*	Heart-leaved Shaggy Pea	-	-
SG	Fabaceae (Faboideae)	-	*Pultenaea retusa*	-	-	-
SG	Fabaceae (Faboideae)	-	*Pultenaea spinosa*	A Bush Pea	-	-
EX	Fabaceae (Faboideae)	*	*Trifolium dubium*	Yellow Suckling Clover	-	-
SG	Fabaceae (Mimosoideae)	-	*Acacia irrorata*	Green Wattle	-	-
SG	Fabaceae (Mimosoideae)	-	*Acacia longifolia*	-	-	-

Growth Form	Family	Exotic	Scientific name	Common Name	BC status	EPBC status
SG	Fabaceae (Mimosoideae)	-	*Acacia parvipinnula*	Silver-stemmed Wattle	-	-
SG	Fabaceae (Mimosoideae)	-	*Acacia ulicifolia*	Prickly Moses	-	-
FG	Goodeniaceae	-	*Dampiera stricta*	-	-	-
FG	Goodeniaceae	-	*Scaevola spp.*	-	-	-
HT	Juncaceae	*	*Juncus acutus*	-	-	-
GG	Juncaceae	-	*Juncus spp.*	A Rush	-	-
GG	Juncaceae	-	*Juncus usitatus*	-	-	-
FG	Juncaginaceae	-	*Triglochin procera*	Water Ribbons	-	-
OG	Lauraceae	-	*Cassytha glabella*	-	-	-
OG	Lauraceae	-	*Cassytha pubescens*	Downy Dodder-laurel	-	-
FG	Lobeliaceae	-	*Pratia purpurascens*	Whiteroot	-	-
GG	Lomandraceae	-	*Lomandra brevis*	-	-	-
GG	Lomandraceae	-	*Lomandra confertifolia*	Matrush	-	-
GG	Lomandraceae	-	*Lomandra cylindrica*	-	-	-
GG	Lomandraceae	-	*Lomandra filiformis*	Wattle Matt-rush	-	-
GG	Lomandraceae	-	*Lomandra glauca*	Pale Mat-rush	-	-
GG	Lomandraceae	-	*Lomandra longifolia*	Spiny-headed Mat-rush	-	-
GG	Lomandraceae	-	*Lomandra multiflora*	-	-	-
GG	Lomandraceae	-	*Lomandra obliqua*	-	-	-
GG	Lomandraceae	-	*Lomandra spp.*	-	-	-
OG	Luzuriagaceae	-	*Geitonoplesium cymosum*	Scrambling Lily	-	-
SG	Malvaceae	-	*Lasiopetalum parviflorum*	-	-	-
EX	Malvaceae	*	*Sida rhombifolia*	Paddy's Lucerne	-	-
SG	Myrsinaceae	-	*Myrsine variabilis*	-	-	-
TG	Myrtaceae	-	*Angophora bakeri*	Narrow-leaved Apple	-	-
TG	Myrtaceae	-	*Angophora floribunda*	Rough-barked Apple	-	-
SG	Myrtaceae	-	*Callistemon linearifolius*	Netted Bottle Brush	V	-
SG	Myrtaceae	-	*Callistemon linearis*	Narrow-leaved Bottlebrush	-	-
SG	Myrtaceae	-	*Callistemon salignus*	Willow Bottlebrush	-	-
TG	Myrtaceae	-	*Corymbia maculata*	Spotted Gum	-	-
TG	Myrtaceae	-	*Eucalyptus acmenoides*	White Mahogany	-	-
TG	Myrtaceae	-	*Eucalyptus agglomerata*	Blue-leaved Stringybark	-	-
TG	Myrtaceae	-	*Eucalyptus amplifolia*	Cabbage Gum	-	-
TG	Myrtaceae	-	*Eucalyptus capitellata*	Brown Stringybark	-	-
TG	Myrtaceae	-	*Eucalyptus crebra*	Narrow-leaved Ironbark	-	-
TG	Myrtaceae	-	*Eucalyptus fibrosa*	Red Ironbark	-	-
TG	Myrtaceae	-	*Eucalyptus moluccana*	Grey Box	-	-
TG	Myrtaceae	-	*Eucalyptus parramattensis subsp. decadens*	Parramatta Red Gum	V	V
TG	Myrtaceae	-	*Eucalyptus punctata*	Grey Gum	-	-
TG	Myrtaceae	-	*Eucalyptus robusta*	Swamp Mahogany	-	-
TG	Myrtaceae	-	*Eucalyptus robusta x tereticornis*	-	-	-

Growth Form	Family	Exotic	Scientific name	Common Name	BC status	EPBC status
TG	Myrtaceae	-	*Eucalyptus tereticornis*	Forest Red Gum	-	-
SG	Myrtaceae	-	*Leptospermum parvifolium*	-	-	-
SG	Myrtaceae	-	*Leptospermum polygalifolium*	-	-	-
SG	Myrtaceae	-	*Leptospermum polygalifolium subsp. polygalifolium*	-	-	-
SG	Myrtaceae	-	*Leptospermum trinervium*	Slender Tea-tree	-	-
SG	Myrtaceae	-	*Melaleuca linariifolia*	Flax-leaved Paperbark	-	-
SG	Myrtaceae	-	*Melaleuca nodosa*	-	-	-
SG	Myrtaceae	-	*Melaleuca sieberi*	-	-	-
SG	Myrtaceae	-	*Melaleuca thymifolia*	Thyme Honey-myrtle	-	-
HT	Oleaceae	*	*Ligustrum sinense*	Small-leaved Privet	-	-
TG	Oleaceae	-	*Notelaea longifolia*	Large Mock-olive	-	-
EX	Onagraceae	*	*Oenothera stricta*	-	-	-
FG	Orchidaceae	-	*Caladenia catenata*	White Caladenia	-	-
FG	Orchidaceae	-	*Microtis parviflora*	Slender Onion Orchid	-	-
FG	Orchidaceae	-	*Pterostylis rufa*	Rusty Hood	-	-
FG	Orchidaceae	-	*Thelymitra pauciflora*	Slender Sun Orchid	-	-
FG	Orchidaceae	-	*Thelymitra spp.*	-	-	-
FG	Oxalidaceae	-	*Oxalis perennans*	-	-	-
EX	Oxalidaceae	*	*Oxalis spp.*	-	-	-
FG	Philydraceae	-	*Philydrum lanuginosum*	Frogsmouth	-	-
FG	Phormiaceae	-	*Dianella caerulea*	Blue Flax-lily	-	-
FG	Phormiaceae	-	*Dianella revoluta*	Blueberry Lily	-	-
SG	Phyllanthaceae	-	*Breynia oblongifolia*	Coffee Bush	-	-
OG	Pittosporaceae	-	*Billardiera scandens*	Hairy Apple Berry	-	-
SG	Pittosporaceae	-	*Bursaria spinosa*	Native Blackthorn	-	-
SG	Pittosporaceae	-	*Pittosporum undulatum*	Sweet Pittosporum	-	-
EX	Plantaginaceae	*	*Plantago lanceolata*	Lamb's Tongues	-	-
EX	Plantaginaceae	*	*Plantago myosuros*	-	-	-
EX	Plantaginaceae	*	*Plantago spp.*	Plantain	-	-
FG	Plantaginaceae	-	*Veronica plebeia*	Trailing Speedwell	-	-
EX	Poaceae	*	*Aira caryophyllea*	Silvery Hairgrass	-	-
HT	Poaceae	*	*Andropogon virginicus*	Whisky Grass	-	-
GG	Poaceae	-	*Anisopogon avenaceus*	Oat Speargrass	-	-
GG	Poaceae	-	*Aristida vagans*	Threeawn Speargrass	-	-
GG	Poaceae	-	*Aristida warburgii*	-	-	-
EX	Poaceae	*	*Briza major*	-	-	-
EX	Poaceae	*	*Briza minor*	Shivery Grass	-	-
HT	Poaceae	*	*Cenchrus clandestinum*	-	-	-
HT	Poaceae	*	*Chloris gayana*	Rhodes Grass	-	-
GG	Poaceae	-	*Chloris ventricosa*	Tall Chloris	-	-
GG	Poaceae	-	*Cynodon dactylon*	Common Couch	-	-
GG	Poaceae	-	*Dichelachne micrantha*	Shorthair Plumegrass	-	-

Growth Form	Family	Exotic	Scientific name	Common Name	BC status	EPBC status
GG	Poaceae	-	*Echinopogon caespitosus*	Bushy Hedgehog-grass	-	-
GG	Poaceae	-	*Echinopogon ovatus*	Forest Hedgehog Grass	-	-
HT	Poaceae	*	*Ehrharta erecta*	Panic Veldtgrass	-	-
GG	Poaceae	-	*Entolasia stricta*	Wiry Panic	-	-
GG	Poaceae	-	*Eragrostis brownii*	Brown's Lovegrass	-	-
HT	Poaceae	*	*Eragrostis curvula*	African lovegrass	-	-
GG	Poaceae	-	*Eragrostis elongata*	Clustered Lovegrass	-	-
GG	Poaceae	-	*Eragrostis parviflora*	Weeping Lovegrass	-	-
HT	Poaceae	*	*Hyparrhenia hirta*	Coolatai Grass	-	-
GG	Poaceae	-	*Imperata cylindrica*	Blady Grass	-	-
EX	Poaceae	*	*Lolium perenne*	Perennial Ryegrass	-	-
HT	Poaceae	*	*Megathyrsus maximus*	-	-	-
GG	Poaceae	-	*Microlaena stipoides*	Weeping Grass	-	-
GG	Poaceae	-	*Oplismenus aemulus*	-	-	-
GG	Poaceae	-	*Panicum simile*	Two-colour Panic	-	-
GG	Poaceae	*	*Panicum spp.*	-	-	-
GG	Poaceae	-	*Paspalidium distans*	-	-	-
HT	Poaceae	*	*Paspalum dilatatum*	Paspalum	-	-
EX	Poaceae	*	*Paspalum notatum*	-	-	-
EX	Poaceae	*	*Paspalum spp.*	-	-	-
GG	Poaceae	-	*Phragmites australis*	Common Reed	-	-
GG	Poaceae	-	*Poa sieberiana*	Snowgrass	-	-
GG	Poaceae	-	*Rytidosperma pallidum*	-	-	-
GG	Poaceae	-	*Rytidosperma spp.*	-	-	-
EX	Poaceae	*	*Setaria parviflora*	-	-	-
EX	Poaceae	*	*Setaria pumila*	Pigeon Grass	-	-
EX	Poaceae	*	*Sporobolus africanus*	Parramatta Grass	-	-
GG	Poaceae	-	*Sporobolus creber*	Slender Rat's Tail Grass	-	-
GG	Poaceae	-	*Themeda triandra*	-	-	-
EX	Poaceae	*	*Vulpia bromoides*	Squirrel Tail Fescue	-	-
FG	Polygonaceae	-	*Persicaria decipiens*	Slender Knotweed	-	-
EX	Primulaceae	*	*Lysimachia arvensis*	-	-	-
SG	Proteaceae	-	*Banksia collina*	-	-	-
SG	Proteaceae	-	*Banksia spinulosa*	Hairpin Banksia	-	-
SG	Proteaceae	-	*Conospermum spp.*	-	-	-
SG	Proteaceae	-	*Grevillea linearifolia*	Linear-leaf Grevillea	-	-
SG	Proteaceae	-	*Grevillea parviflora subsp. parviflora*	Small-flower Grevillea	V	V
TG	Proteaceae	-	*Grevillea robusta*	Silky Oak	-	-
SG	Proteaceae	-	*Hakea dactyloides*	Finger Hakea	-	-
SG	Proteaceae	-	*Hakea sericea*	Needlebush	-	-
SG	Proteaceae	-	*Isopogon anemonifolius*	Broad-leaf Drumsticks	-	-
SG	Proteaceae	-	*Lambertia formosa*	Mountain Devil	-	-
SG	Proteaceae	-	*Persoonia linearis*	Narrow-leaved Geebung	-	-

Growth Form	Family	Exotic	Scientific name	Common Name	BC status	EPBC status
FG	Ranunculaceae	-	*Ranunculus inundatus*	River Buttercup	-	-
FG	Ranunculaceae	-	*Ranunculus plebeius*	Forest Buttercup	-	-
GG	Restionaceae	-	*Empodisma minus*	-	-	-
HT	Rosaceae		*Rubus fruticosus sp. agg.*	Blackberry complex	-	-
SG	Rosaceae	-	*Rubus parvifolius*	Native Raspberry	-	-
SG	Rosaceae	-	*Rubus spp.*	-	-	-
FG	Rubiaceae	-	*Pomax umbellata*	Pomax	-	-
SG	Rutaceae	-	*Correa reflexa*	Native Fuschia	-	-
SG	Rutaceae	-	*Zieria smithii*	-	-	-
SG	Santalaceae	-	*Exocarpos cupressiformis*	Cherry Ballart	-	-
SG	Santalaceae	-	*Exocarpos strictus*	Dwarf Cherry	-	-
SG	Santalaceae	-	*Leptomeria acida*	Sour Currant Bush	-	-
EX	Scrophulariaceae	*	*Linaria pelisseriana*	Pelisser's Toadflax	-	-
HT	Solanaceae	*	*Cestrum parqui*	Green Cestrum	-	-
EX	Solanaceae	*	*Solanum nigrum*	Black-berry Nightshade	-	-
FG	Solanaceae	-	*Solanum prinophyllum*	Forest Nightshade	-	-
SG	Sterculiaceae	-	*Lasiopetalum ferrugineum*	-	-	-
SG	Thymelaeaceae	-	*Pimelea linifolia*	Slender Rice Flower	-	-
GG	Typhaceae	-	*Typha orientalis*	Broad-leaved Cumbungi	-	-
HT	Verbenaceae	*	*Lantana camara*	Lantana	-	-
EX	Verbenaceae	*	*Verbena bonariensis*	Purpletop	-	-
OG	Xanthorrhoeaceae	-	*Xanthorrhoea spp.*	-	-	-
OG	Zamiaceae	-	*Macrozamia flexuosa*	-	-	-

Growth form - *TG=Tree; SG=Shrub; GG=Grass and grass-like; FG=forb; EG=Fern; OG=Other, HT=High threat, EX=Exotic

V= vulnerable

Appendix E – Expert report Green and Golden Bell Frog/Green Thighed Frog

MEMORANDUM			
TO	Arien Quin		
FROM	Frank Lemckert		
DATE	19 January 2022	PURPOSE	Habitat assessment for threatened frogs
SUBJECT	Expert Advice Report - Green and Golden Bell Frog and Green-thighed Frogs for the Kurri Kurri Smelter re-development.		

1. Introduction

Eco Logical Australia (ELA) was engaged by GHD to undertake an assessment of the habitats available for the Green and Golden Bell Frog (GGBF), *Litoria aurea,* and Green-thighed Frog (GTF), *Litoria brevipalmata*, within lands enclosed by the proposed "Development Boundary" of the BioCertification area located at Loxford NSW (refer to Figure 1). The work was completed by ELA's accredited expert in these two species, Dr Frank Lemckert, who was also engaged to provide an assessment of adequacy of previous surveys and the potential for those surveys to have detected both species. The aim of this report is to provide GHD with expert advice as to whether the two species would likely be present on the site and if further survey for either species is warranted and, if so, provide recommendations on how any such survey should be completed.

Hence this work consisted of two parts. One was to undertake a site inspection of the lands enclosed within the development boundary and areas within 200 m of the boundary (study area) in order to provide an expert assessment of the potential for each species to be present and breeding on the site in the current conditions. The second was to review reporting on the surveys completed previously on this site for the GGBF to provide an expert view as to whether those would likely have detected the frogs if they were present. And if not, provide an expert view as to what other surveys would be required in order to provide a sufficient level of certainty as to whether the GGBF is present or absent.

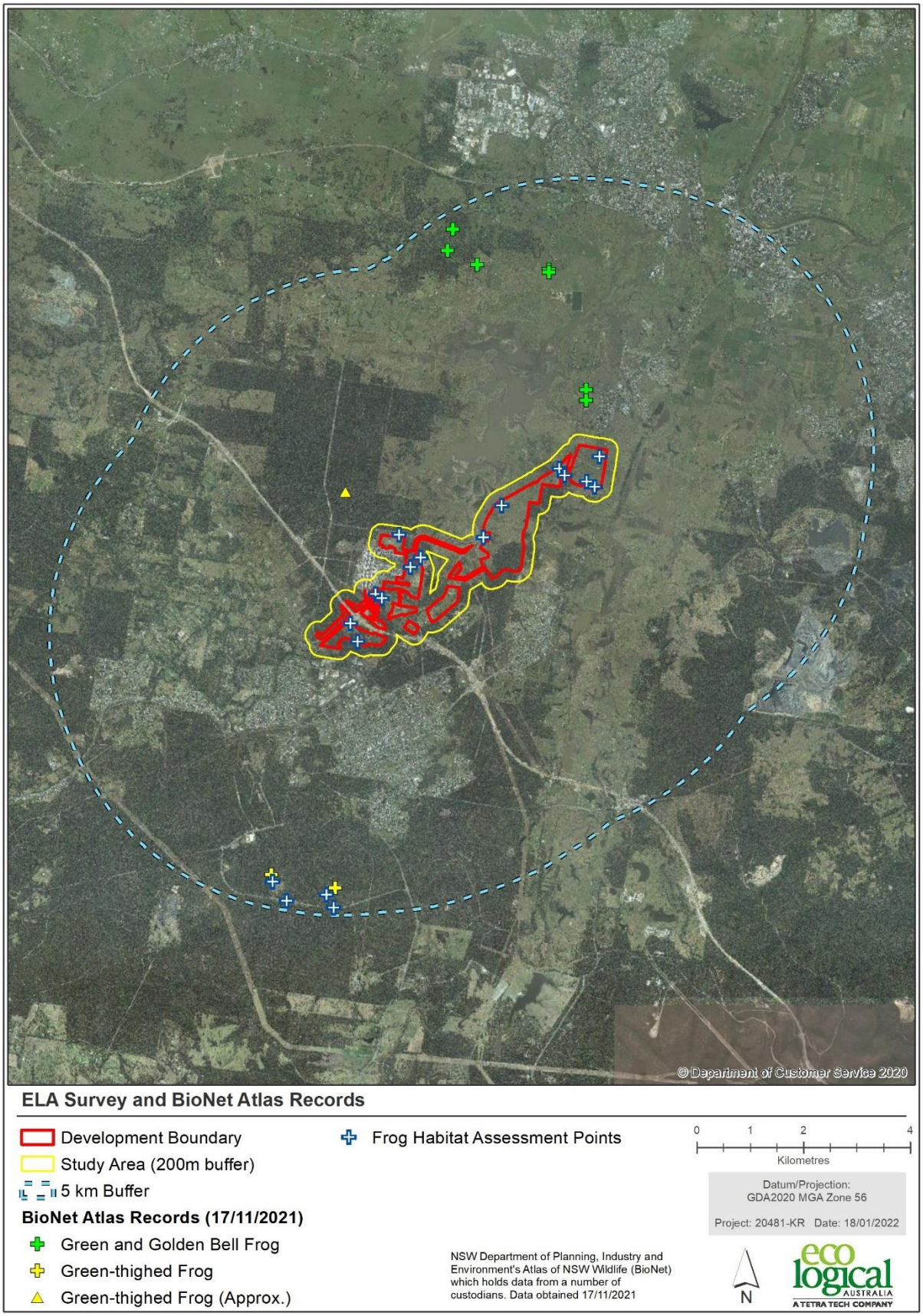

Figure 1. Study area, inspection points and records of the GGBF and GTF available on BioNet

2. Habitat Requirements

2.1.1. Green and Golden Bell Frog

Breeding sites for the GGBF include a wide range of natural water bodies and the species has been recorded inhabiting all but fast flowing streams (White and Pyke 1996). It also inhabits many human-created environments, including highly disturbed sites such as abandoned mines and quarries (Pyke et. al. 2002), as well as artificial wetlands that have been created at both Kooragang Island (Hamer et. al. 2002) and Sydney Olympic Park (Darcovich and O'Meara 2008). White and Pyke (1996) undertook a review of the known breeding habitat of the GGBF and found that they preferred to breed in water bodies that were still, shallow, ephemeral, unshaded, with aquatic plants and free of the Plague Minnow (*Gambusia holbrooki*) and other predatory fish. This study also found that breeding occurs in a significantly higher proportion of sites with ephemeral (temporary) ponds, rather than sites with fluctuating or permanent ponds. Hamer et. al. (2002) found a similar result for the GGBF populations at Kooragang Island where larger males would move to ephemeral water bodies to breed when they were available, although reproduction was also associated with permanent water bodies. The frogs in that study also tended to remain relatively faithful to one water body. The presence of the Plague Minnow does not exclude GGBF from breeding in a water body, but success appears to be dependent on the presence of more complex aquatic vegetation, which allows the GGBF to breed successfully (Hamer et. al. 2002). Hence the Plague Minnow does still appear to be a sole determinant of the likely presence of the GGBF in most situations.

The GGBF is unusual for an Australian frog in that the species appears to remain generally associated with water bodies, remaining within the riparian zone unless migrating between water bodies. Most frogs migrate 50-300 m from the breeding site to settle into recognisably different complementary non-breeding habitat in which they spend the majority of the year (Lemckert 2004). Terrestrial habitats immediately adjacent to water bodies (< 50 m) are typically used for foraging and shelter and preferably consist of grassy areas and vegetation no higher than woodlands and contain a range of diurnal shelter sites such as logs, rocks or dense vegetation (White and Pyke 1996). However, there are observations of GGBF moving into taller forests (e.g. dry sclerophyll forest at Nowra; M. Greenlees Pers. Comm. and dense woodlands at Meroo; F. Lemckert Pers. Obs.) and even foraging in suburban backyards (DEC 2005). This again demonstrates the adaptability and lack of habitat specificity of this frog.

Adult frogs show a strong site fidelity in regards to returning to the same ponds over time (Hamer et al. 2008), but their movements around those ponds and immediately adjacent areas are relatively random for most individuals and especially juveniles (F. Lemckert Pers. Obs.). Females though, have been observed to congregate together into specific shelter and foraging sites in areas immediately adjacent to breeding sites (Hamer 1998, Pyke and White 2001).

Another unusual aspect of the GGBF is its well-known habit of basking, typically within areas of aquatic vegetation, in order to increase body temperatures (Pyke and White 2001). Basking in frogs is unusual (being generally nocturnal), but such activities in ectotherms typically allow for periods of greater activity or faster digestion of food items. Whilst the importance of this activity for its physiological requirements is not known, individual GGBF appear to bask regularly. On this basis, it is likely that basking is an important physiological activity for the GGBF. Basking typically occurs within or on the edge

of emergent aquatic vegetation, which likely allows individuals the option to make a rapid escape from diurnal predators. The presence of water bodies that contain emergent vegetation are known important determinants of the presence of GGBF (White and Pyke 1996; Hamer et al. 2002) and form an important resource for the GGBF and in the consideration of their potential presence.

Christy (2001) and Muir (2008) state that terrestrial movements of the GGBF are primarily undertaken through more open environments that contained patches of shelter such as rocks, logs or ponds or areas of thick vegetation. Such habitats provide relatively little impediment to the movements of frogs but allow for individuals to seek shelter as required. Terrestrial movements are typically undertaken at night and are most likely associated with rainfall events (F. Lemckert Pers. Obs.) which would provide protection against desiccation.

Mahony (1999) cautions that the studies that have been carried out since the declines of the GGBF do not necessarily identify the actual preferred requirements of the species. He notes that the changed environment and factors causing the declines may have "altered" the optimal habitats for the species in comparison to their habitat use patterns prior to the declines. This is based on the fact that the use of ephemeral breeding sites was not noted for the bell frog group in earlier habitat descriptions. Such altered habitat use has been noted for other species such as *Litoria lorica* that now is only present in open rocky streams whereas it was once known as a rainforest stream species (Puschendorf et al 2011). This change is attributed to the impacts of the chytrid fungus, with the frog only surviving in a relatively extreme environment where the fungus is affected by the hotter conditions. Given the chytrid fungus appears also to have been at least a significant contributor (and probably the major one) to the decline of the GGBF, there is a significant potential that the GGBF is now living successfully only in a different set of environments to what it historically did. However, that is unlikely to ever be confirmed.

A critical consideration in the likely presence/absence of the GGBF are metapopulation dynamics. The GGBF is considered to follow a classical metapopulation structure with the "local" population consisting as a series of patchy populations within the larger metapopulation. Individuals move regularly between a mosaic of wetlands across a broad area throughout a single breeding season (Hamer et al. 2008; Hamer & Mahony 2010). There is high site-specific population turnover with local extinctions being balanced by colonisations by regularly dispersing individuals, but with the overall population remaining stable. There are core sites that provide ongoing and regular reproductive success and that maintain long-term populations, but a major part of the population dynamics is driven by inter-year success of breeding at a range of available breeding sites, with years of very good reproductive success leading to opportunities to expand ranges and colonise new sites. On Kooragang Island, GGBF typically reside in permanent waterbodies where they exhibit high site fidelity, but during periods of high rainfall disperse over several hundred metres to breed at ephemeral water bodies that have flooded (Hamer et al. 2008). Reproductive activity (e.g. calling) typically occurs over several nights at these ephemeral waterbodies, with individuals returning to core permanent waterbodies. In times of poor rainfall, the core sites become the refuges for the species and Valdez et al. (2015) found that probability of occupancy of a site increased at large and permanent wetlands.

Following on from this is the identified need for connected sites to allow this population interaction. Hamer (2016) found that the presence of the GGBF at sites at Nowra was dependent on accessibility of ponds, a factor mediated both by the presence of vegetation and the extent of roads in the area, with

the presence of roads providing a likely serious barrier to pond use. The presence of vegetation directly around ponds correlated significantly with the potential for greater species diversity. The type of pond available also was important, with the species avoiding steep sided concrete ponds. The apparent negative impacts of roads was confirmed in follow up work (Hamer 2018) where it was again found that the extent of accessible habitat (habitat close to ponds and not isolated from the pond by a road) positively influenced the likelihood of pond occupancy. Extinctions of GGBF were significantly more likely to occur at ponds in areas with higher densities of roads, but were significantly less likely at ponds with higher aquatic vegetation cover. The spatial arrangement of wetlands and the extent of wetlands measured in a 1 km radius has been found to be an important predictor of pond occupancy by GGBF in studies by Hamer et al. (2002), Hamer and Mahony (2010) and Valdez et al. (2015) with more ponds, ponds in closer proximity and already occupied ponds increasing the potential for the GGBF to be present or occupy a previously unoccupied pond (Puschendorf et al. 2011).

2.1.2. Green-thighed Frog

The habitat requirements of the GTF have received much less attention than the GGBF, but still appear to be moderately well understood. The species is one of only a handful of eastern temperate Australian species that exhibit "explosive" breeding. Males congregate around large, temporary pools that form only after very heavy rainfall events (Barker et al. 1995; Lemckert et al. 2006) and calling generally lasts for only one or two nights and reproduction is highly variable. In the area from Coffs Harbour down to the Central Coast of NSW Lemckert et al. (2006) found breeding sites for the GTF were typically partly or wholly within rainforest or wet sclerophyll forest or in wet gully lines (Lemckert et al. 2006). The species appears to move into more open forests in the northern half of its distribution, but has been rarely recorded in such locations in the southern half of its range.

Lemckert et al. (2006) recorded that the GTF typically call and breed in depressions adjacent to streams (e.g. old billabongs), but that human created depressions, such as flooded road verges or excavated hollows were also used. Most pools contained relatively little emergent vegetation and contained a base made up of leaf litter and woody debris (Lemckert et al. 2006). A couple of known sites located not directly in the native vegetation, but instead immediately adjacent to it.

Based on the work of Ledlin (1997) and Lemckert et al (2006), this species appears to breed essentially only in relatively large ephemeral pools – typically sites that are at least 10 m long, 5 m wide and have water depths of greater than 30 cm. These sites fill only after sustained rains or bursts of heavy rain, usually being identified by falls of over 50 mm and often closer to 100 mm over 24-48 hours. This appears likely to be a response to such a highly specific set of breeding conditions that require sites that will hold water for a sufficiently long period to ensure tadpoles can reach metamorphosis.

The non-breeding habitat use for this GTF has only really been assessed through a radio-tracking study by Lemckert and Slatyer (2002). This study found tracked frogs remained within areas of forest where frogs foraged and moved through low vegetation 59% of the time, at heights between 10 cm and 150 cm above the ground. Daytime shelter sites were either under dense leaf litter or in thick vegetation, both of which provide good camouflage and moist conditions that minimise desiccation risks. The work indicated that cover, in the form of thick leaf litter or dense low vegetation, may be a critical requirement for the survival of the Green-thighed Frog (Lemckert and Slatyer (2002).

3. Site Inspection

Dr Lemckert conducted an assessment of the available habitats in the "Development Area" and 5km buffer zone (in accordance with NSW Biodiversity Assessment Methods, DPIE 2020) with GHD ecologist Arien Quin on the 16th of November 2021. The inspection involved driving around the study area to observe the range of different vegetation and habitat types present within the actual development area as well as any potential breeding habitats located within 200 m of its boundary that frogs in the development area might migrate to for breeding (see Figure 1). A visual inspection was undertaken of water bodies and riparian areas as they were encountered, resulting in stops at 15 locations with the aim being to obtain a detailed understanding of the potential breeding sites (temporary and permanent water bodies) that are present in the study area and assess how suitable these sites are for breeding for either species. The quality of the water bodies present was also assessed for non-breeding breeding habitat for the GGBF and to provide connectivity across the landscape, which is important for the GGBF. The habitats within the surrounding 50-100 m of the water bodies were also assessed for potential foraging and shelter and habitats for the GTF and to allow migration between water bodies for the GGBF. The range of different habitats investigated can be seen in the photo plates provided in Appendix 1.

4. Survey Review

The following documents were reviewed for the surveys conducted in the study area to date:

- Cenwest 2004. Hydro Aluminium Kurri Kurri: Terrestrial Vertebrate Fauna Assessment. Report prepared by Cenwest Environmental Services.
- ELA 2016. Hydro Aluminium Kurri Kurri Biodiversity Certification Assessment Report. Prepared for Hydro Aluminium Kurri Kurri Pty Ltd.
- GHD 2021. Hydro Aluminium Kurri Kurri Pty Ltd Biodiversity Certification Assessment Report. Report prepared by GHD.

The previous survey results were taken into account to consider how well the GGBF had been surveyed overall in the area in the last 10 years (recognising that five years is the typically accepted time-frame that survey data is considered as “current”). The Cenwest (2004) report was looked at to provide some historical context about the presence of the GGBF and the GTF in the study area.

5. Results

5.1. Green and Golden Bell Frog Habitat

The study area contained a range of ponds and streams with still or slow moving pools that could potentially provide suitable breeding habitat for the GGBF. Figure 2 provides a map of the locations of water bodies inspected and examples of these are shown in Plates 2, 4, 9, 10, 11, 12 & 14 that are provided in Appendix 1. These ponds include significant areas of emergent vegetation that the GGBF prefer for daytime shelter and for males to hold onto when calling. These ponds varied greatly in size and were scattered widely across the study area and so provide a mosaic of ponds and pools that are close enough (less than 500 m apart) for GGBF to reasonably easily migrate between.

The study area also includes large areas of suitable non-breeding habitat in the form of ponds with emergent vegetation, creek lines with riparian vegetation and adjacent grassy paddocks with some embedded remnant vegetation. This provides a mosaic of both shelter sites at the ponds and streams and immediately adjacent grassland and open woodland foraging habitat that the frogs can move into each night to forage.

The habitat was assessed as good quality non-breeding habitat but provides compromised breeding habitat as follows:

- The major problem identified in the site inspection was the widespread nature of the Plague Minnow, *Gambusia holbrooki*. This fish was ubiquitous and evident in high density in almost all potential breeding habitats. The presence of this species typically precludes significant reproduction for the GGBF as it eats the eggs and tadpoles, and sites with the Plague Minnow are rarely used for breeding. Only one pond was located that clearly did not have the Plague Minnow, which is the pond shown in Plates 10 and 11.
- Furthermore, permanent streams were also seen to contain large numbers of European Carp (*Cyprinus carpio*) which is a species that also impacts on the GGBF and its breeding through eating the eggs and tadpoles and making the water turbid. Hence the breeding habitat throughout the study area is compromised as breeding habitat for the GGBF.
- In regards to non-breeding habitat, as noted above the area contains a diversity of water bodies that are spread across the landscape and provide good connectivity. This included a range of streams that can form longer movement corridors (e.g. Plates 7 and 8). The presence of the Plague Minnow does not affect the adults and sub-adults and they can move relatively freely in such environments. Furthermore, the presence of a patchwork of native vegetation and cleared paddocks provides good habitat for foraging and shelter for frogs when moving around or between water bodies. So the habitat within the study area is very good non-breeding habitat for the GGBF.

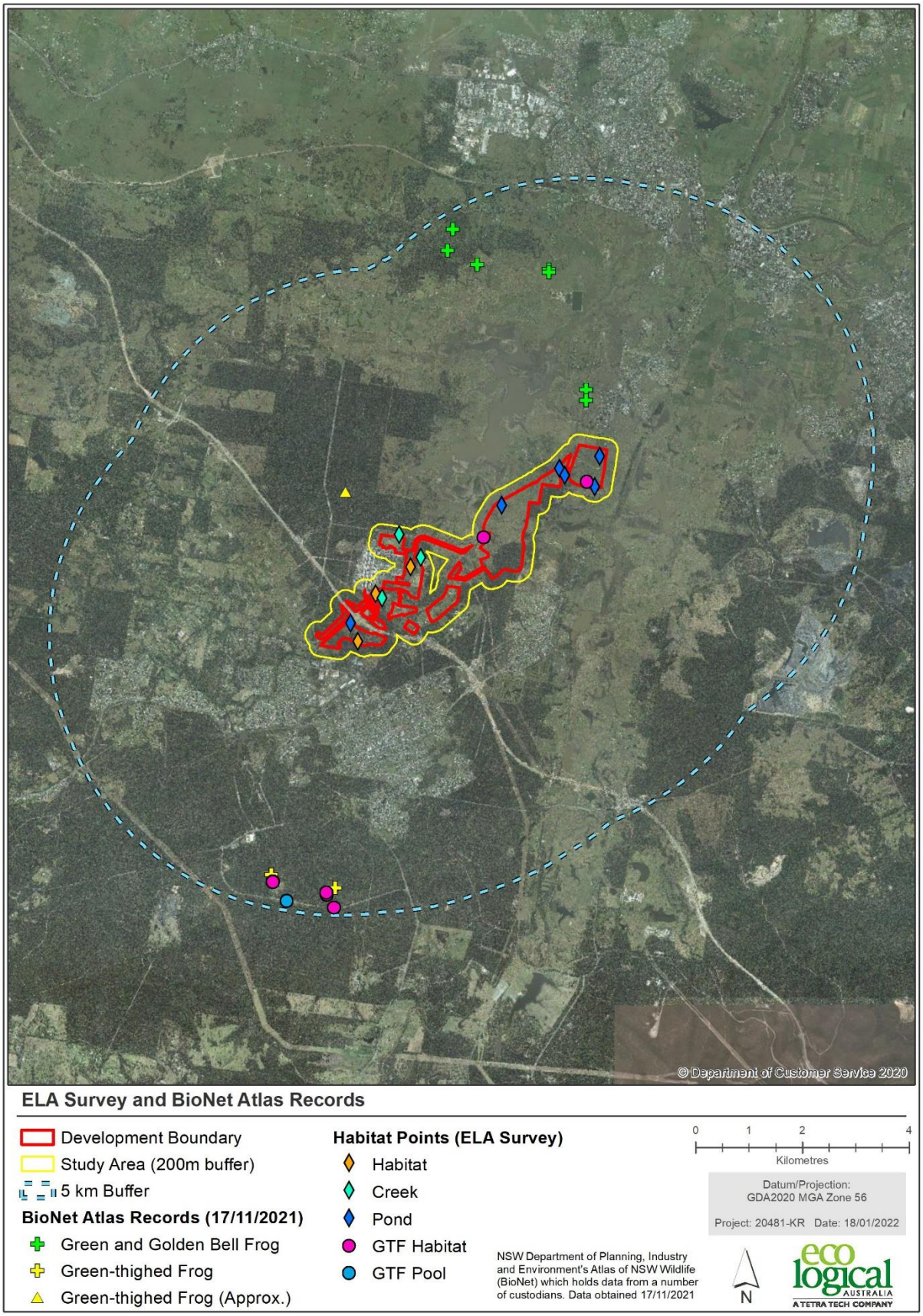

Figure 2. Locations of water bodies and habitat points looked at during site inspection

5.2. Green-thighed Frog Habitat

The study area contains no evident suitable breeding habitat for the GTF. The species requires larger ephemeral water bodies within or adjacent to areas of enclosed vegetation. There were no such areas located anywhere within the areas of habitat that were viewed or would be likely anywhere else. Ephemeral water bodies were actually notable for their absence, despite significant recent rainfalls that should have at least partly filled smaller ephemeral pools and the streams were noted for being full. Only one area within the proposed development footprint showed any similarity to suitable breeding habitat (Plates 13 and 14; northern GTF habitat point in Figure 2). It is an area of more enclosed riparian vegetation with paperbarks that has a moderate shrub layer within that vegetation and the drainage line has a number of ponds. These appear to be semi-permanent however and occur along the flow line and consequently that contain the Plague Minnow. The presence of this pest species again would impact severely on the GTF and it is highly unlikely the GTF would use these locations for breeding.

The site inspection found limited non-breeding habitat for the GTF. Few areas were observed that provided the wetter riparian vegetation that the species appears to require in this part of its range. As the Plates in general show, the environment is mostly paddocks or woodlands to dry eucalypt forests. Plate 5 shows the typical grassy understorey that does not provide the cover that the GTF uses for foraging and shelter.

As a contrast, two known GTF locations were visited in the Kurri Kurri Area (two southern points in Figure 1) to assess the habitat present there. These sites can be seen in Plates 15 and 16 and are very typical of GTF habitat found elsewhere, having a denser shrubby understorey and a good cover of leaf litter. They also contain numerous depressions that can flood after heavy rains and so provide the GTF with its preferred breeding habitat. No such habitat was evident anywhere in the study area.

5.3. Survey Review for the Green and Golden Bell Frog

The survey requirements for GGBF are outlined in the BAM guidelines published after the three listed surveys reviewed (DPIE 2020). The intent of the guidelines is to ensure that surveys are conducted multiple times over a period that will provide differing environmental conditions, and that surveys are conducted during the breeding season to maximise the probability of detection.

The review considered whether the existing survey effort met the intent of the 2020 survey guidelines (DPIE 2020).

The BAM frog survey guidelines provide the following requirements for the GGBF that should be completed over a minimum 14 day period:

Table 1: BAM Survey Guidelines for the Green and Golden Bell Frog (DPIE 2020)

Species		Survey Methods	
Green and Golden Bell Frog, Litoria aurea.		**500m transect of suitable breeding habitat** **50 m2 water surface (tadpoles)**	
Aural-visual surveys	**Nov. – March**	**480 mins**	**4**

Species		Survey Methods	
Acoustic recorder	**Nov. – March**	**154 recorder days**	**1 x 14 days**
Tadpole search	**Nov. – March**	**10 mins/50 m2 of surface area**	**Up to 2**

Survey methods: Aural-visual or acoustic recorder surveys can be completed along the edges of suitable breeding habitat or, if feasible, through shallow wetlands. Tadpole surveys can be used to replace up to two of the aural-visual surveys. Tadpole searches should target areas of shallow and open water where the tadpoles are likely to congregate. If the plague minnow (*Gambusia holbrooki*) is present this method is not recommended. The presence of the plague minnow should be recorded.

Surveys should sample the available range of waterbodies on the subject land. Sweep netting should target areas of open water.

Potential habitat: Suitable breeding and non-breeding shelter habitat consists of any waterbody with emergent aquatic vegetation and without the plague minnow (*Gambusia holbrooki*), although the green and golden bell frog will still occasionally breed in sites with this introduced pest fish. Foraging habitat and migratory habitat are areas of native and non-native vegetation.

The guidelines also state the following in regards to survey conditions:

> **2.5 OPTIMISE THE METEOROLOGICAL CONDITIONS FOR THE SURVEY**
>
> *Frogs are particularly responsive to climatic conditions. Being ectotherms with permeable skin makes them prone to desiccation and lower activity during cooler, dry conditions. Surveys during dry, windy and/or cold conditions, when frogs reduce activity, should be avoided. Note that windy conditions not only desiccate frogs, but also disperse calls. Calling is energetically costly for males and they will reduce calling in conditions that minimise breeding opportunity.*

5.3.1. GHD surveys

The review of the surveys conducted previously by GHD indicated that call playback surveys targeting GGBF and GTF were completed on the 26th of November 2019 and between the 24th and 28th of February 2020. The report indicates also that this resulted in a total of five hours of amphibian surveys. This covers the correct survey period for the GGBF. The report states that only two constructed detention ponds would be impacted by the development and surveys targeted those two locations. If that is the case then the level of effort provided would be adequate for the detection of frogs at these two ponds and the surveys were spread over an extended period of time that would assist in detecting the species. However, other ponds and streams were evident within the development area and would potentially be impacted by any proposed works. These appear to have only been the subject a much reduced survey effort. If development will impact potential breeding habitat outside the two ponds and identified as

potential GGBF habitat in this assessment then the level of survey effort has not been to the usually accepted level.

No GGBF were recorded through the GHD survey (GHD 2021).

GHD also conducted active searches of woody debris, loose bark and other ground litter throughout the subject site targeting threatened frogs for a total of five person hours. This method is unlikely to produce records for the GGBF, which stays close to water bodies, and so does not provide any greater certainty for determining the presence/absence of the species.

In regards to the conditions at the time of the surveys, the GHD report (GHD 2021) notes that:

The Kurri Kurri area received approximately 47 mm of rainfall the week prior to the 24 – 28 February 2020 fauna surveys. In addition, there was a further 9 mm of rain recorded during the February surveys. Although the site was still considerably dry as a result of long term drought, these rainfall events resulted in suitable conditions to complete frog surveys within the site".

This level of rainfall would likely have resulted in any GGBF present becoming active and initiate foraging and dispersal between nearby water bodies. This would have made them more easily spotted during visual searches of water bodies. It is not likely that this level of rainfall would have initiated calling activity based on the observation that the site was still dry. The GGBF will preferably used flooded and ephemeral areas for breeding and these would not have been available for breeding under these conditions. The dry conditions would also likely have curtailed the movements of frogs to more distant ponds to initiate breeding as the dry ground would have desiccated individuals and the absence of pooled water would not have provided sites to re-hydrate. So calling seems unlikely to have occurred and assisted in detecting the species. However, it is noted that the species is relatively easy to detect at water bodies regardless of calling activity.

5.3.2. Eco Logical Australia surveys

Eco Logical conducted aural-visual surveys with call playback between the 26th of November 2014 and the 29th of January 2015. The report detailing this work (ELA 2016) notes that this survey targeted lentic habitats and associated vegetation broadly within this study area and were conducted over 6 separate nights. Calls of the GGBF were played at each location for a minimum of 5 minutes followed by at least 5 minutes of listening, repeated at least once. Aquatic vegetation in the water bodies and bank areas were then searched by torchlight over a minimum of 1 hour.

The timing of the ELA surveys fits into the appropriate survey period but the actual number of nights surveys were conducted at any one site was not specified. The indications were that sites were surveyed between 1 and 3 nights each. This provides some level of replication between sites and the effort put in of more than one hour per site would likely be adequate for the size of water bodies evident in the study area. The report does note that the water storage areas within and adjacent to the smelter were surveyed for three nights, which would be the same ponds targeted by GHD. Therefore, those sites were surveyed on multiple occasions over the two studies. It is noted that these surveys were completed more than five years ago and so do not meet the standard accepted requirement of occurring within the last five years if they are to be used in assessments.

No GGBF were located through the ELA surveys, which is consistent with the records that the GGBF has not been detected for more than 10 years and is considered broadly absent from this part of the Hunter Valley.

A nocturnal driving transect was conducted by ELA through the study area on the night of 16 December 2014 to detect amphibian and reptile species foraging on or crossing roads. Again, this survey method does not really provide a significant addition to the detection rates of the GGBF.

5.3.3. Cenwest surveys

The surveys conducted by Cenwest in 2004 provided for reptile and amphibian surveys at 10 sites in spring and autumn and with a specific targeted amphibian survey conducted from the 21st to the 26th of November 2003 after a significant rainfall event. The methods are not described in clear detail as to what methods were undertaken at each point or how much effort and the number of repeat surveys were conducted for each point. Hence it is not possible to understand the true survey effort completed. These surveys also did not detect the GGBF at any location, although GTF were collected in a pitfall trap to the north of the study area. It would appear at least that the GGBF was not present in any significant number even at this time.

6. Discussion

6.1. Presence of the Green and Golden Bell Frog

The surveys indicated there is no current high quality breeding habitat present for the GGBF in the study area. Despite there being many potential water bodies present for breeding, the presence of the Plague Minnow and Carp means that it is unlikely that the GGBF can successfully breed in the area and that the ponds in general are constantly re-stocked with fish as a result of floodwaters entering them. Only one pond was located that may have been free of introduced fish, which provides little opportunity for the species to maintain a population, even though there is ample habitat for foraging and shelter and the ponds and creeks appear to provide good connectivity.

Furthermore, the GGBF is now found almost exclusively in locations 10 km of less (Mahony et al. 2013) from the coast, presumably due to the effects of the amphibian chytrid fungus that is attenuated by the presence of salt in the environment. The location of the study area is well beyond 10 km from any salt water and this correlates well with the absence of records for the GGBF in the broader (10 km radius) locality over the last 10 years, with the last record on BioNet for the locality being from 2008. The indications are that all populations in the Hunter Valley away from the coast are likely to be extinct. A discussion with Dr Michael Mahony indicated that the Gillieston Heights population was present prior to the development of the area, but that there were no known records in recent times, which fits with a failure to detect the species by the most recent surveys. This all suggests that the GGBF is no longer present in the study area due to a combination of the effects of the chytrid fungus, the presence of introduced fish and land development. Until pests and disease are controlled it is unlikely that the species can re-establish itself in the study area, even with otherwise favourable habitat being present.

6.2. Presence of the Green-thighed Frog

The habitat assessments indicated that there is not suitable breeding habitat for this species within the study area. The GTF relies on larger and longer-lasting ephemeral ponds located within area of wetter forest with dense understorey and leaf litter. Such habitats were not seen present anywhere during the inspection. The habitats available contrasted markedly with the habitats present at two reference sites visited some 10 km to the south of the study area, where there was a clearly suitable environment of depressions that could flood located within areas of riparian vegetation with a denser ground cover. This indicates that the GTF would not breed within the study area.

The records of two individuals caught in a pitfall trap by Cenwest (2004) demonstrate that the species is or at least has been present within the locality. However, these are the only records from close to the study area and are > 500 m from the proposed development site. The absence of any suitable breeding habitat within the study area or within 200 m of it would indicate that the GTF does not use the study area for any important activities as part of its life-cycle. It is expected to typically travel no more than 100-200 m from its breeding site and breeding habitat is not located close enough to the study area to expect any frogs to use the available habitats on any more than a very irregular and transient basis.

6.3. Previous Surveys for the Green and Golden Bell Frog

The previous surveys for the GGBF carried out by GHD and Eco Logical Australia provided a moderate level of effort to detect the GGBF on the site. They were carried out at the correct time off the year and used methods recognised as suitable to detect the GGBF. The effort placed into each site does not generally meet the standard of survey effort recommended under the current BAM guidelines, but this was not a requirement at the time of the studies being undertaken.

Both studies provide some replication of survey effort at some of the potential GGBF breeding sites and extended their surveys over multiple periods that would have assisted in reducing the potential for the survey conditions alone to cause a negative result.

The meteorological conditions that the surveys were carried out under were varied and would likely have been suitable for GGBF to be active, although it was likely the GGBF would have been calling through the GHD surveys as conditions were dryer. However, and as previously noted, this species is usually detected visually even when not calling and so would be expected to have been detected if it was present.

The skill and experience of the surveyors is the main other consideration in the studies completed. My understanding is that the surveys for GHD were completed by Ben Lewis and Luke Obrien and both of these ecologists have demonstrated knowledge and experience in surveying for GGBF and GTF. The surveyors used by ELA included Daniel McKenzie and Antony Von Chrismar who both have significant experience with frog surveys. Therefore both teams of surveyors had sufficient skill and experience to be expected to find GGBF and GTF if the effort and conditions were appropriate.

Of specific relevance however is Section 6.1 of this report that provides a consideration of the potential for the GGBF to be present within the study area given the noted extinctions away from coastal areas since the 1990s resulting from the amphibian chytrid fungus.

7. Conclusion

The study area contains a range of water bodies that could provide breeding habitat for the GGBF and that includes streams, pools and ponds.. The number and location of water bodies present in the study area indicates also that there is good landscape connectivity that the GGBF prefers. However, the widespread presence of introduced predatory fish and particularly the Plague Minnow indicates that suitable breeding habitat is highly constrained for the GGBF and there is little chance for consistent successful breeding to take place to maintain a local metapopulation.

In addition, the location of the study area more than 10 km from a coastal location strongly suggests that any local metapopulation of the GGBF will have been and would continue to be affected by the amphibian chytrid fungus that has caused extinctions of populations of the GGBF across its range. It is most likely that the local population is currently extinct as a result of the effects of the chytrid fungus. This correlates with the absence of any records for this species from locality since 2008 and it is reasonable to conclude that the GGBF is no longer present in the study area.

The survey efforts completed for the GTF by both GHD and Eco Logical Australia were not undertaken after periods of sufficiently heavy rainfall to expect this species to be detected. However, the habitat assessment indicates a lack of potential ephemeral breeding sites being present within the study area. The alternative reference sites provide for habitat that is not present in the study area, even though the species has previously been recorded within 1-2 km to the north of the study area by Cenwest in 2004. It is considered that the GBF does not use the study area to support any important parts of its life-cycle.

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APPENDIX 1: PLATES OF SITES AND MAP OF PLATE LOCATION

Plate 1. Woodland vegetation on the study site.

Plate 2. Large reed filled water body that is suitable breeding habitat for the Green and Golden Bell Frog except for the presence of the Plague Minnow.

Plate 3. Typical dry woodland lower storey vegetation and ground cover lacking shrubs and thicker layer of leaf litter.

Plate 4. Permanent ponded area present in study area that is suitable for breeding for the Green and Golden Bell Frog except for the presence of the Plague Minnow. Note the presence of large areas of emergent vegetation.

Plate 5. Grassy woodland habitat typical of areas with retained native vegetation.

Plate 6. Dense regenerating understorey with litter and some shrub cover, but without suitable breeding habitat for the Green-thighed Frog.

Plate 7. Permanent creek in study area that contained the Plague Minnow.

Plate 8. Stream running through study area that contained the Plague Minnow and European Carp.

Plate 9. Ponded water within cleared fields within the study area

Plate 10. Pond at Gillieston Heights (note housing development in background).

Plate 11. Edge of pond at Gillieston Heights.

Plate 12. Large permanent pond in study area. Note pond has little emergent vegetation making it less suitable Green and Golden Bell Frog habitat.

Plate 13. Large permanent pond within best, but still not adequate, Green-thighed Frog habitat. Note the better canopy coverage.

Plate 14. Wetter riparian habitat in the study area that provided the best, but still not adequate habitat for the Green-thighed Frog. Note the leaf litter, but still not good shrub layer

Plate 15. Example of known Green-thighed Frog breeding habitat located 10 km to the south of the study area. Note the denser canopy and depressions with leaf litter.

Plate 16 Example of known Green-thighed Frog breeding habitat located 10 km to the south of the study area showing filled depressions and thicker shrub layer.

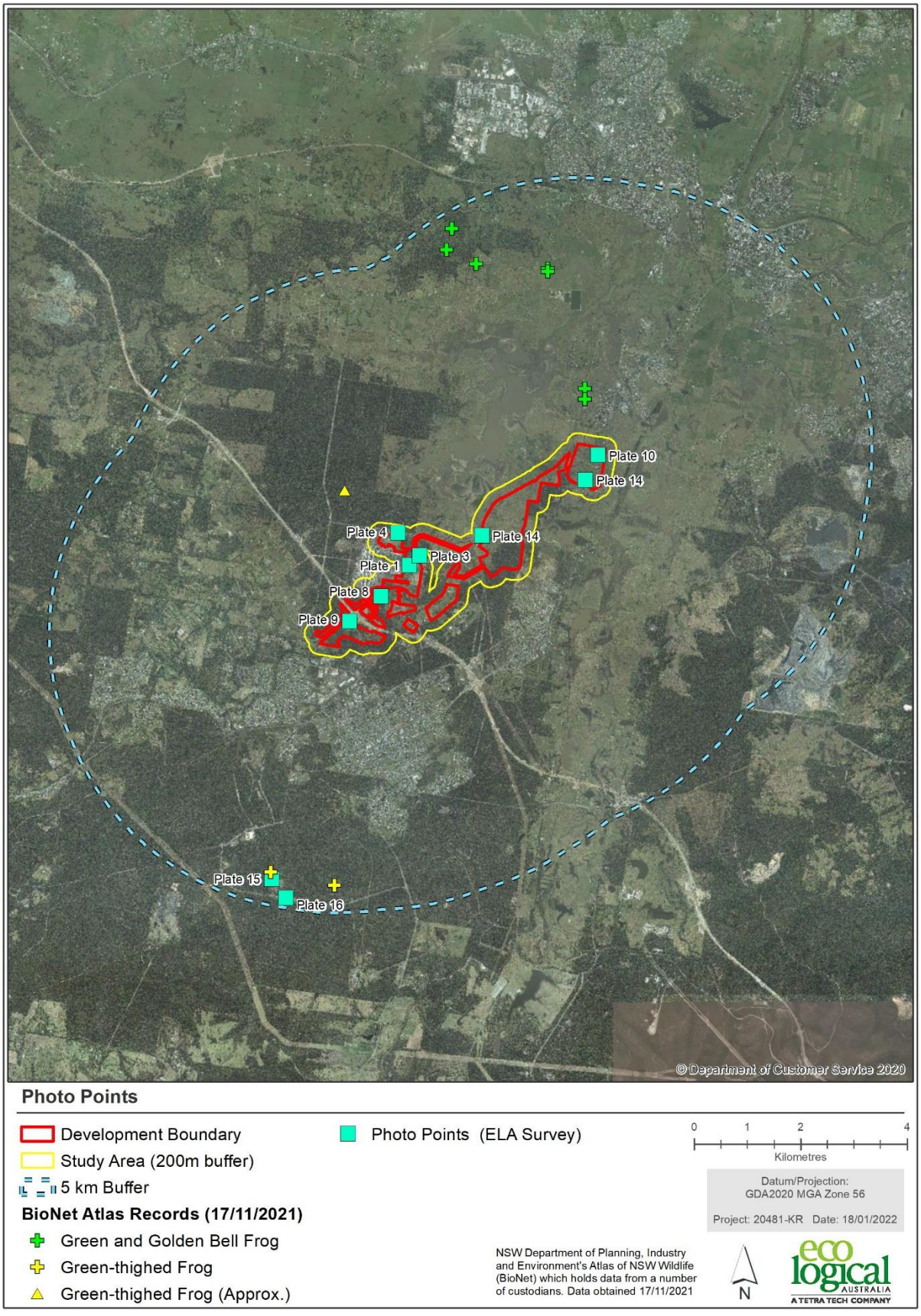
Plate 10
Plate 14
Plate 4
Plate 14
Plate 3
Plate 1
Plate 8
Plate 9
Plate 15
Plate 16
© Department of Customer Service 2020
Photo Points
Development Boundary
Study Area (200m buffer)
5 km Buffer
BioNet Atlas Records (17/11/2021)
Green and Golden Bell Frog
Green-thighed Frog
Green-thighed Frog (Approx.)
Photo Points (ELA Survey)
0 1 2 4
Kilometres
Datum/Projection:
GDA2020 MGA Zone 56
Project: 20481-KR Date: 18/01/2022
NSW Department of Planning, Industry and Environment's Atlas of NSW Wildlife (BioNet) which holds data from a number of custodians. Data obtained 17/11/2021
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Appendix F – Expert report for Swift Parrot and Regent Honeyeater

Hydro Swift Parrot and Regent Honeyeater important habitat expert assessment

Dr Ross Crates

Executive summary:

GHD Pty. Ltd. engaged Dr Ross Crates on behalf of Hydro Aluminium Pty Ltd. to undertake an expert assessment of important habitat for Swift Parrot (*Lathamus discolour)* and Regent Honeyeater (*Anthochaera phrygia)* as part of the supporting documents to the Biodiversity Certification Assessment report for the Hydro development site located at Kurri Kurri, NSW. The proposed development footprint contains 68.6 Ha of mapped important habitat for the Swift Parrot and 50.6 Ha of mapped important habitat for the Regent Honeyeater.

Aims:

- Undertake a comprehensive assessment of vegetation condition within the Hydro development footprint mapped as important habitat for Regent Honeyeater and / or Swift Parrot.
- Undertake habitat and targeted bird surveys within the Hydro development footprint mapped as important habitat for Regent Honeyeater and / or Swift Parrot.
- Refine the important habitat mapping for both species based on field surveys and expert elicitation such that only important habitat for either species is included in the mapping.
- Undertake habitat assessments and bird surveys within the proposed Hydro Biodiversity Stewardship Site. Refine the important habitat mapping based on the results of the field surveys and expert elicitation to determine the quantity of important Regent Honeyeater and Swift Parrot habitat contained within the proposed Biodiversity Stewardship Site.
- Undertake an assessment of serious and irreversible impacts of the proposed Hydro development on the Swift Parrot and Regent Honeyeater based on the results of the revised important habitat mapping for both species.

Results

- The proposed development will result in the loss of 47.55 Ha of important Swift Parrot habitat and 34.63 ha of important Regent Honeyeater habitat.
- These figures represent 0.042 % and 0.006 % of the mapped important habitat for the Swift Parrot and Regent Honeyeater in New South Wales, respectively.
- The proposed Hydro Biodiversity Stewardship Site will protect in perpetuity approximately 607.25 Ha of important Swift Parrot and Regent Honeyeater habitat.
- A serious and irreversible impact statement regarding the potential impact of the proposed Hydro development on both the Swift Parrot and Regent Honeyeater accompanies this document.

Caveats to the report.

- The expert advice in this report is provided on the understanding that all possible measures have already been taken in the planning process to first avoid and second to minimise potential impacts to Swift Parrot and Regent Honeyeater as is required under the NSW *Biodiversity Conservation Act 2016* and the *Local Land Services Act 2013*.
- Bird surveys were undertaken outside of the period Swift Parrots are present on mainland Australia. Bird survey data provided in this report cannot be used to infer absence of Swift Parrots from the site.
- Due to a lack of data availability and uncertainty surrounding future planning approvals, the report does not assess potential cumulative impacts of the loss of important Swift Parrot and Regent Honeyeater habitat that may occur as a result of multiple development approvals both within the Lower Hunter region or further afield. However, it is acknowledged that cumulative impacts arising from piecemeal loss if mapped Swift Parrot and Regent Honeyeater habitat should be taken into consideration.

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1 Introduction

1.1 Swift Parrot and Regent Honeyeater population status and requirement for an expert report.

The Swift Parrot and Regent Honeyeater are listed as Critically Endangered under the *Environmental Protection and Biodiversity Conservation Act* (Department of the Environment 2015, 2016), having undergone rapid population decline in recent decades.

The Hydro site at Kurri Kurri contains mapped important habitat for both species, with 68.6 and 50.6 Ha of mapped important Swift Parrot and Regent Honeyeater habitat falling within the proposed development footprint, respectively. The important habitat mapping for both species is based on remotely-sensed vegetation data in New South Wales, and is constructed based on buffers of confirmed sighting/breeding locations. Therefore, the mapping potentially includes habitat that does not in reality constitute important habitat for either species, and also potentially omits habitat that does represent important habitat for either species.

Following a review of the draft Biodiversity Certification Assessment Report (BCAR), the Biodiversity Conservation Division (BCD) requested a recognised expert of both species undertake habitat assessments and surveys to quantify the condition, extent and relative importance of habitats within both the proposed Hydro development footprint and the proposed Biodiversity Stewardship Site, such that potential impacts of the proposed Hydro development can as much as possible avoid, minimise and offset any potential impacts on the Swift Parrot and Regent Honeyeater.

1.2 Background information- Swift Parrots and Regent Honeyeaters in the Tomalpin Woodlands near Kurri Kurri.

The woodlands of the lower Hunter Valley are one of the most important areas in the country for Swift Parrots and Regent Honeyeaters (Commonwealth of Australia 2011, 2016). Most records of both species within the locality occur to the south-west of the Hydro site (Figure 1), reflecting a higher proportion of wooded/forested habitat in that area. Although habitats of the Lower Hunter Valley are used in many years, they are particularly important for both species as drought refugia, when conditions are less suitable in more western parts of their ranges (Saunders & Heinsohn 2008).

There are four contemporary records of Swift Parrots within 2km of the proposed Hydro development boundary (Figure 1). The closest Regent Honeyeater record is approximately 2.8km away. Hydro is private property, so it is noted that a lack of Regent Honeyeater or Swift Parrot sightings within the development footprint could be in part due to low observer coverage in the area.

In 2020 and 2021, a total of 80 captive-bred Regent Honeyeaters have been released in the Lower Hunter valley, approximately 4.5km south-west of the Hydro site (SWIFFT 2021).

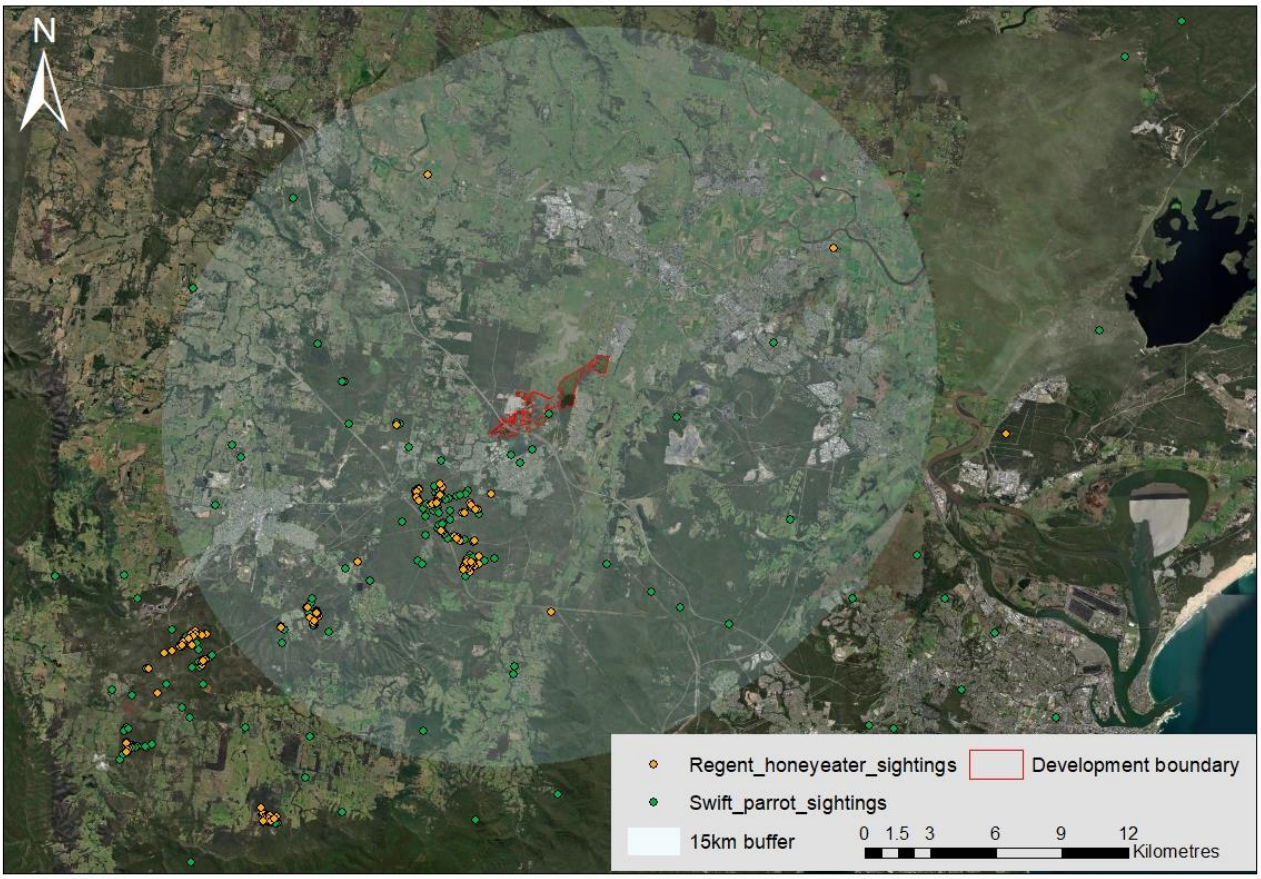

Figure 1: Location of Swift Parrot and Regent Honeyeater sightings since 2010 in the lower Hunter Valley with respect to the Hydro development footprint. Source: BirdLife Australia.

2: Assessments of mapped Swift Parrot and Regent Honeyeater habitat within the proposed Hydro development footprint

2.1 Methodology

2.1.1 Habitat assessments

Five days of field surveys, focussed on areas within the Hydro development footprint intersecting mapped important habitat for the Regent Honeyeater and/or Swift Parrot (Figure 2), were undertaken. A total of 74 habitat assessment sites were established within the proposed development footprint during this period (Figure 2). An additional three days of field surveys were conducted within the proposed Hydro Biodiversity Stewardship Site (BSS), where 45 habitat assessment sites were established. Further information on the methodology used within the BSS is provided in section 4 of this report.

The habitat assessments collected the same data as collected at survey sites for the National Regent Honeyeater and Swift Parrot Monitoring Programs (NRHMP & NSPMP, Crates et al., 2017) coordinated by the Australian National University and BirdLife Australia. The survey site is defined as a 50m radius surrounding the survey location. The data collected are outlined in Table 1. One to two photographs were taken at each habitat assessment site to provide a visual representation of the vegetation community, structure, composition and condition within the site. Of the habitat data collected, particular focus was paid to the habitat features outlined in Table 2 (Crates et al. 2017).

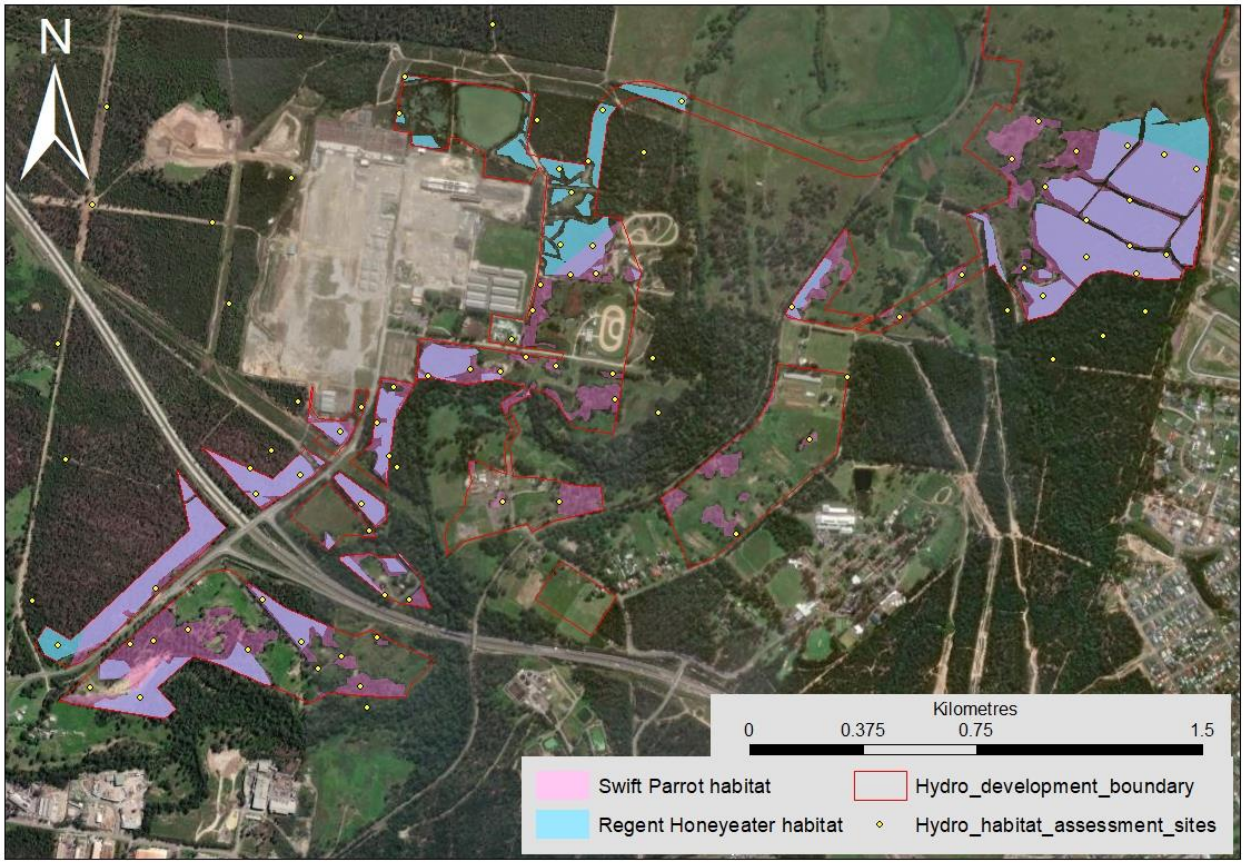

Figure 2: Location of habitat assessment sites with respect to BAM mapped important habitat for the Swift Parrot and Regent Honeyeater within the Hydro development proposal footprint, Kurri Kurri. Note that Regent Honeyeater mapped habitat overlapping with Swift Parrot mapped habitat appears as lilac colouring under semi-transparent Swift Parrot habitat, rather than light blue.

Table 1: Habitat covariates collected at each habitat assessment site within the Hydro development footprint.

Covariate	Description	Citation
Spatial location	WGS84 decimal latitude longitude to 2m accuracy	(Webb et al., 2014)
Canopy cover	Canopy cover to the nearest 5%.	(Mac Nally et al., 2000)
Tree species	Proportional contribution to total canopy cover of each tree species present.	(Downey, 1998)
Tree age	Proportion of trees present defined as young, immature, mature or old growth based on diameter and breast height (DBH).	(Downey, 1998; Griebel et al., 2017)
Tree health	Proportion of trees in the site that are: dead, dying, stressed, mildly stressed or healthy.	(Nolan et al., 2021)
Shrub cover	% shrub cover (vegetation height 30cm to 2m) to the nearest 5%	(Maron et al., 2011)
Live mistletoe	Total number of clumps of live mistletoe across all mistletoe species	(Watson & Herring, 2012)
Woody debris	4-level factor: 0 = no coarse woody debris, 3 = abundant woody debris	(Ford, 2011)
Distance to standing water	6-level factor: 0 = water present within site, 4 = water >300m away, 5 = unknown	(Crates et al., 2017)

Table 2: Habitat features of particular relevance when determining potential importance to Swift Parrots and Regent Honeyeaters.

Habitat feature	Justification	Relevant species	Citation
The proportion of mature or old growth trees*	Regent Honeyeaters and Swift Parrots tend to prefer to nest and forage in old growth trees where available. Larger trees flower more profusely or for longer periods, thus providing a reliable nectar resource for both species.	Both	Commonwealth of Australia 2016
Presence/absence of long-flowered mistletoe *Dendropthoe vitellina*	Long-flowered mistletoe is a key nectar resource and breeding substrate for Regent Honeyeaters in the Tomalpin woodlands. Most records of Regent Honeyeaters in the lower Hunter Valley are in areas with a relatively high abundance of *D. vitellina*.	Regent Honeyeater	Roderick et al., 2014
Proportion of key feed tree species (nectar-producing or lerp-hosting) within associated plant community types	Within associated plant community types, the proportion of key feed tree species may be relatively minor. Key feed tree species may be absent from some sections of mapped important habitat within the development footprint.	Both	NSW DPIE 2016
Tree health/vegetation condition.	Within associated plant community types, tree health may render habitat unviable if most trees are dead or dying.	Both	Nolan et al. 2021

*Old growth trees are defined here as those with a diameter at breast height exceeding 1 metre.

A total of 82 survey sites were assessed, throughout the mapped habitat for Regent Honeyeaters and Swift Parrots within and surrounding the proposed development footprint (Figures 2 & 11).

2.1.2 Bird surveys.

A total of 119 bird surveys were undertaken at 99 habitat assessment sites across the development footprint (n = 74 sites) and the Biodiversity Stewardship Site (n = 45 sites) between October and December 2021. Repeat

surveys were conducted at 20 sites within the proposed development footprint where blossom was found to be present. Surveys followed the methodology used for the NRHMP and NSPMP (Crates et al., 2017). Surveys lasted five minutes, with the abundance of all bird species detected visually or aurally within 50m of the site location recorded. A simple factorial score of local blossom abundance from zero (no blossom) to four (very heavy blossom) was also recorded. Bird surveys were repeated at some sites in November 2021 when key *Eucalyptus* or *Corymbia* feed trees were in blossom to increase the probability of detecting any Regent Honeyeaters present within the development footprint. Note that bird surveys were conducted outside of the period Swift Parrots are present on mainland Australia (i.e. May-September, Higgins 1999).

In addition to potentially determining the presence of Regent Honeyeaters within the development footprint, data from bird surveys can provide useful information on the presence of other specialist woodland bird species. The specialist woodland bird species considered as surrogates / indicators of important habitat for Swift Parrots or Regent Honeyeaters within the lower Hunter Valley were:

- Brown Treecreeper *Climacteris picumnus*,
- Black-chinned Honeyeater *Melithreptus gularis*
- Fuscous Honeyeater *Lichenostomus fuscus*
- Dusky Woodswallow *Artamus cyanopterus*
- Little Lorikeet *Glossopsitta pusilla*.

Presence of these surrogate species can indicate relatively high-quality habitat and provides indirect evidence that these habitats could at times be exploited by Regent Honeyeaters or Swift Parrots.

2.2 Refinement of mapped important Regent Honeyeater and Swift Parrot habitat.

Important habitat mapping for Swift Parrot in New South Wales is based on remote vegetation classification and buffering of the location of confirmed Swift Parrot sightings. A 2 km radial buffer is placed around areas with five or more Swift Parrot records, where observations have occurred over two or more years and are within 2 km of one another, or areas with a single record of 40 or more birds (NSW DPIE 2020). For Regent Honeyeaters, a 5 km buffer is placed around confirmed breeding records, and a 1 km buffer around foraging records of any number of individuals (NSW DPIE 2021).

This mapping methodology is necessary given the vast wintering and breeding range of the Swift Parrot and Regent Honeyeater, respectively within NSW. However, it means that at a finer scale, the mapping could include areas that in reality are very unlikely to represent potential foraging habitat for either species, or breeding habitat for the Regent Honeyeater. Conversely, other areas that do represent potential important habitat for either species may not be included within the mapping. Fine-scale field validation and refinement of the Swift Parrot and Regent Honeyeater important habitat mapping within the proposed Hydro development area by a species' expert is therefore an important step to ensure that 'the avoid, minimize and offset' procedure (NSW DPIE 2019) is implemented as effectively as possible.

The proposed Hydro development footprint contains 68.6 Ha of mapped important Swift Parrot habitat and 50.6 Ha of mapped important Regent Honeyeater habitat (Figure 2). The important habitat mapping for both species was refined based on the results of field habitat assessments, bird surveys and expert opinion.

The approach to refine the important habitat mapping was to construct new shapefile polygons of areas that were mapped as important habitat within the proposed development footprint for the Swift Parrot and/or Regent Honeyeater. These new numbered polygons (n = 57) outline areas that, in the expert opinion of the author, should not be included as important Swift Parrot or Regent Honeyeater habitat, with accompanying justification and supporting images.

The revised mapping shapefile accompanies this report, within the 'mapping' sub-folder under the name 'Hydro_mapped_important_swift_parrot_regent_honeyeater_habitat_to_remove_from_development_boundary.shp'. Note that the revised mapping does not account for any required buffers around mapped important habitat for either species.

3. Results

3.1 Bird surveys

Blossom was present at 52 of the 119 site surveys, with the majority of blossom occurring in either *E. fibrosa, E. parramattensis* or *Callistemon* sp.

No Regent Honeyeaters were detected during bird surveys. Only two indicator species (Little Lorikeet and Fuscous Honeyeater) were detected at five of 54 sites within the proposed development footprint and five sites within the proposed stewardship site (Table 3). The raw bird survey data is provided in supplementary file S2.

Table 3: Summary of Regent Honeyeater and other indicator species detected at bird monitoring sites within the Hydro development footprint and Stewardship site.

Species	Development footprint (54 sites, 74 surveys)	Stewardship Site (45 sites, 45 surveys)
Regent honeyeater	0	0
Little lorikeet	3	4
Fuscous honeyeater	2	1
Dusky woodswallow	0	0
Brown treecreeper	0	0
Black-chinned honeyeater	0	0

3.2 Swift Parrot and Regent Honeyeater habitat within the Hydro development footprint- Overview.

The former Hydro Aluminium site is located within one of the most important areas in the country for the Regent Honeyeater and Swift Parrot, with multiple records of both species occurring within 15km of the development footprint over the past decade (Figure 1). Vegetation communities within the Hydro development footprint are highly variable, however, and generally speaking the habitats within the Hydro development footprint are of low to moderate importance for both species, relative to other known important sites for both species within the lower Hunter Valley, such as Werakata National Park and the Hunter Economic Zone (Roderick et al. 2014). Variability in habitat quality within the Hydro development footprint is explained primarily by soil type, stand age, tree health and vegetation community type.

3.3 Areas to be removed from important habitat mapping.

Results of the field surveys led to the suggested removal of 57 vegetation polygons, totalling 27.3 Ha of mapped important habitat for the Swift Parrot and / or Regent Honeyeater (Figure 3). The polygons for removal intersected with 21.05 Ha of mapped Swift Parrot habitat and 15.97 Ha of mapped Regent Honeyeater important habitat. The proposed Hydro development footprint therefore intersects with 47.55 Ha of important Swift Parrot habitat and 34.63 Ha of important Regent Honeyeater habitat. Explanations as to reasons for removal from important habitat mapping are provided in Table 4.

The proposed revisions to the important habitat mapping for the Swift Parrot and Regent Honeyeater, described below, are based on field surveys of habitats within the development footprint. The primary reasons why some areas of mapped important habitat for both species are suggested to be removed from the mapping include:

- A lack of canopy cover: Some mapped habitat has been historically cleared, whilst in other areas there is no mature canopy cover present.
- Errors in the remote vegetation classification: Some mapped habitat contains non-native, planted vegetation, whilst in others key feed tree species within mapped important plant community types are absent or only form a very small proportion of the total canopy cover.
- Poor tree health: In some areas, trees are predominantly in poor health, are dead, or have been subject to historically high levels of disturbance.

- A lack of key habitat features or surrogate bird species: Long-flowered mistletoe is a key breeding resource for Regent Honeyeaters within the lower Hunter Valley (Roderick et al. 2014), however field surveys revealed that all mistletoe species are extremely scarce within the proposed Hydro development footprint. Bird surveys found that other threatened species that can serve as indicators of potential Regent Honeyeater or Swift Parrot habitat were either not detected or were sparsely-distributed at low abundances within the development footprint.

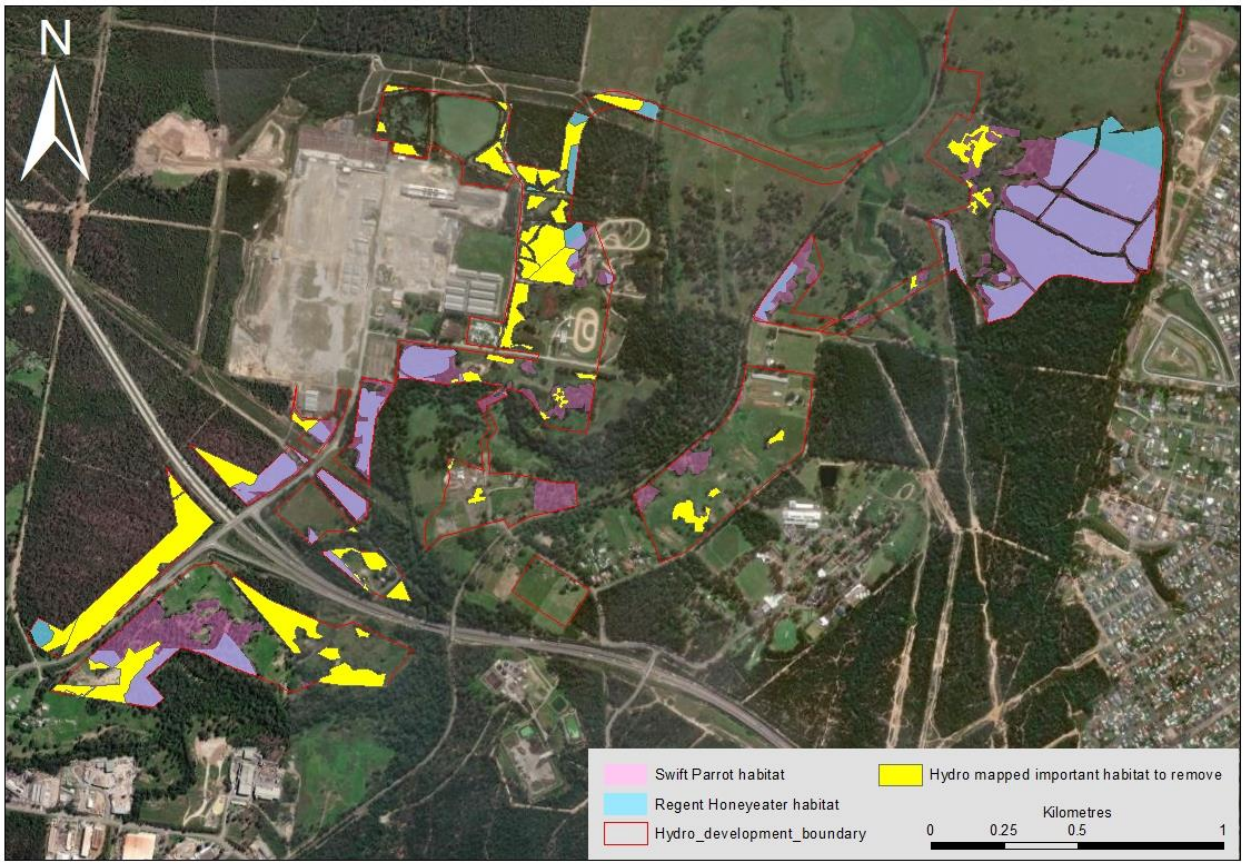

Figure 3: Proposed areas to be removed from Swift Parrot and / or Regent Honeyeater important habitat mapping within the proposed Hydro development footprint following field assessments. Note that Regent Honeyeater mapped habitat overlapping with Swift Parrot mapped habitat appears as lilac colouring under semi-transparent Swift Parrot habitat, rather than light blue.

Mapped important habitat for Regent Honeyeaters and/or Swift Parrots within the development footprint to be retained is shown in Figure 3. The areas include patches of mature woodland or forest, predominantly comprising the key Regent Honeyeater and Swift Parrot feed tree species of grey gum (*Eucalyptus punctata),* coastal grey box (*E. moluccana*), broad-leaved ironbark (*E. fibrosa*), cabbage gum (*E. amplifolia*) or stringybark spp (Figure 4). Spotted gum (*Corymbia maculata*) is only very sparsely distributed within the proposed development footprint. In addition to producing nectar when in blossom, *E. punctata, E.moluccana* and *E.amplifolia* are also known to host lerp (Psyllid spp.), infestations of which could provide both Swift Parrots and Regent Honeyeaters with additional food resources even when key feed tree species are not in blossom.

Figure 4: Areas of important mapped habitat for Swift Parrot and / or Regent Honeyeater within the Hydro proposed development footprint. Images obtained from habitat assessment sites HYD.001, HYD.043 and HYD.060.

Figure 5: Example polygons of mapped important Swift Parrot or Regent Honeyeater habitat that is suggested to be removed from the mapping. Top: Polygon #26, HYD.063. Habitat already cleared. Middle: Polygon 55, HYD.034. Largest trees dead, no mature canopy cover remaining. Bottom: Polygon 23, HYD.064. Primarily non-native vegetation.

Table 4: Polygons to be removed from the important habitat mapping for the Swift Parrot and Regent Honeyeater within the proposed Hydro development footprint.

Polygon No.	Species	Closest survey site	Canopy cover	Ppn. mature / old growth trees	Long-flowered mistletoe abundance	Ppn. Key feed tree species	Ppn healthy trees	No. surrogate Species detected	Comments
32	SP	HYD.048	5	0	0	0	100	0	This is young *Casuarina sp.* and does not constitute Swift Parrot foraging habitat.
33	SP	HYD.048	5	0	0	0	0	0	The small section has been previously cleared. There are no trees to the west of the track.
34	SP RH	HYD.028	35	30	0	40	90	0	Mapped as Swift Parrot habitat but the vegetation community is *E. parramattensis* and *A. bakeri*. Images from HYD.028 show this is primarily low-shrubby forest with a dense understorey of *Melaleuca* sp. on poor quality sandy soil. While this PCT is an EEC in and of itself, this polygon is not considered to represent important habitat for Swift Parrots or Regent Honeyeaters
35	SP	HYD.022	25	25	0	100	90	0	Aerial imagery shows there are no trees in this section.
36	SP	HYD.022	25	25	0	100	90	0	Aerial imagery shows there are no trees in this section.
37	SP	HYD.022	25	25	0	100	90	0	Aerial imagery shows there are no trees in this section.
38	SP	TBC			0				Aerial imagery shows there are no trees in this section.
39	SP	HYD.047	40	50	0	80	100	0	Aerial imagery shows there are no trees in this section.
40	SP	HYD.054	55	30	0	70	90	0	Aerial imagery shows there are no trees in this section.
41	SP	HYD.054	55	30	0	70	90	0	Aerial imagery shows there are no trees in this section.
42	SP	HYD.052	30	10	0	100	100	0	Trees in this strip have been planted. The proportion of grey gum is very small. There is a higher proportion of exotic pines. Does not constitute important Swift Parrot habitat.
43	SP	HYD.063	10	35	0	0	75	0	This area is a pure stand of fire-affected *A. floribunda.*
44	RH	HYD.030	30	35	0	70	80	0	Mapped as Regent Honeyeater habitat but see comment with FID 22: poor quality low shrubby woodland. The area of *E. parramattensis – A. bakeri* has been removed from this section of mapped Regent Honeyeater habitat. The area containing PCT 1600 has been retained- see image attached to HYD.030.

45	SP RH	HYD.027	10	20	0	50	70	0	Habitat transitions to low shrubby woodland on sandy soil, more similar to vegetation community in proximity to HYD.027. Not important Swift Parrot or Regent Honeyeater habitat.
46	SP	HYD.036	25	15	0	0	80	0	Vegetation within the development footprint here is 100% *A. floribunda / bakeri.* Not important Swift Parrot habitat.
47	SP RH	HYD.023	35	25	0	80	30	0	Small trees, mostly dead on poor sandy soils. Not Regent Honeyeater or Swift Parrot habitat.
48	SP	HYD.035	25	15	0	0	80	0	Pure stand of young *A. floribunda*. Not important Swift Parrot habitat
49	SP RH	HYD.032 HYD.033	20	80	0	40	80	0	Young, shrubby forest on poor sandy soil. Not important Swift Parrot or Regent Honeyeater habitat.
50	SP RH	HYD.050	15	30	0	90	90	0	This polygon contains a cleared area dominated by exotic shrubs. Remove from the mapping for both species.
51	SP	HYD.049	15	10	0	80	85	0	Appears to be planted roadside veg. Some exotic species including pines. Some bigger trees in poor health. Can be removed from mapping.
52	SP	HYD.058	10	100	0	20	80	0	Polygon removes 2 *E. crebra* and 2 *A. bakeri.* Single mature *E. tereticornis* retained.
53	SP	HYD.057	10	100	0	0	100	0	Stand is 100% *E.crebra* and can be removed from the Swift Parrot habitat mapping.
54	SP	HYD.057	30	40	0	50	80	0	Patch is mainly non-native vegetation. Definitely not thin-leaved apple / grey gum as mapped. Mainly narrow-leaved mahogany. Can be removed from Swift Parrot mapping.
55	SP	HYD.034	15	10	0	100	50	0	Trees are mostly dead. Can be removed from mapping.
56	SP	HYD.041	10	0	0	10	100	0	Mostly dense scrub. No mature trees. Remove from mapping.
57	SP RH	HYD.028	35	30	0	0	90	0	Mapped as Swift Parrot habitat but the vegetation community is *E. parramattensis* and *E. bakeri.* Images from HYD.028 show this is primarily low-shrubby forest with a dense understorey of *Melaleuca* sp. on poor quality sandy soil. While this PCT is an EEC in and of itself, it is not considered to represent important habitat for Swift Parrots or Regent Honeyeaters.
26	SP RH	HYD.063	0	0	0	0	0	0	Has been cleared- see images associated with HYD.063.
24	SP RH	HYD.058	15	70	0	80	70	0	Some large old trees to remain but some are dead.
30	SP RH	HYD.058	20	5	0	20	70	0	The north-western section contains no trees, trees present are in poor health and small.

11	SP	HYD.057	10	10	0	50	90	0	Mainly *Melaleuca* swamp/scrub with minimal eucalypt canopy. Not important Swift Parrot habitat.
20	SP	HYD.057	10	10	0	50	90	0	Mainly *Melaleuca* swamp/scrub with minimal eucalypt canopy. Not important Swift Parrot habitat.
23	SP	HYD.064	15	100	0	0	65	0	Primarily non-native vegetation including silky oak and pine. Not important Swift Parrot habitat.
21	RH	HYD.051, HYD.056	25	5	0	100	100	0	This section contains some planted Eucalypts. Native veg is young, generally sparse and shrubby. Although there are some key feed tree species present (including *E. sideroxylon* which is presumably planted), it does not constitute important Regent Honeyeater habitat.
22	SP RH	HYD.053-055	15	5	0	40	100	0	No spotted gum present here, it is immature *E.fibrosa* and *Melaleuca* sp. The section containing mature *E. fibrosa* in proximity to the raceway has been retained, but the rest does not constitute important Swift Parrot or Regent Honeyeater habitat.
19	SP	HYD.019	0	0	0	0	0	0	No trees present in this segment of mapping
3	RH	HYD.053, HYD.066	15	0	0	60	100	0	The vegetation here is young and shrubby on poor quality sandy soils.
1	RH	HYD.066	15	0	0	60	100	0	The vegetation here is young and shrubby on poor quality sandy soils.
8	RH	HYD.066	15	0	0	60	100	0	The vegetation here is young and shrubby on poor quality sandy soils.
2	RH	HYD.066	15	0	0	60	100	0	The vegetation here is young and shrubby on poor quality sandy soils.
11	RH	HYD.067	10	10	0	0	95	0	Primarily *Melaleuca* and *Allocasuarina* swamp. Does not constitute important Regent Honeyeater habitat.
7	RH	HYD.067	10	10	0	50	100	0	
4	RH	HYD.067	40	40	0	60	100	0	Some key feed tree species present but soils are sandy, no mistletoe present. A proportion of the mapping containing mature stringybarks has been retained.
6	RH	HYD.069							
10	RH	HYD.068	35	30	0	70	85	0	Some mature grey gum/stringybark woodland in the gully to the eastern side of this polygon has been retained. The proportion removed is less mature with a smaller proportion of key feed tree species. No long-flowered mistletoe, or any other mistletoe species.

9	RH	HYD.073	40	0	0	40	100	0	The eastern (downslope, Creekside vegetation) containing grey box and cabbage gum has been retained. Higher up the slope the vegetation contains immature *E.fibrosa* and *E. parramattensis*
5	RH	HYD.069	40	0	0	20	100	0	Young, shrubby regrowth on poor-quality soils. Not important Regent Honeyeater habitat.
12	RH	HYD.070	15	0	0	50	100	0	Young, dense, scrubby woodland on sandy soils.
13	RH	HYD.070	15	0	0	50	100	0	Young, dense, scrubby woodland on sandy soils.
14	RH	HYD.070	15	0	0	50	100	0	Young, dense, scrubby woodland on sandy soils. Some grey gum present.
15	RH	HYD.070	30	10	0	50	100	0	Young, dense, scrubby woodland on sandy soils. Some grey gum present.
18	RH	HYD.071	20	0	0	40	100	0	Young, dense regrowth of *E. parramattensis* and narrow-leaved apple. Not important Regent Honeyeater habitat.
17	RH	HYD.072	20	10	0	20	100	0	Young, dense regrowth of *E. parramattensis* and narrow-leaved apple. Not important Regent Honeyeater habitat.
16	RH	HYD.072	20	10	0	20	100	0	Young, dense regrowth of *E. parramattensis* and narrow-leaved apple. Not important Regent Honeyeater habitat.

3.4 Areas to be included in the important habitat mapping.

Two polygons, totalling approximately 0.19 Ha, containing a single mature *E. fibrosa* and three mature *E. punctata* within the development footprint should be included within the important habitat mapping for both species (Figures 6 & 7).

Table 5: Important Regent Honeyeater and Swift Parrot habitat within the proposed Hydro development footprint to be included in the mapping.

Polygon No.	Species	Closest survey site	Canopy cover	Ppn. mature / old growth trees	Long-flowered mistletoe abundance	Ppn. Key feed tree species	Ppn healthy trees	No. surrogate Species detected	Index score	Comments
1	SP RH	HYD.045	100	100	0	100	100	1		Single mature *E. fibrosa* has been removed from the important habitat within a cleared area. This tree should be re-instated within the mapping.
2	SP RH	HYD.059	100	100	0	100	100	0		Three large old *E. punctata* currently not included in the mapping but should be.

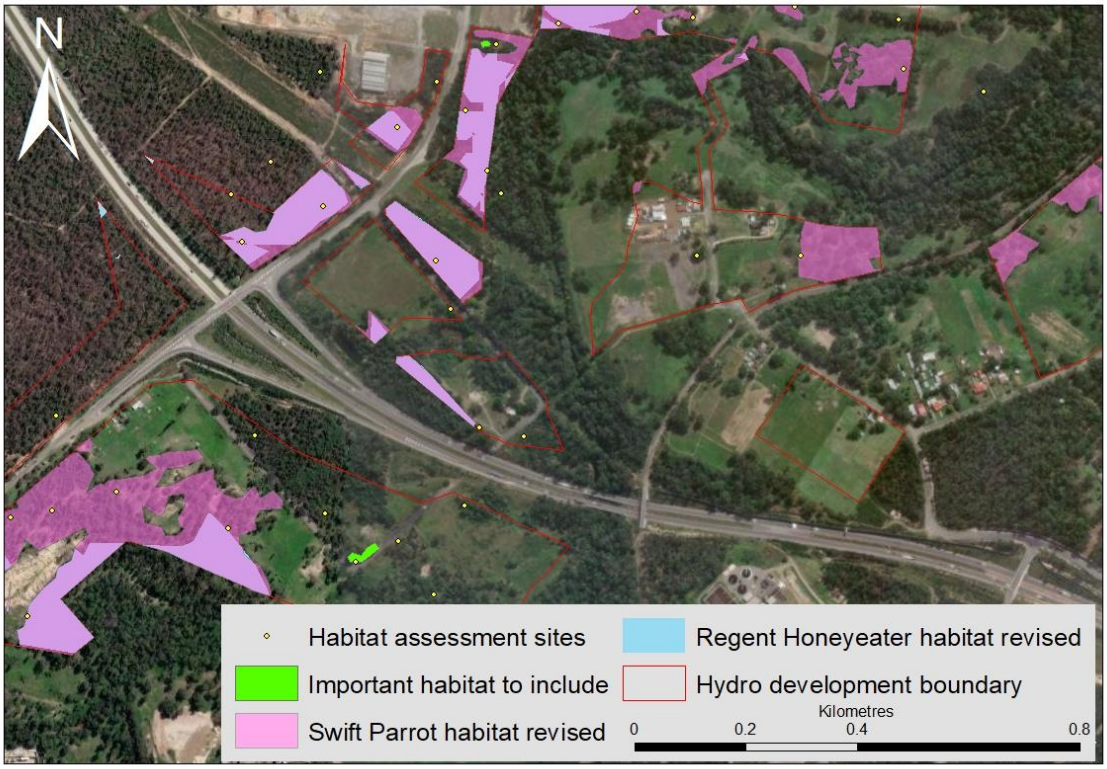

Figure 6: Locations of important Swift Parrot and Regent Honeyeater habitat within the proposed Hydro development footprint to be included within the important habitat mapping. Note that overlapping Regent Honeyeater and Swift Parrot important habitat appears lilac coloured in the figure.

Figure 7: Habitat within polygons 1 and 2, Table 6, to be included within the important Regent Honeyeater and Swift Parrot mapping.

4. Assessments of Swift Parrot and Regent Honeyeater habitat within the proposed Hydro Biodiversity Stewardship Site.

4.1 Background.

The proposed Hydro Biodiversity Stewardship site contains 767.9 Ha of habitat within and surrounding the proposed Hydro development footprint (Figure 8).

Of this 767.9 Ha, 204.8 Ha is mapped as important Swift Parrot habitat (Figure 8). However, because of the methodology used to produce the Swift Parrot important habitat mapping (i.e. buffering of Swift Parrot sightings), there is potential for more important Swift Parrot habitat to be present within the proposed stewardship site that is currently not mapped because the habitat lies more than 2-5 km from a Swift Parrot sighting.

In contrast to Swift Parrots, 647.1 Ha of the proposed Hydro Biodiversity Stewardship Site is mapped as important Regent Honeyeater habitat, but some of this habitat may, in reality, not represent important habitat for the Regent Honeyeater (Figure 9).

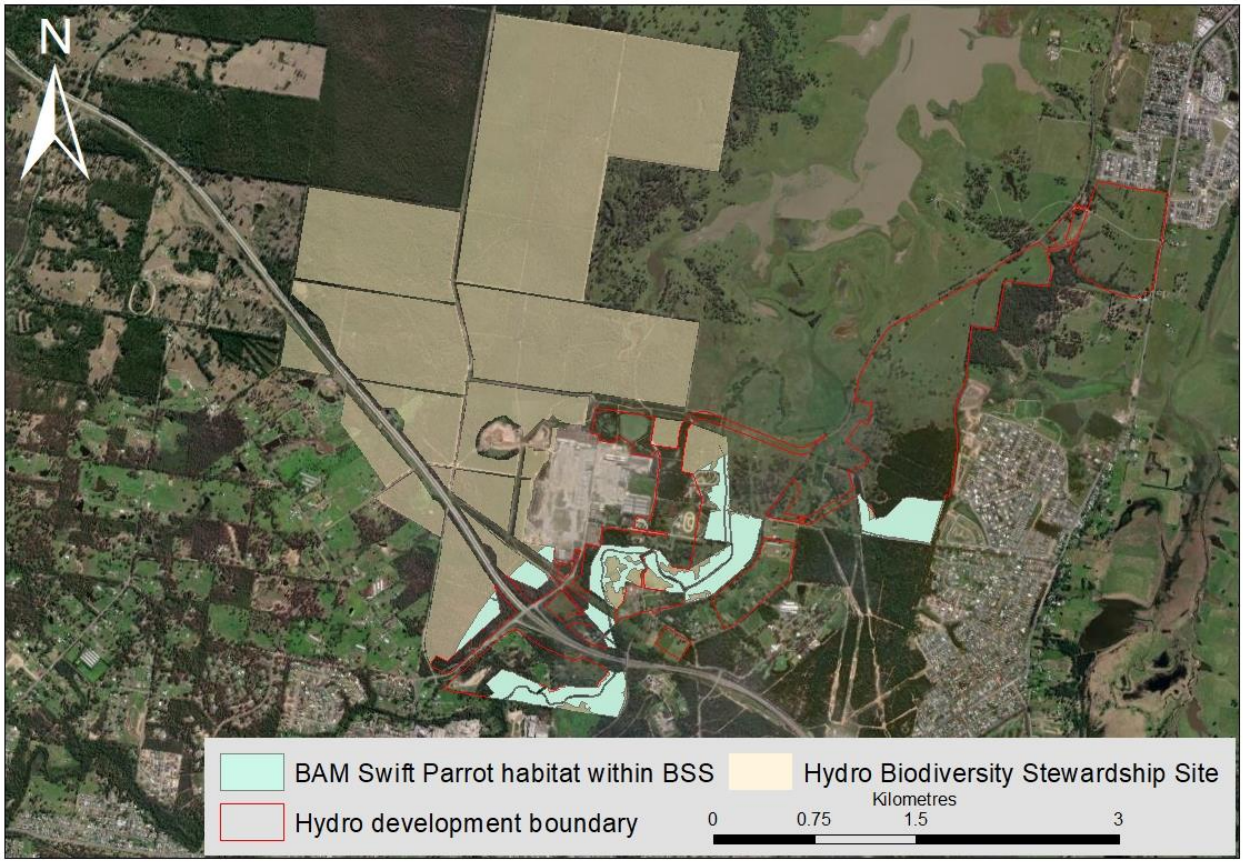

Figure 8: Distribution of the proposed Hydro Biodiversity Stewardship Site. Shown in blue is the current mapped important Swift Parrot habitat within the proposed stewardship boundary based on the original BAM mapping.

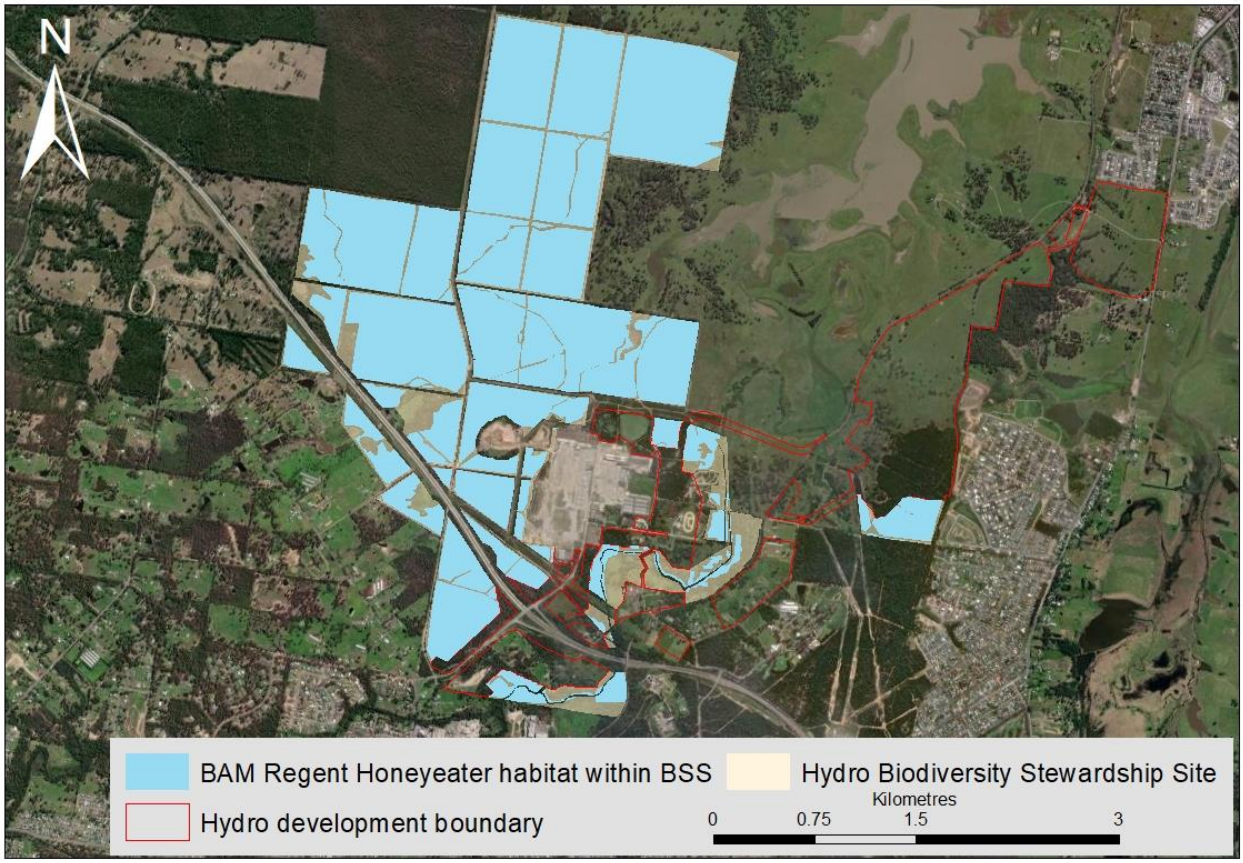

Figure 9: Distribution of the proposed Hydro biodiversity stewardship site. Shown in blue is current mapped important Regent Honeyeater habitat within the proposed stewardship boundary based on the original BAM mapping.

There is a requirement therefore, to refine the important habitat mapping for both the Swift Parrot and the Regent Honeyeater within the proposed Hydro Biodiversity Stewardship site based on field assessments of the vegetation communities and condition within the Stewardship Site by a species' expert.

4.2 Methodology

The same methodology used to assess habitat and conduct bird surveys within the proposed development footprint was used within the proposed stewardship sites (see section 2.1.1). All accessible tracks were driven within and surrounding the stewardship site. A total of 45 habitat and bird assessment sites were established within and surrounding the Stewardship Site (refer to Figure 10). Assessment sites were focussed as much as possible on areas where trees were in blossom.

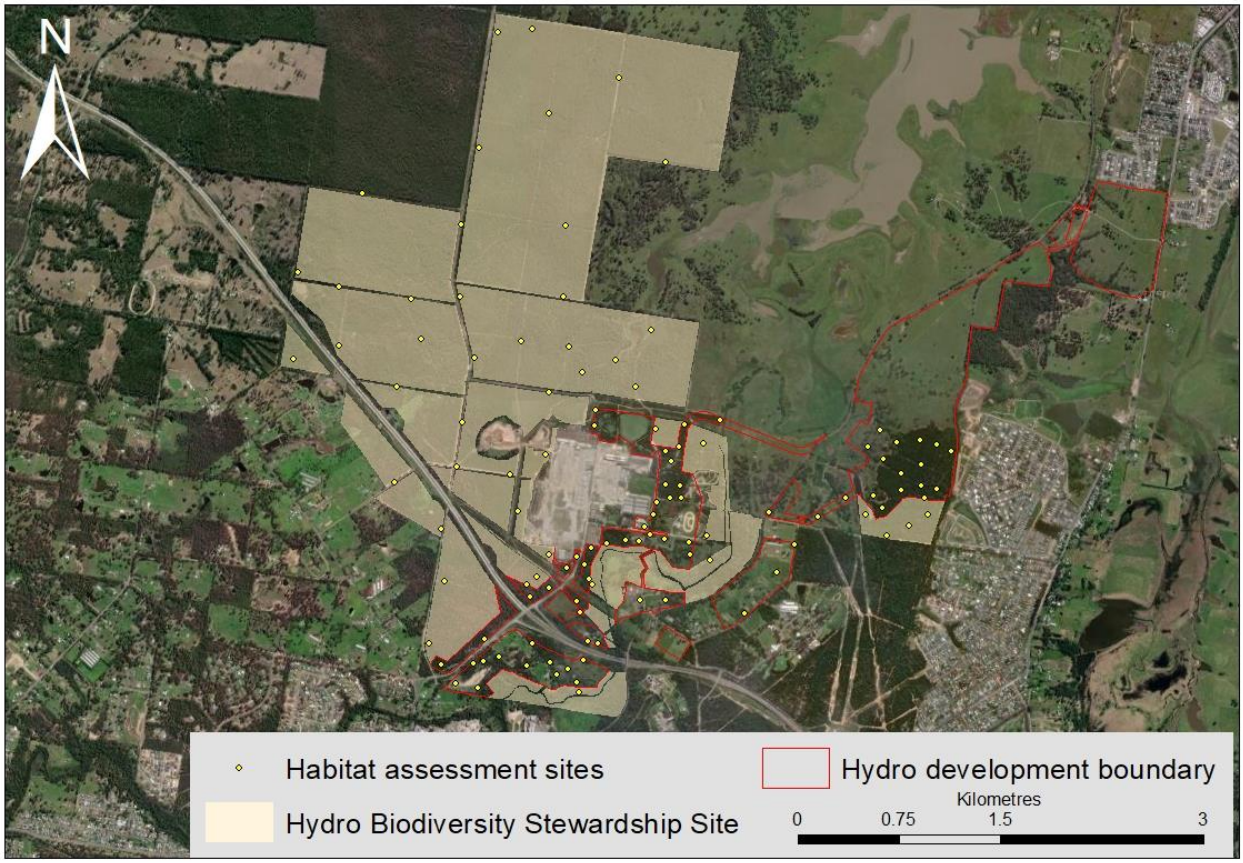

Figure 10: Distribution of habitat assessment and bird monitoring sites within and surrounding the Hydro Biodiversity Stewardship Site.

Based on visual assessments of the habitats encountered within the stewardship boundary and the results of the habitat assessments, the mapping for both species within the stewardship site was revised such that only important habitat for either species was included.

4.3 Results

Vegetation communities within the Hydro stewardship boundary were variable with respect to their importance to Regent Honeyeaters and Swift Parrots. Areas to the north and north-west of the Stewardship Site represent important habitat for both species, with large stands of *E. fibrosa* interspersed with patches of *C. maculata*. These areas represent the most important areas for both species within the stewardship site and development footprint. Other important areas for both species include the vegetation communities surrounding the creek line running through the south-eastern area of the stewardship boundary and the wetland area to the north of the industrial zone. These areas are dominated by *E. amplifolia* interspersed with *E. punctata, A. floribunda, E. moluccana* and stringybark spp. (Figure 11).

No Regent Honeyeaters were detected at any of the 45 survey sites within the Hydro Stewardship site. Two indicator species- Fuscous Honeyeater and Little Lorikeet- were detected at 1 and 4 sites, respectively (Table 3). The raw bird survey data is provided accompanying this report in the sub-folder 'Bird survey data.'

Figure 11: Examples of important Swift Parrot and Regent Honeyeater habitat within the Hydro Biodiversity Stewardship Site. Top and middle: *E. fibrosa* / *C. maculata* forest (HYD. 089 & HYD.092); Bottom: *E. amplifolia* woodland (HYD.075).

Other parts of the stewardship site, particularly those at slightly higher elevations on poorer quality, sandy soils do not represent potential habitat for Regent Honeyeaters or Swift Parrots. These areas are primarily near the centre of the stewardship area, to the west of the industrial area and are dominated by areas of *E. parramattensis* similar in structure and composition to areas that have been suggested to be removed from the Swift Parrot important habitat mapping within the proposed development footprint (Figure 12). It is noted that some parts of the stewardship site were affected badly by fire in 2016, most of which are not considered to represent important Swift Parrot or Regent Honeyeater habitat.

The areas considered to represent important Swift Parrot and Regent Honeyeater habitat within the Hydro stewardship site are shown in Figure 12. The revised mapping indicates there is 607.25 Ha of important Regent Honeyeater and Swift Parrot habitat within the Hydro Biodiversity Stewardship Site.

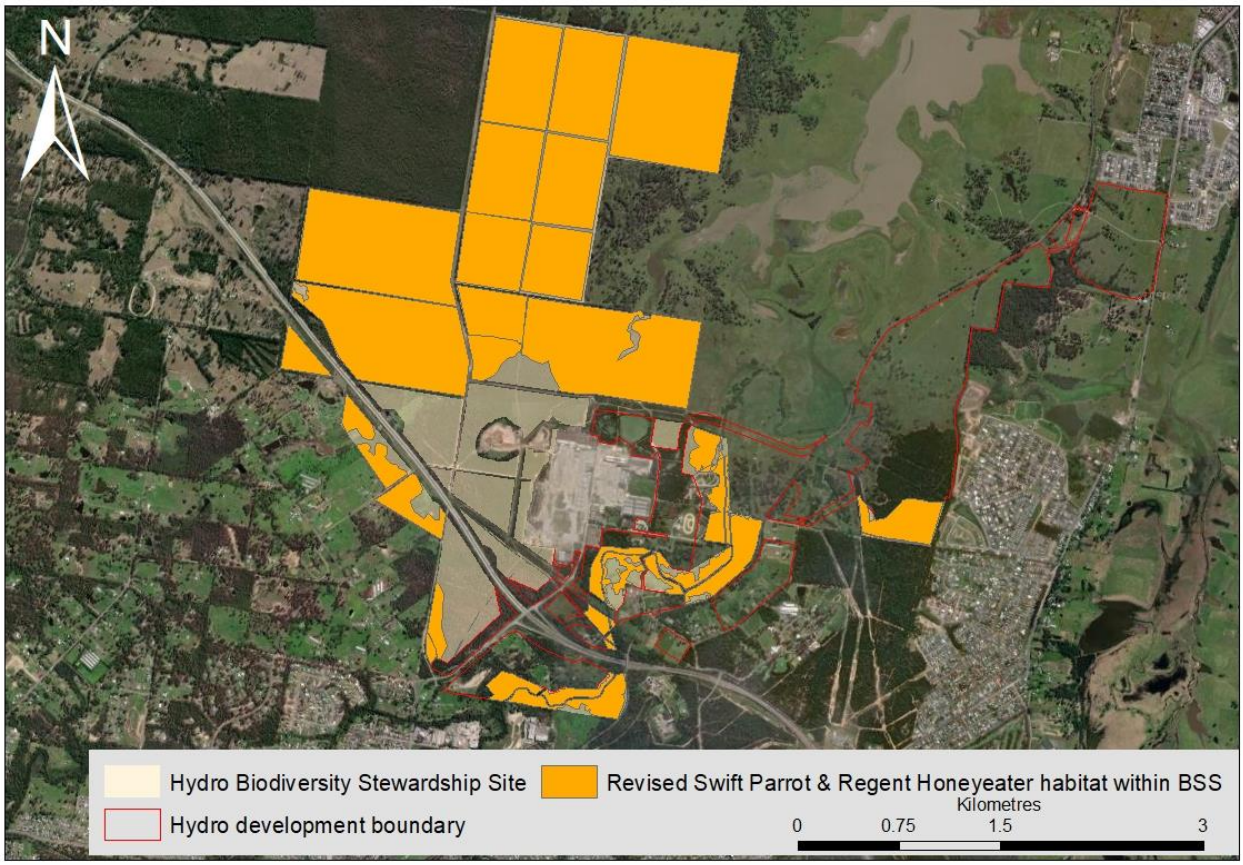

Figure 12: Revised mapping showing the distribution of important habitat for the Swift Parrot and Regent Honeyeater within the Hydro Biodiversity Stewardship Site.

5. Conclusion

Following extensive field-based habitat and bird surveys, an assessment by a recognised species expert, Dr Ross Crates, has concluded that the quantity of mapped important habitat for the Swift Parrot and Regent Honeyeater within the Hydro development footprint is 47.55 Ha and 34.63 Ha, respectively. These values represent a reduction of 21.05 Ha and 15.97 Ha on previous estimates of important habitat for both species, respectively. The remaining mapped important habitat within the proposed Hydro development footprint is considered to be of low to moderate quality, relative to other areas of mapped important habitat for the Swift Parrot and Regent Honeyeater within the lower Hunter Valley, such as parts of Werakata National Park and the Hunter Economic Zone (Roderick et al. 2014). It is considered unlikely that Swift Parrots or Regent Honeyeaters would utilise mapped habitats within the proposed Hydro development footprint, and none of the remaining mapped important habitat within the Hydro development footprint is considered critical habitat for either species S.ee the serious and irreversible impact assessment accompanying this report for further details on the likely impacts of the proposed development on both species.

The most important habitat for the Swift Parrot and Regent Honeyeater within the Hydro estate is contained within the proposed Hydro Biodiversity Stewardship Site. In particular, the areas of (i) *E.fibrosa* / *C.maculata* forest in the north of the BSS, and (ii) *E.amplifolia* / *E.punctata* woodlands surrounding the wetlands north of the industrial zone (Figure 11) are most similar to those habitats that Swift Parrots and Regent Honeyeaters are known to occupy within the lower Hunter Valley. Water is a key habitat feature for both species, and most of the important habitat for Swift Parrots and Regent Honeyeaters in close proximity to water bodies that could be used for drinking or bathing is already contained within the BSS. This includes the creek line running through the south-east section of the Hydro estate, as well as the larger wetland area to the north of the proposed development footprint and to the east of the main BSS. Similarly, areas of highest soil fertility adjacent to waterbodies on which key Swift Parrot and Regent Honeyeater feed tree species grow are principally located within the BSS, unless they have been retained in the revised important habitat mapping within the development footprint.

Since Swift Parrots and Regent Honeyeaters are both highly mobile species, potential impacts of the loss of mapped important habitat on the dispersal capacity of both species through habitat corridors are considered to be low. See the SAII assessment for further assessment of risks of habitat fragmentation and barriers to dispersal associated with habitat loss.

Field surveys revealed that some mapped important Regent Honeyeater habitat within the proposed Hydro BSS does not represent important habitat for this species. The area of important Regent Honeyeater habitat within the BSS has been revised down from 647.1 Ha to 602.75 Ha. Areas removed from the BSS mapping are primarily ridge top plant community types on poorer-quality, sandy soils. The area of important Swift Parrot habitat within the BSS has been revised up from 204.8 Ha to 602.75 Ha.

Further changes to the proposed development footprint to avoid and minimise impacts on Regent Honeyeaters and Swift Parrots are beyond the scope of this expert assessment. However, additional ways in which potential impacts of the proposed Hydro development on the Swift Parrot and Regent Honeyeater could be reduced or mitigated include:

- Seeding of Long-flowered Mistletoe within the BSS, particularly within *E. firbrosa - C. maculata* forests. This would require a rigorous study to assess the efficacy of seeding as a viable conservation strategy, but if successful could substantially increase the value of the BBS for Regent Honeyeaters.
- Noisy Miner management. Suppression of Noisy Miners within the BSS could reduce the impact of Noisy Miners on any Swift Parrots and Regent Honeyeaters that may look to utilise habitats within the BSS. This would also require monitoring to assess the efficacy of noisy miner management within the Hydro BSS as a long-term conservation strategy and ensure that rapid recolonisation by Noisy Miners does not occur.

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7. Author Curriculum Vitae

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Selected employment history:

- October '21 – present: **Owner, FutureFauna-** Ecological consulting, research and conservation.
- September '18 – present: **Postdoctoral Fellow, Australian National University-** Designing, implementing and managing national monitoring programs for the regent honeyeater and swift parrot. Publication of peer-reviewed articles pertaining to woodland bird conservation. Student supervision, teaching.
- September '10 – November '13: **Edward Grey Institute, University of Oxford- Graduate research assistant.** RA to professor Ben Sheldon, on a major ERC grant to study the social ecology and dispersal of wild birds.

Academic history:

- 2015-2018 - Australian National University, Australia. PhD, conservation biology.
- 2006-2010 - University of East Anglia. BSc (1st class Hons) Ecology with a year in Australasia.
- 1999-2006 - Barton Court Grammar School, Canterbury. 4 A-levels grade A and 8 GCSEs grade A*- A.

Academic awards:

- Michael Graham prizes for best performance in Ecology & best conservation project, University of East Anglia.
- Australian National University, Australian Postgraduate Award Research Scholarship.

Selected publications:

- Heinsohn, R, Crates, R. et al. (2022). Population viability in data deficient nomadic species: What it will take to save regent honeyeaters from extinction. *Biological Conservation* **266:** 109430.
- Crates, R. et al. (2021). Poor quality monitoring data underestimate the impact of Australia's megafires on a critically endangered songbird. *Diversity and Distributions.*
- Crates, R. et al. (2021). Loss of vocal culture and fitness costs in a critically endangered songbird. *Proceedings of the Royal Society series B.* **288**: 20210225.
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Selected Grants:

- NSW Local Land Services: Regent honeyeater population monitoring program. $300,000
- CWP renewables: Sapphire Wind Farm swift parrot and regent honeyeater biodiversity offset. $250,000
- Commonwealth of Australia Department of Agriculture, Water & Environment: Noisy miner management assessment. $70,000
- Commonwealth of Australia Department of Agriculture, Water & Environment: King Island scrubtit and brown thornbill population genetics $70,000
- BirdLife Australia: Regent honeyeater monitoring, nest protection and noisy miner management. $60,000
- Bin Zayed Species Conservation Fund: Ecology and conservation of the regent honeyeater. $28,000

Appendix G – SAII Assessments

Assessment of proposal to result in potential SAII for Swift Parrot

The BAM states that "*To assist the consent authority to evaluate the extent and severity of the impact on an entity at risk of a serious and irreversible impact (SAII), the BDAR or BCAR must contain details of the assessment SAII, in accordance with the criteria set out in Subsection 9.1.1 for impacts on each TEC and in Subsection 9.1.2 for each threatened species*".

The following information is provided in accordance with the requirements of Section 9.1.2. of the BAM (DPIE 2020a) in relation to the extent and severity of potential impacts of the proposal on the Swift Parrot (*Lathamus discolor*).

1. The assessor is required to provide further information in the BDAR or BCAR for any species at risk of an SAII, including the action and measures taken to avoid the direct and indirect impact on the species at risk of an SAII. Where these have been addressed elsewhere the assessor can refer to the relevant sections of the BDAR or BCAR.

The land proposed for biodiversity certification is part of an approximately 1,400 ha parcel of land owned by Hydro Aluminium Pty Ltd. In 2014 initial investigations and environmental constraints studies were undertaken to inform a preliminary master plan for the proposal. The factors considered at this stage generally consisted of identifying conservation land, developable land and flood prone land.

The proposed development site rezoning masterplan footprint has undergone a number of revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value within the Hydro lands could be avoided as far as is practical.

Various iterations of the masterplan footprint have been developed and amended in response to detailed understanding of the site's biodiversity values and offsets requirements. Hydro's intention through the rezoning process and development of the preliminary masterplan was to avoid and minimise impacts on high biodiversity values within the site (including habitat for Swift Parrot) and to balance their offset requirements for land identified for development with likely credits that would be created within the areas proposed for conservation (which are generally in better condition than those within the subject site). This includes the avoidance of large intact vegetation remnants that would provide higher quality potential foraging habitat for the Swift Parrot.

In 2014, a preliminary assessment was completed that assessed and evaluated a range of identifiable constraints within the entire Hydro land parcel. This assessment process produced a preliminary masterplan for the site. The intention of the preliminary masterplan was to be able to identify broad characteristics and potential land uses, which was then subject to more detailed study and refinement. Regarding the native vegetation on site, the assessment considered and put forward the conservation of areas of highest biodiversity value, which are primarily located to the north-west of the site and focused areas for development predominantly in previously disturbed areas that have been subject to clearing and ongoing grazing practices, isolated patches of low and/or poor condition vegetation or at the edges of larger patches of existing vegetation.

Following the design of the preliminary masterplan, a Biodiversity Certification Assessment (BCA) of the site was prepared in accordance with the provisions in the now repealed *Threatened Species Conservation Act 1995* (ELA 2016). Based on recommendations in the BCA (ELA 2016), Hydro amended the masterplan to further avoid impacts on biodiversity values, with the footprint of the development lands reduced from 1229 ha to 657 ha, resulting in the avoidance of impacts to a further 572 ha of potential Swift Parrot Habitat (based on previous assessments).

Further refinement and update of the rezoning masterplan was undertaken in 2019 in order to further reduce impacts to areas of high biodiversity value including potential Swift Parrot habitat. This resulted in the area of development land being further reduced to 301 ha. These amendments resulted in the further avoidance of approximately 45 ha of potential foraging habitat for the Swift Parrot.

768 ha of land adjacent to the subject site is proposed to be set aside for conservation in perpetuity under a Biodiversity Stewardship Agreement (BSA) as a Biodiversity Stewardship Site (BSS). The majority of the BSS (607.25 ha) contains vegetation types that would provide potential foraging resources for the Swift Parrot (Crates 2022) (refer to Appendix F). The proposed Stewardship site would form one of largest patches of Swift Parrot Habitat to be conserved on private land within the Hunter IBRA subregion.

2. The assessor must consult the TBDC and/or other sources to report on the current population of the species including:

a. evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) presented by an estimate of the:

i. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer).

Sightings data and population viability analysis both support evidence of rapid population decline of the Swift Parrot in NSW over the past decade. Population models predict that a greater than 80% population decline within three generations is likely to occur (BirdLife Australia, unpublished data, Heinsohn et al. 2015).

ii. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer) as indicated by: an index of abundance appropriate to the species; decline in geographic distribution and/or habitat quality; exploitation; effect of introduced species, hybridisation, pathogens, pollutants, competitors or parasites.

Population models predict a decline in the Swift Parrot population of 78.8 - 94.7% over three generations, equalling 12-18 years (Heinsohn et al. 2015). The estimated generation length for Swift Parrots is 5.4 years (Garnett et al. 2011). Sightings data of Swift Parrots in NSW provide evidence of a decline in the species' abundance and to a lesser extent the species' geographic distribution over the past decade (BirdLife Australia). Because the primary drivers of Swift Parrot population decline- namely predation of nests by sugar gliders *Petaurus breviceps* and loss of breeding habitat to logging (Stojanovic et al. 2014)- occur within their Tasmanian breeding grounds (Heinsohn et al, 2015), the effects of introduced species, hybridisation, pathogens, pollutants and parasites within their NSW wintering range are likely to be minimal. The 2019/20 bushfires affected approximately 12% of mapped important Swift Parrot habitat in NSW, and the species' habitat selection in NSW may be impacted by the presence of large numbers of Noisy Miners (Mac Nally et al. 2012; Thompson et al. 2015).

b. evidence of small population size (Principle 2, clause 6.7(2)(b) BC Regulation) presented by:

i. an estimate of the species' current population size in NSW.

Because Swift Parrots are highly mobile, have a very large range within NSW and occur in different parts of the state in different years contingent on environmental conditions, it is challenging to estimate accurately the current NSW population size. Combining data from sightings in recent years (BirdLife Australia), population models (Heinsohn et al. 2015), genetic evidence (Olah et al. 2021) and expert opinion (Garnett & Baker 2021), a current NSW Swift Parrot population of 200 to 1500 individuals is considered to be a credible estimate. It is noted that there is high annual variation in the size of the NSW Swift Parrot population depending on environmental conditions in other parts the species' winter range (Kennedy & Tzaros 2005).

ii. an estimate of the decline in the species' population size in NSW in three years or one generation (whichever is longer).

Population models predict a decline in the Swift Parrot population of 78.8 - 94.7% over three generations, equalling 12-18 years (Heinsohn et al. 2015). Given that the species forms a single genetic management unit (Stojanovic et al. 2018), it is assumed that this rate of population decline is occurring *on average* within NSW, although there is substantial inter-annual variation in the NSW Swift Parrot population size driven by environmental variation within the species' wintering range (Kennedy & Tzaros 2005).

iii. where such data is available, an estimate of the number of mature individuals in each subpopulation, or the percentage of mature individuals in each subpopulation, or whether the species is likely to undergo extreme fluctuations

The number of mature individuals in the NSW Swift Parrot population is likely to range between 200 and 1500 individuals in any one year. The population size is likely to undergo extreme fluctuations dependent on environmental conditions throughout the species' winter range (Kennedy & Tzaros 2005).

c. evidence of limited geographic range for the threatened species (Principle 3, clause 6.7(2)(c) BC Regulation) presented by:

i. extent of occurrence

Swift parrots do not have a limited geographic range in NSW. NSW DPIE BAM support have indicated that measures of EOO are not relevant to Swift Parrot SAII assessments.

ii. area of occupancy

Swift parrots do not have a limited geographic range in NSW. NSW DPIE BAM support have indicated that measures of AOO are not relevant to Swift Parrot SAII assessments.

iii. number of threat-defined locations (geographically or ecologically distinct areas in which a single threatening event may rapidly affect all species occurrences).

Winter occurrence records of Swift Parrot in NSW are widespread throughout the eastern part of the state (Figure 1).

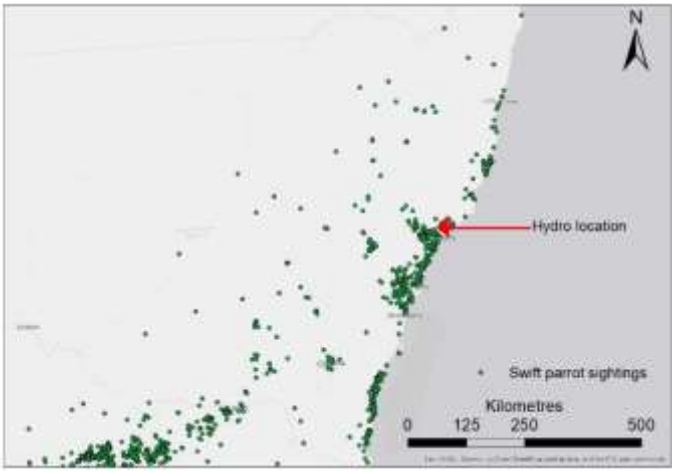

Figure 1: Distribution of Swift Parrot sightings within NSW 2010-2021. Source: BirdLife Australia.

Significant proportions of the population can at times aggregate in very small parts of the species' NSW range (Saunders & Heinsohn 2008). This means that on rare occasions, a significant proportion of the population could be affected if a threatening event occurred at such a location at a time when Swift Parrots were occupying it. However, given the high mobility of the species, the fact that Swift Parrots do not breed in NSW and the fact that the population is generally widely distributed in NSW when present, it is considered very unlikely that a single threatening event could rapidly affect all species occurrences, and that any such effects are likely to be indirect (e.g. temporary loss of habitat associated with wildfire) rather than direct (e.g. mortality of individuals in wildfire).

iv. whether the species' population is likely to undergo extreme fluctuations

The NSW Swift Parrot population is known to undergo extreme fluctuations in both size and distribution (Saunders & Heinsohn 2008, BirdLife Australia, unpublished data). These fluctuations are primarily driven by environmental conditions (predominantly lagged rainfall) that determine the distribution of nectar and lerp resources at state-wide levels (Saunders & Heinsohn 2008, Saunders & Tzaros 2011).

d. evidence that the species is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation) because:

i. known reproductive characteristics severely limit the ability to increase the existing population on or occupy new habitat (e.g. species is clonal) on, a biodiversity stewardship site.

Swift Parrots do not breed in NSW so reproductive characteristics are not relevant to the species' ability to increase the existing population on, or occupy new habitat within, a NSW biodiversity stewardship site.

ii. the species is reliant on abiotic habitats which cannot be restored or replaced (e.g. karst systems) on a biodiversity stewardship site.

Swift Parrots are not reliant on abiotic habitats that cannot be restored or replaced on a biodiversity stewardship site. However, Swift Parrots are generally reliant upon mature, high-quality woodland or forest in NSW (Saunders & Heinsohn 2008). The loss of such habitats cannot be restored or replaced in NSW within a timescale that would be of conservation relevance to the Swift Parrot (i.e. approximately two decades), given the species' predicted rate of population decline over that period (Heinsohn et al. 2015). However, the extent of the mapped important Swift Parrot habitat within the proposed subject site is considered to be of low to medium importance (Crates 2022). The vast majority of the highest quality important Swift Parrot habitat within the Hydro site is contained within the proposed Biodiversity Stewardship Site (BSS) (Crates 2022).

iii. life history traits and/or ecology is known but the ability to control key threatening processes at a biodiversity stewardship site is currently negligible (e.g. frogs severely impacted by chytrid fungus).

The ecology of Swift Parrots is well known in NSW and threatening processes of partial relevance to the Swift Parrot such as feral species, weed infestation, fire risk and window / fence collisions can be managed within a biodiversity stewardship site. However, the species' high mobility, small population size and specific habitat requirements make it challenging to ensure that lost important foraging habitat within NSW can be replaced with functional foraging habitat within a BSS. Whilst the habitat characteristics of a biodiversity stewardship site could have similar attributes to those within a subject site, there is no practical way to encourage Swift Parrots to utilise habitats within stewardship sites instead.

However, since (i) the vast majority of important Swift Parrot habitat (including the highest quality areas) are contained within the proposed BSS (Crates 2022); and (ii) the proposed BSS is over ten times the size of the mapped important Swift Parrot habitat within the subject site, it is considered that Swift Parrots are already more likely to occupy habitats within the BSS than they are to occupy habitats within the proposed subject site.

3. Where the TBDC indicates data is 'unknown' or 'data deficient' for a species for a criterion listed in Subsection 9.1.2(2.), the assessor must record this in the BDAR or BCAR.

Swift Parrots are not listed as data unknown or data deficient.

4. In relation to the impacts from the proposal on the species at risk of an SAII, the assessor must include data and information on:

a. the impact on the species' population (Principles 1 and 2) presented by:

i. an estimate of the number of individuals (mature and immature) present in the subpopulation on the subject land (the site may intersect or encompass the subpopulation) and as a percentage of the total NSW population.

No Swift Parrots have been detected within the subject site during previous targeted surveys, and there are no historical records of Swift Parrots occurring within the subject site. It is noted however, that the majority of the subject site is private property and therefore observer coverage of the subject site for Swift Parrots is very likely to be lower than in other, nearby mapped important Swift Parrot habitat (e.g. Werakata NP).

The most likely estimate of the number of individuals present within the subject land is zero. Based on expert habitat assessment of vegetation communities and condition within the subject site and the number of sightings of Swift Parrots within the Hunter IBRA subregion in the past decade, the maximum plausible number of Swift Parrots that could potentially occupy habitats within the subject site at any one time is estimated to be 50 individuals, though the likelihood of this occurring is considered to be very small. Therefore, the number of individual Swift Parrots potentially present at times within the subject site is estimated to represent between zero and 33% of the NSW population (assuming a minimum NSW population of 150 birds in years when environmental conditions are poor) or between zero and 3.3% of the NSW population (assuming a minimum NSW population of 1500 individuals in years when environmental conditions are particularly good). These estimates are based on the precautionary principle, and it should therefore be noted that based on expert opinion, the probability that more than 1% of the NSW Swift Parrot population would occupy foraging habitats within the proposed subject site at any one time is considered to be low.

ii. an estimate of the number of individuals (mature and immature) to be impacted by the proposal and as a percentage of the total NSW population, or

iii. if the species' unit of measure is area, provide data on the number of individuals on the site, and the estimated number that will be impacted, along with the area of habitat to be impacted by the proposal.

There are 112,301 ha of mapped important habitat for the Swift Parrot in NSW (BAM support 2021). The proportion of mapped important habitat to be impacted within the subject site represents 0.042% of the total mapped habitat in NSW. The approximate area of mapped Important Swift Parrot habitat within the Hunter IBRA sub-region is 17,473 ha, with 41,142 ha mapped within the Sydney Basin IBRA region. The proposal will remove 47.55 ha of important foraging habitat, representing a reduction of approximately 0.3% of mapped important habitat in the Hunter IBRA sub-region and a 0.12 % reduction in the mapped important Swift Parrot habitat within the Sydney Basin bioregion. Note these calculations are based on important habitat mapping provided by BCD and have been altered in accordance with the proposed modifications to the important habitat mapping suggested in the expert report provided in .

b. impact on geographic range (Principles 1 and 3) presented by:

i. the area of the species' geographic range to be impacted by the proposal in ha, and a percentage of the total AOO, or EOO within NSW.

The subject site will lead to the loss of approximately 47.55 ha of important Swift Parrot habitat. This figure represents 0.042% of mapped important Swift Parrot within NSW. BAM support have indicated that the percentage of AOO or EOO within NSW is not relevant for Swift Parrot SAII assessments.

ii. the impact on the subpopulation as either: all individuals will be impacted (subpopulation eliminated); OR impact will affect some individuals and habitat; OR impact will affect some habitat, but no individuals of the species will be directly impacted.

The subject site will result in the loss of some habitat, however no individual Swift Parrots are likely to be directly impacted by the development.

iii. to determine if the persisting subpopulation that is fragmented will remain viable, estimate (based on published and unpublished sources such as scientific publications, technical reports, databases or documented field observations) the habitat area required to support the remaining population, and habitat available within dispersal distance, and distance over which genetic exchange can occur (e.g. seed dispersal) and pollination distance for the species.

Swift parrots are known to undertake long-distance movements both during migration from Tasmania to mainland Australia (Higgins 1999) and within mainland Australia during the winter (Saunders & Heinsohn 2008). The extent to which individual birds exhibit a degree of philopatry to wintering sites is poorly understood, however. Since the entire Swift Parrot population represents a single genetic management unit, with genetic exchange (i.e. breeding) occurring solely within Tasmania (Olah et al. 2021), it is reasonable to assume that individual Swift Parrots could occupy habitats anywhere within the species' NSW range (including 112,301 ha of mapped important habitat).

If it is conservatively assumed that Swift Parrot dispersal within NSW is less than predicted and that Swift Parrots occupying the lower Hunter IBRA sub-region are predominantly restricted to the Sydney Basin bioregion, then any Swift Parrots impacted by loss of foraging habitat within the subject site could occupy 41,142 ha of mapped important habitat elsewhere within the Sydney Basin bioregion (i.e. their conservatively-estimated maximum winter dispersal distance).

It is predicted with a high degree of confidence that the impact of the subject site will not lead to additional fragmentation of the Swift Parrot (sub)population and therefore will not affect the viability of the Swift Parrot (sub)population in this respect.

iv. to determine changes in threats affecting remaining subpopulations and habitat if the proposed impact proceeds, estimate changes in environmental factors including changes to fire regimes (frequency, severity); hydrology, pollutants; species interactions (increased competition and effects on pollinators or dispersal); fragmentation, increased edge effects, likelihood of disturbance; and disease, pathogens and parasites. Where these factors have been considered elsewhere in relation to the target species, the assessor may refer to the relevant sections of the BDAR or BCAR.

The primary threat associated with fragmentation of habitats arising as a result of the Hydro development are potential increases in the local population of Noisy Miners. Noisy Miners are edge specialists (Piper & Catterall 2003) and can prevent Swift Parrots from occupying potential foraging or breeding habitats when their numbers exceed a threshold density of approximately 0.65 birds per hectare (Thompson et al. 2015). Noisy miners are already present in some areas of mapped important Swift Parrot habitat adjacent to the subject site, but there are some additional areas of mapped habitat that could become exposed to Noisy Miners as a result of fragmentation of habitats surrounding the subject site.

It is not envisaged that the proposed development would lead to changes in other threats to the remaining Swift Parrot population, such as hydrology, pollutants, fragmentation, disturbance, disease or parasites. Threats should be considered in the context that the probability of Swift Parrots occurring within and surrounding the subject site which is considered to be low.

Assessment of potential SAII for Regent Honeyeater

Development on the land proposed for biodiversity certification would result in an impact on a potential SAII entity through the proposed removal of potential Regent Honeyeater (*Anthochaera phrygia*) foraging habitat. This section presents the additional impact assessment provisions for threatened fauna species that may be considered a SAII entity, as required by Section 9.1.2 of the BAM (DPIE 2020a).

1. The assessor is required to provide further information in the BDAR or BCAR for any species at risk of an SAII, including the action and measures taken to avoid the direct and indirect impact on the species at risk of an SAII. Where these have been addressed elsewhere the assessor can refer to the relevant sections of the BDAR or BCAR.

The land proposed for biodiversity certification is part of an approximately 1,900 ha parcel of land owned by Hydro Aluminium Pty Ltd. In 2014 initial investigations and environmental constraints studies were undertaken to inform a preliminary master plan for the proposal. The factors considered at that stage generally consisted of identifying conservation land, developable land and flood prone land.

The proposed development site rezoning masterplan footprint has undergone a number of revisions through the proposal planning and design process that have looked at how impacts to areas of higher conservation value within the Hydro lands could be avoided as far as is practical. Various iterations of the masterplan footprint have been developed and amended in response to detailed understanding of the site's biodiversity values and offsets requirements. Hydro's intention through the rezoning process and development of the preliminary masterplan was to avoid and minimise impacts on high biodiversity values within the site and to balance their offset requirements for land identified for development with likely credits that would be created within the areas proposed for conservation.

In 2014, an initial assessment was completed that assessed and evaluated a range of identifiable constraints within the entire Hydro land parcel. This assessment process produced a preliminary masterplan for the site. The intention of the preliminary masterplan was to be able to identify broad characteristics and potential land uses, which was then subject to more detailed study and refinement. Regarding the native vegetation on site, the assessment considered and put forward the conservation of areas of highest biodiversity value, which are located to the north-west of the site and focused areas for development predominantly in previously disturbed areas and isolated patches of low and/or poor condition vegetation or at the edges of larger patches of existing vegetation.

Following the design of the preliminary masterplan, a Biodiversity Certification Assessment (BCA) of the site was prepared in accordance with the provisions in the now repealed *Threatened Species Conservation Act 1995* (ELA 2016). Based on recommendations in the BCA (ELA 2016), Hydro amended the masterplan to further avoid impacts on biodiversity values, with the footprint of the development lands reduced from 1229 ha to 657 ha, resulting in the avoidance of impacts to approximately 570 ha of potential Regent Honeyeater habitat (based on previous assessments).

Further refinement and update of the rezoning masterplan was undertaken in 2019 in order to further reduce impacts to areas of high biodiversity value. This resulted in the area of development land being further reduced to 243 ha. These amendments resulted in the additional avoidance of approximately 45 ha of important Regent Honeyeater habitat.

768 ha of land adjacent to the subject site is proposed to be set aside for conservation in perpetuity under a Biodiversity Stewardship Agreement (BSA) as a Biodiversity Stewardship Site (BSS). A total of 607.25 ha of land identified as important habitat for the Regent Honeyeater (based on the important area mapping) would be conserved within the proposed BSS. The BSS would form one of largest patches of Regent Honeyeater habitat to be conserved on private land within the Hunter IBRA Subregion.

2. The assessor must consult the TBDC and/or other sources to report on the current population of the species including:

a. evidence of rapid decline (Principle 1, clause 6.7(2)(a) BC Regulation) presented by an estimate of the:

i. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer).

The Regent Honeyeater population continues to decline in NSW. Due to the species' life-history attributes of small population size, large range and irregular, long-distance movement patters (Commonwealth of Australia 2016), it is challenging to estimate with confidence the size of the NSW Regent Honeyeater population and the rate at which it is declining. Best estimates suggest that the NSW Regent Honeyeater population may have halved over the past decade, with a contemporary population comprising between 150 and 300 individuals (Garnett et al. 2021). A population viability analysis based on parameters derived from monitoring of the wild population since 2015 predicts that the species will be very close to extinction within two decades (Heinsohn et al. 2022).

ii. decline in population of the species in NSW in the past 10 years or three generations (whichever is longer) as indicated by: an index of abundance appropriate to the species; decline in geographic distribution and/or habitat quality; exploitation; effect of introduced species, hybridisation, pathogens, pollutants, competitors or parasites.

In addition to the information provided in response to 2a (i) above, there is evidence of a decline in the geographic distribution of the Regent Honeyeater over the past decade. Regent Honeyeaters have not been seen and have not bred in the Pilliga / Warrumbungles region since 2015, whilst sightings in the NSW Northern Tablelands and the NSW South Coast regions have continued to dwindle (Garnett et al. 2021, NRHMP, unpublished data). There has been a substantial decline in the quality of known breeding habitat over recent years. The 2019/20 drought led to widespread eucalypt die-off in the Bundarra-Barraba area. Recent observations show that needle-leaf mistletoe *Amyema cambagei*- a key breeding resource for Regent Honeyeaters- is suffering widespread mortality (Crates et al. In revision). Consequently, there is good evidence that on top of an observable population decline and range contraction over the past decade, Regent Honeyeaters have also experienced a decline in the quality and quantity of known breeding and foraging habitat in recent years.

b. evidence of small population size (Principle 2, clause 6.7(2)(b) BC Regulation) presented by:

i. an estimate of the species' current population size in NSW.

The contemporary, wild Regent Honeyeater population is estimated to consist of 150-200 individuals in NSW (Crates et al. 2019, Garnett et al. 2021). The NSW population has been recently supplemented by the reintroduction of 80 zoo-bred birds into the lower Hunter Valley in 2020-21. Monitoring of the reintroduced birds suggests that approximately 50-60 of these zoo-bred individuals may survive in the wild at the time of writing (November 2021). Therefore, it is estimated that the NSW Regent Honeyeater currently comprises 200-265 individuals.

ii. an estimate of the decline in the species' population size in NSW in three years or one generation (whichever is longer).

The available evidence from sightings data and population viability analysis suggests that the NSW population has declined by approximately 30-50% in three years. In 2017 (the last productive season for the species), the National Regent Honeyeater Monitoring Program (NRHMP) managed by the Australian National University detected approximately 140 mature wild individuals in NSW. In 2021 to date (January 2022), with conditions comparable to 2017, the NRHMP has located approximately 80 mature wild individuals. These figures represent a 43% decrease in the population over four years. Capacity to identify the extent to which the population has declined in the short-term is hindered by the species' small population size, large range and irregular settlement patterns.

iii. where such data is available, an estimate of the number of mature individuals in each subpopulation, or the percentage of mature individuals in each subpopulation, or whether the species is likely to undergo extreme fluctuations

The majority of the NSW Regent Honeyeater population occurs within the greater Blue Mountains region, encompassing key breeding areas such as the Capertee, lower Hunter, Goulburn, Burragorang and Widden River valleys. Colour banding data confirm individual birds frequently move between these areas within the greater Blue Mountains (Commonwealth of Australia 2016). The population is known to undergo extreme fluctuations based on environmental conditions. During drought conditions, the birds do not occupy their regular breeding areas and the number of individuals sighted by the public or through the NRHMP falls substantially. There is little information available on what areas Regent Honeyeaters occupy during drought years and what impact droughts have on Regent Honeyeater breeding productivity.

Genetic data suggest that the NSW Regent Honeyeater population comprises a single genetic management unit, but there is evidence of some weak population genetic structure (Kvistad et al. 2015, Crates et al. 2019). Song data shows that the Blue Mountains and Northern Tablelands populations have distinct vocal dialects, though there is vocal evidence that some birds from the Northern Tablelands immigrate into the Blue Mountains population (Crates et al. 2021).

c. evidence of limited geographic range for the threatened species (Principle 3, clause 6.7(2)(c) BC Regulation) presented by:

i. extent of occurrence

Regent Honeyeaters do not have a limited geographic range in NSW. NSW DPIE BAM support have indicated that measures of EOO are not relevant to Regent Honeyeater SAII assessments.

ii. area of occupancy

Regent Honeyeaters do not have a limited geographic range in NSW. NSW DPIE BAM support have indicated that measures of AOO are not relevant to Regent Honeyeater SAII assessments.

iii. number of threat-defined locations (geographically or ecologically distinct areas in which a single threatening event may rapidly affect all species occurrences).

Although Regent Honeyeaters are known to repeatedly occur and breed in a small number of important areas when conditions allow, the population is generally not concentrated in threat-defined locations given the species' high mobility. The most important areas for the species include the Capertee Valley, parts of the lower Hunter Valley, the Burragorang Valley and the upper Hunter Valley including the Goulburn, Merriwa and Widden river valleys. When breeding in these areas, Regent Honeyeaters tend to form small nesting aggregations where multiple pairs will breed in close proximity (Geering and French 1998, Crates et al. 2019). Were a single threatening event such as a bushfire or severe thunderstorm to occur in any of these locations (particularly during a breeding event), it would have a significant impact on subsequent species' occurrences in that location. However, because the Regent Honeyeater is highly mobile, with birds tending to nest in (a small number of) different locations each year, a single threatening event would have a significant impact on the population but is likely to impact only a proportion of the population. Catastrophic wildfires such as the 2019/20 wildfires are a possible exception (Crates et al. 2021).

iv. whether the species' population is likely to undergo extreme fluctuations

The number of Regent Honeyeaters detected in NSW through the NRHMP and through public sightings undergoes extreme fluctuations. For example, since 2015 the number of mature Regent Honeyeaters detected through the NRHMP has ranged from 140 in 2017 to around 30 in 2019. Whilst there are recent records of Regent Honeyeaters in Queensland (BirdLife Australia, unpublished data), it is anticipated that most birds remain within NSW during droughts and that the fluctuation in numbers reflects a current lack of knowledge on the areas Regent Honeyeaters occupy during drought events.

d. evidence that the species is unlikely to respond to management (Principle 4, clause 6.7(2)(d) BC Regulation) because:

i. known reproductive characteristics severely limit the ability to increase the existing population on or occupy new habitat (e.g., species is clonal) on, a biodiversity stewardship site.

The nomadic movement and unpredictable settlement patterns of Regent Honeyeaters make it extremely challenging to implement management actions that will positively benefit the species in the short term. Noisy Miner suppression in recent years has successfully reduced threats in some key breeding areas such as the Capertee Valley and Goulburn River (Crates et al. 2019, Crates et al. in preparation), however it is considered unlikely that Regent Honeyeaters would respond positively to management to the extent that population declines observed over recent decades may be reversed (Heinsohn et al. 2022). Nest protection measures have anecdotally been beneficial in some areas (R. Crates, pers. Obs.), but implementing nest protection measures will only ever benefit a proportion of the population that can be located early each breeding season.

Habitat restoration and biodiversity stewardship will benefit Regent Honeyeaters in the longer term and are undoubtedly required at a large scale if the species is to achieve long-term population recovery. However, given the observed rate of population decline and population viability predictions (Garnett et al. 2021, Heinsohn et al. 2022), habitat restoration and / or biodiversity stewardship are considered unlikely in and of themselves to save Regent Honeyeaters from extinction in the coming decades.

ii. the species is reliant on abiotic habitats which cannot be restored or replaced (e.g. karst systems) on a biodiversity stewardship site.

Regent Honeyeaters are not dependent upon abiotic habitats which cannot be restored or replaced; however the species' is extremely selective in terms of its breeding habitat. Habitats within the proposed subject site are unlikely to be utilised by Regent Honeyeaters for breeding. Even within the lower Hunter IBRA sub-region, known breeding activity is limited to a very small proportion of the species' mapped important habitat. Loss of important (i.e. known) breeding habitat is very unlikely to be replaced on a biodiversity stewardship site in the short to medium term (i.e. the time frame in which the species' conservation needs are most pressing).

The mapped important habitat within the subject site is very unlikely to be used for breeding, and the vast majority of the highest quality Regent Honeyeater habitat within the Hydro site is contained within the proposed Biodiversity Stewardship Site, totalling 607.25 Ha of important Regent Honeyeater habitat.

iii. life history traits and/or ecology is known but the ability to control key threatening processes at a biodiversity stewardship site is currently negligible (e.g. frogs severely impacted by chytrid fungus).

Life-history traits of the Regent Honeyeater are relatively well-known (Franklin et al. 1989) however knowledge of the species' movement patterns is a major knowledge gap. Some of the threats faced by Regent Honeyeaters such as high rates of nest predation (Crates et al. 2019) and exclusion from habitats by Noisy Miners (Mac Nally et. al. 2012) can in theory be managed through predator suppression (Crates et al. 2020). Exclusion from foraging habitats by larger nectarivorous bird species is also a threat that is very challenging to manage, particularly when Regent Honeyeaters occur by themselves or in small flocks (Crates et al. 2017).

The biggest challenge in terms of managing threats facing Regent Honeyeaters at biodiversity stewardship sites is to encourage the birds to occupy those sites. Regent Honeyeaters are now extremely rare and have very specific habitat requirements, and so the probability that birds would occupy stewardship sites is small, as is the case for the majority of the species' mapped important habitat in NSW. However, since (i) the vast majority of important Regent Honeyeater habitat within the Hydro site (including the highest quality areas) are contained within the proposed BSS; and (ii) the proposed BSS is over ten times the size of the mapped important Regent Honeyeater habitat within the subject site, it is considered that Regent Honeyeaters are already more likely to occupy habitats within the BSS than they are to occupy mapped habitats within the proposed subject site.

It is considered unlikely that Regent Honeyeaters will respond positively to management to the extent that population declines observed over recent decades may be reversed (Heinsohn et al. 2022).

3. Where the TBDC indicates data is 'unknown' or 'data deficient' for a species for a criterion listed in Subsection 9.1.2(2.), the assessor must record this in the BDAR or BCAR.

Regent Honeyeaters are not listed as data unknown or data deficient.

4. In relation to the impacts from the proposal on the species at risk of an SAII, the assessor must include data and information on:

a. the impact on the species' population (Principles 1 and 2) presented by:

i. an estimate of the number of individuals (mature and immature) present in the subpopulation on the subject land (the site may intersect or encompass the subpopulation) and as a percentage of the total NSW population.

No Regent Honeyeaters have been detected occupying the subject site during targeted surveys and there are no historical records of Regent Honeyeaters within the subject site. To date (January 2021), no zoo-bred birds (either colour-marked or radio tracked) recently released in Werakata National Park have been detected occupying the proposed subject site (BirdLife Australia, unpublished data).

The most probable number of Regent Honeyeaters occupying the subject site is zero. Should any Regent Honeyeaters occupy habitats within the subject site, it is considered likely that this would be for foraging only and that, based on expert habitat assessments, it is considered unlikely that wild Regent Honeyeaters would utilise habitats within the subject site for nesting. It is also considered unlikely that zoo-bred and released birds would utilise habitats within the subject site for nesting. Ongoing monitoring of the zoo-bred population recently released in Werakata NP will provide better information on their habitat selection in the broader area in future.

The largest known number of Regent Honeyeaters occurring in the lower Hunter Valley IBRA subregion in the past 10 years is 80-100 birds in 2012 (Roderick & Ingwersen 2012) and in the past 5 years this number is 40 birds in 2017. It is therefore considered very unlikely that more than 20 Regent Honeyeaters would use habitats within the subject site at any one time. This precautionary estimate of 20 birds represents between 20 and 50 % of the population (including zoo-bred birds) occurring in the Hunter IBRA subregion and between eight and 13 % of the total estimated NSW population. It is noted that these estimates are a precautionary upper limit estimate. The most likely proportion of the NSW Regent Honeyeater population that could utilize habitats with the subject site is zero and it is considered very unlikely that more than 3% of the NSW population would at times utilize habitats within the subject site. Given how selective Regent Honeyeaters are in terms of breeding habitat, it is considered that the species is very unlikely to nest within the proposed subject site.

ii. an estimate of the number of individuals (mature and immature) to be impacted by the proposal and as a percentage of the total NSW population, or

iii. if the species' unit of measure is area, provide data on the number of individuals on the site, and the estimated number that will be impacted, along with the area of habitat to be impacted by the proposal.

There are 541,997 ha of mapped important habitat for the Regent Honeyeater in NSW (BAM support 2021). The proportion of mapped important habitat to be impacted within the subject site therefore represents 0.006% of the total mapped habitat in NSW. The approximate area of mapped Important Regent Honeyeater habitat within the Hunter IBRA sub-region is 20,985 ha, with 250,011 ha mapped within the Sydney Basin IBRA region. The proposal will remove 34.63 ha of habitat identified as important for the Regent Honeyeater, representing a reduction of approximately 0.17 % of mapped important habitat in the Hunter IBRA sub-region and a 0.01 % reduction in the mapped important Regent Honeyeater habitat within the Sydney Basin bioregion (Crates 2022).

b. impact on geographic range (Principles 1 and 3) presented by:

i. the area of the species' geographic range to be impacted by the proposal in ha, and a percentage of the total AOO, or EOO within NSW.

The subject site will lead to the loss of 34.63 ha of important Regent Honeyeater habitat, representing 0.006% of mapped important Regent Honeyeater habitat within NSW. BAM support have indicated that the percentage of AOO or EOO within NSW is not relevant for Regent Honeyeater SAII assessments.

ii. the impact on the subpopulation as either: all individuals will be impacted (subpopulation eliminated); OR impact will affect some individuals and habitat; OR impact will affect some habitat, but no individuals of the species will be directly impacted.

The subject site will result in the loss of some potential foraging habitat, but it is not anticipated than any individual Regent Honeyeaters will be directly impacted by the development.

iii. to determine if the persisting subpopulation that is fragmented will remain viable, estimate (based on published and unpublished sources such as scientific publications, technical reports, databases or documented field observations) the habitat area required to support the remaining population, and habitat available within dispersal distance, and distance over which genetic exchange can occur (e.g. seed dispersal) and pollination distance for the species.

It is difficult to estimate the amount of habitat required to support the remaining Regent Honeyeater population, particularly considering that the population appears to be declining even with the amount of habitat currently available. The Tomalpin Woodlands of the lower Hunter Valley in the vicinity of the subject site are a key breeding and wintering area for the Regent Honeyeater (Roderick et al. 2014, Commonwealth of Australia 2016). The fact that Regent Honeyeaters have not been detected occupying or breeding within the subject site, despite its proximity to these key areas suggest that higher quality habitats than are present within the subject site are available within the broader area. Some of these sections of higher quality habitat are present within the proposed Hydro biodiversity stewardship site.

It is acknowledged that survey effort in the subject site has been lower than in other areas of the lower Hunter (e.g. Werakata NP) because there is no public access to the Hydro site. However expert assessment of the habitats within the subject site considers the remaining 34.63 ha of important Regent Honeyeater habitat to be of low to medium priority for the species, considering both the quality and quantity of available habitat elsewhere within the lower Hunter Valley IBRA subregion.

Regent Honeyeaters are a highly mobile species that regularly undertake long-distance movements. As such it is considered that the loss of 34.63 ha of important Regent Honeyeater habitat within the subject site will not result in additional fragmentation on the local or regional Regent Honeyeater subpopulation to the extent that the (sub)population becomes (more) unviable.

iv. to determine changes in threats affecting remaining subpopulations and habitat if the proposed impact proceeds, estimate changes in environmental factors including changes to fire regimes (frequency, severity); hydrology, pollutants; species interactions (increased competition and effects on pollinators or dispersal); fragmentation, increased edge effects, likelihood of disturbance; and disease, pathogens and parasites. Where these factors have been considered elsewhere in relation to the target species, the assessor may refer to the relevant sections of the BDAR or BCAR.

The primary threat associated with fragmentation of habitats arising as a result of the Hydro development are potential increases in the local population of Noisy Miners. Noisy Miners are edge specialists (Piper & Catterall 2003) and can prevent Regent Honeyeaters occupying potential foraging or breeding habitats when their numbers exceed a threshold density of approximately 0.65 birds per hectare (Thompson et al. 2015). Noisy miners are already present in some areas of mapped important habitat adjacent to the subject site, but there are some areas of mapped habitat that could become exposed to Noisy Miners as a result of fragmentation of habitats surrounding the subject site.

It is not envisaged that the proposed development would lead to changes in other threats to the remaining Regent Honeyeater population, such as hydrology, pollutants, fragmentation, disturbance, disease or parasites. Threats should be considered in the context that the probability of Regent Honeyeaters occurring within and surrounding the subject site are considered to be low.

Appendix H – Assessments of Significance for MNES

In accordance with the EPBC Act Significant Impact Guidelines 1.1 (DotE, 2013) Assessments of Significance (AoS) were prepared for biota listed under the EPBC Act that would be impacted by the proposal. These include:

Threatened ecological communities

- River-flat eucalypt forest on coastal floodplains of southern NSW and eastern Victoria – listed as a critically endangered ecological community under the EPBC Act

Threatened flora

- Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) – listed as a vulnerable species under the EPBC Act
- Bynoe's Wattle (*Acacia bynoeana*) – listed as a vulnerable species under the EPBC Act
- Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*) - listed as a vulnerable species under the EPBC Act

Threatened fauna

- Grey-headed Flying-fox (*Pteropus poliocephalus*) - listed as a vulnerable species under the EPBC Act
- Large-eared-Pied Bat (*Chalinolobus dwyeri*) - listed as a vulnerable species under the EPBC Act
- Swift Parrot (*Lathamus discolor*) - listed as a critically endangered species under the EPBC Act
- Regent Honeyeater (*Anthochaera phrygia*) – listed as a critically endangered species under the EPBC Act

Migratory species

- White-bellied Sea-eagle (*Haliaeetus leucogaster*) - listed as a migratory species under the EPBC Act

Table AH 1 provides as summary of impacts of the proposal on MNES and conclusions of the completed AoS.

Table AH 1 Summary of impacts on MNES

Threatened biota	Listing under EPBC Act	Associated PCTs/habitat[1]	Impact	Potential for significant impact
River-flat eucalypt forest on coastal floodplains of southern NSW and eastern Victoria	CEEC	PCT 1594 PCT 1591	Removal of 7.6 ha (7.07 ha in good condition (condition class B3) and 0.53 ha in moderate condition (condition class C2)	Possible
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	V	PCT 1633 PCT 1600	Removal of up to 1495 individuals	Possible
Bynoe's Wattle (*Acacia bynoeana*)	V	PCT 1633 PCT 1600	Removal of up to 6 individuals	Unlikely
Parramatta Red Gum (*Eucalyptus parramattensis* subsp.	V	PCT 1633	Removal of 3224 individuals (including 1064 adults, 1612 juveniles and 548	Possible

Threatened biota	Listing under EPBC Act	Associated PCTs/habitat[1]	Impact	Potential for significant impact
decadens)			seedlings)	
Grey-headed Flying-fox (*Pteropus poliocephalus*)	V	PCT 1633 PCT 1600	Removal of up to 84.1 ha of foraging habitat	Unlikely
Large-eared-Pied Bat (*Chalinolobus dwyeri*)	V	PCT 1633 PCT 1600	Removal of up to 84.1 ha of foraging habitat	Unlikely
Swift Parrot (*Lathamus discolor*)	CE	PCT 1633 PCT 1600	Removal of up to 84.1 ha of foraging habitat	Possible
Regent Honeyeater (*Anthochaera phrygia*)	CE	PCT 1600	Removal of up to 36.4 ha of foraging habitat	Possible
White-bellied Sea-eagle (*Haliaeetus leucogaster*)	M	PCT 1633 PCT 1600	Removal of up to 84.1 ha of foraging habitat	Unlikely

[1] PCT associations have been sourced from DPIE TBDC

CEEC= critically endangered ecological community

V= vulnerable species

CE = critically endangered species

M = migratory species

River-flat eucalypt forest on coastal floodplains of southern NSW and eastern Victoria - critically endangered

Description

The CEEC is found on the floodplains of the eastern and southern watershed of the Great Dividing Range from central and southern New South Wales to eastern Victoria, with the northern end of its range extending to around Raymond Terrace, just north of Newcastle.

The CEEC occurs on alluvial landforms related to coastal river floodplains and associated sites where transient water accumulates. The CEEC is typically found below 50 m ASL. The CEEC occurs on alluvial soils of various textures including silts, clay loams and sand loams, gravel and cobbles.

The structure of the community is generally a tall open forest to woodland dominated by eucalypt species that may exceed 40 m in height but can be considerably shorter. The local expression of the ecological community is influenced by its location relative to the riparian areas of the floodplain, frequency of inundation, local climate, latitude and the contribution of biota from surrounding areas. Hence, there is regional variation of key species, although structure and function remain similar throughout the extent.

Distribution in the subject site

Within the subject site this CEEC predominantly occurs along the alluvial terraces associated with Swamp Creek and its tributaries. There are also several smaller patches located to the east of the former smelter site which comprise of mature planted vegetation that was established as part of land rehabilitation undertaken for the former Aluminium smelter.

An assessment was completed of vegetation within the subject site that has potential to be commensurate with River Flat Eucalypt Forest CEEC. This included reviewing plot data and completing assessments within quadrats established in PCTs located on floodplain alluvial soils, Including PCT 1594, PCT 1598 and PCT 1591. This assessment determined that approximately 7.6 ha of vegetation mapped as PCT 1594 (Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter and a small patch of PCT 1591 Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter) meets the identification guidelines and condition thresholds for the River Flat Eucalypt Forest CEEC described in the conservation advice for the community.

Figure 5-2 shows the distribution of the community within the subject site.

EPBC Act - Assessment of Significance – River-flat eucalypt forest on coastal floodplains
According to the DotE (2013) 'significant impact criteria' for critically endangered ecological communities, an action is likely to have a significant impact on a critically endangered community if there is a real chance or possibility that it will:
Reduce the extent of an ecological community
The current extent of the River-flat eucalypt forest on coastal floodplains of southern New South Wales and eastern Victoria across its range is approximately 20,500 ha, of which 10,600 ha occurs within NSW. The proposal would result in the removal of up to 7.6 ha of this CEEC, comprised of numerous patches ranging in size and condition. With approximately 7.07 ha in good condition (condition class B3) and 0.53 ha in moderate condition (condition class C2). Removal of 7.6 ha represents approximately 0.004% of the total extent of the CEEC and 0.07% of the NSW extent of the CEEC.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines
Previous disturbance at the site has resulted in the current, fragmented distribution of this community. Across the subject site the community occurs in numerous discrete patches that range in size from 0.5 ha to up to 4 ha. Within the subject site larger patches of this CEEC are connected to other plant community types, while some are surrounded by mixed grassland and therefore more subject to edge effects. Patches that are larger and less disturbed are likely to provide greater biodiversity value and are likely to be

EPBC Act - Assessment of Significance – River-flat eucalypt forest on coastal floodplains
buffered to disturbance by the surrounding vegetation (DAWE 2020c). However, even patches in heavily cleared areas where they meet the minimum condition thresholds have high conservation value (DAWE 2020). Patches that occur at the natural edge of the community range, such as the proposal site, are also likely to be considered high conservation value. The current proposal would not cause fragmentation of a larger patch of this community, but it would result in the removal of patches such that a network of patches of this CEEC would no longer be present within the site. This in turn would increase the distance between patches within the broader landscape as well as reduce the size of several patches where this CEEC is part of larger patches that extend out of the subject site. Reducing the size of these patches would potentially reducing their long term viability and contribute to increased isolation of patches within the broader landscape.
Adversely affect habitat critical to the survival of an ecological community
Habitat or areas most critical to the survival of the community are patches in the best condition and closest to the benchmark state of the ecological community. Patches of the community within the subject site correspond with classes B3 and C2 in the conservation advice for the community (DAWE 2020c). Areas corresponding with Class B3 are likely to represent habitat critical to the survival of the ecological community. Patches that are in Class C2, although not the best examples of the community, are still considered important particularly where they occur in positions that are important for biodiversity or function. The removal of 7.6 ha of this community has the potential to adversely affect habitat critical to the survival of the CEEC by removing patches of high conservation value that would be considered critical to the survival of the CEEC.
Modify or destroy abiotic (non-living) factors (such as water, nutrients, or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns
The proposal would cause soil disturbance due to the earthworks required for construction this could lead to alteration of surface water drainage patterns and increase runoff from areas of hardstand. This may in turn impact area of CEEC adjoining the subject site. The impacts to soil, water and nutrients would be manageable with appropriate engineering, stormwater management and implementation of erosion and sedimentation controls.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species, for example through regular burning or flora and fauna harvesting
There is a risk that increased edge effects associated with vegetation clearing within this CEEC may lead to some changes in species composition through the introduction and spread of exotic species through the community. These potential impacts however would be managed through ongoing management activities within these areas that will form part of a biodiversity stewardship site. It is therefore unlikely that the project would result in a substantial change in species composition including causing a decline or loss of functionally important species within adjoining patches of River-flat eucalypt forest.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including but not limited to:
The areas of the ecological community impacted by the proposal are likely to already have reduced community integrity and functionality due to previous disturbance. The composition of the ecological community within the proposal area has been modified due to previous disturbance and are prone to edge effects including invasion by exotic species. The small size and fragmented distribution of patches reduces functionality and minimises connectivity that allows movement and dispersal of species that may be functionally important.
1. assisting an invasive species, that are harmful to the listed ecological community to become established, or
Vegetation disturbance at the site has the potential to increase weed incursion to surrounding vegetation including adjoining areas of this CEEC and increasing edge effects by removing buffering vegetation. Where this community occurs in the surrounding landscape, the proposal has the potential to impact on its quality or integrity, these impacts would be mitigated through the ongoing management of vegetation adjoining the site (including patches of River-flat eucalypt forest CEEC) which will form part of a biodiversity stewardship site.

EPBC Act - Assessment of Significance – River-flat eucalypt forest on coastal floodplains
2. causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community or
It is unlikely that the proposal would result in regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into patches of this ecological community that adjoin the subject site.
Interfere with the recovery of an ecological community
The proposal would result in the removal of 7.6 ha of River-flat eucalypt forest CEEC. This would interfere with the recovery of the community as it is in opposition with the conservation advice provided in DAWE 2020, particularly the following key objectives: – Protect and conserve remaining areas of the ecological community – Avoid further clearance and destruction of the ecological community – Retain other native vegetation near patches of the ecological community, where they are important for connectivity, diversity of habitat, and/or act as buffer zones between the ecological community and threats or development zones – Where regeneration occurs, provide measures that will support the regeneration to maturity – Protect mature trees and stags, particularly with hollows.
Conclusion of Assessment of Significance
The proposal has the potential to result in a significant impact on River-flat eucalypt forest on coastal floodplains CEEC due to the following: – The proposal would result in the removal of approximately 7.6 ha of this community including 7.07 ha in good condition and 0.53 ha in moderate condition – The proposal would adversely impact habitat critical to the survival of the CEEC – The proposal has the potential to interfere with the recovery of the CEEC

Threatened flora

Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*) - vulnerable

Distribution

Small-flower Grevillea (*Grevillea parviflora* subsp *parviflora*) occurs as several disjunct populations within NSW. The distribution of the species comprises two relatively distinct regional populations, one in the Lower Hunter and Central Coast regions, and the other generally south-west of Sydney. There are also several outlying populations that have been recorded in the Port Stephens, Great Lakes, Singleton, Campbelltown, Wollondilly and Wingecarribee LGAs.

Habitat requirements

Small-flower Grevillea is known to grow on sandy to gravelly clay over shale on crests, upper slopes or plains in a range of topographic positions including riparian areas. The species is known from a range of vegetation types from heath and shrubby woodland to open forests. Populations have also been recorded on disturbed sites along roads and tracks and within open areas of habitat (TSSC 2008). The species is capable of suckering via underground rhizomes. Due to this habit it is often difficult to determine the numbers of plants present at a site and population estimates are essentially a reflection of the number of suckers rather than individual plants.

The NPWS impact assessment guidelines for this species state that although most populations of Small-Flower Grevillea are relatively large due to the suckering nature of the species, the health and long-term viability of populations is likely to be dependent on adequate seedling recruitment. As such any activity or development that impacts on the accumulation of seed in the soil seedbank, seed germination or seedling growth is likely to be a threat to the population or species (NPWS 2002).

Occurrence with the subject site

Approximately 1495 Small-flower Grevillea (*Grevillea parviflora* subsp *parviflora*) stems occur within the subject site. The stems within the subject site form part of the large regional, Kurri Kurri population. This population extends east to Heddon Greta, north through the Hydro buffer lands to near Bishops Bridge, west to near Ettalong and south to near Stanford Merthyr (DPIE 2022a). The total area of this larger regional population is approximately 5000 ha. The Kurri Kurri population is considered to be an important population of the species as it is a disjunct species and the Kurri population is near the northern extent of its range. The population is also likely to be a key source population and is likely to play an important role in maintaining genetic diversity of the species.

EPBC Act - Assessment of Significance - Small-flower Grevillea (*Grevillea parviflora* subsp *parviflora*)
According to the DotE (2013c) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of a species
Approximately 1,495 Small-flower Grevillea (*Grevillea parviflora* subsp *parviflora*) stems occur within the subject site. This number, however, does not necessarily represent the number of individuals, as the species is known to sucker from rhizomes. The stems were recorded within a number of patches of PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area that occur to the north-east and west of the former Hydro Smelter Site. The stems recorded within the site occur within approximately 10.9 ha of occupied habitat. The plants within the subject site form part of an important regional population that extends east to Heddon Greta, north through the Hydro buffer land to near Bishops Bridge, west to near Ettalong and south to near Stanford Merthyr (DPIE 2022a). The total area of this larger regional population is approximately 5000 ha (DPIE 2022a). Clearing activities associated with the proposal would result a small decrease, in the size of this important population, however this impact would be small relative to the size of the regional population (approximately 0.21 percent). The proposal may therefore result in a small decrease in the in the Kurri Kurri population of Small-flower Grevillea.
Reduce the area of occupancy of an important population
The proposal would result in the removal of approximately 40.7 ha of potential habitat for Small-flower Grevillea within areas of Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland within the subject site. Within this vegetation type the area of occupancy of Small-flower Grevillea has been calculated to be approximately 10.9 ha (applying a 30 metre buffer around individuals and including contiguous vegetation between groups of individuals recorded during targeted surveys that were completed across the entire site). The proposal would therefore result in an approximate 10.9 ha reduction in the known area of an important population of Small-flower Grevillea. There is also potential that proposal would impact additional areas of occupancy where this species may be present within the stored soil seed bank. Although the proposal would result in the reduction in the area of occupancy of an important population of Small-flower Grevillia. This species is known to occur within at least 22 ha of occupied habitat within the 275 ha of suitable Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland (PCT 1633) habitat that occurs within an 800 ha biodiversity stewardship site located adjacent to the development site that would be and conserved to offset the impacts of the proposal. This estimate of occupied habitat within adjoining vegetation however is conservative as detailed targeted surveys have not been completed though this vegetation and in reality, the extent of the population and occupied habitat is likely to be much larger.
Fragment an existing important population into two or more populations
The individuals proposed to be impacted by the proposal are located near the edges of the known local population (DPIE 2022a). The removal of these individuals would therefore not result in the fragmentation of the population into two or more populations.
Adversely affect habitat critical to the survival of the species
There are no areas of habitat that have been declared or are known to be critical to the survival of the Small-flower Grevillea.

EPBC Act - Assessment of Significance - Small-flower Grevillea (*Grevillea parviflora* subsp *parviflora*)
Disrupt the breeding cycle of an important population
There is limited information available on the breeding cycle of the Small-flower Grevillea although the species is known to regenerate from both suckering and seeds. The NSW National Parks and Wildlife Service Environmental Impact Assessment guidelines identify that impacts on the accumulation of seed in the soil seedbank, seed germination or seedling growth is likely to be a threat to the population or species (NPWS 2002). Inappropriate fire regimes are cited as the primary threat to these stages of the species life cycle. The proposed action would include provisions for buffers and fire protection zones that would minimise potential impacts from fire on individuals that may be present within vegetation adjacent to the subject site. Regular mowing or slashing of vegetation adjacent to the proposed Hunter Express Way off ramps could also result in the prevention of some individuals present within this vegetation from maturing or setting seed. Overall, however it is unlikely that the proposal would disrupt the breeding cycle of the greater regional population which the individuals within the subject site form a part as there are substantial areas of alternative habitat/known occurrence of this species including 275 ha of potential habitat (including 22 ha of known occupied habitat) located within a proposed biodiversity stewardship site that will be established and managed to offset the impacts of the proposal.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove approximately 10.9 ha of occupied habitat for the Small-flower Grevillea. This represents a small area relative to the area known to be inhabited by the regional population (approximately 0.21 percent) which includes approximately 5000 ha of known habitat. The proposal also has the potential to modify or decrease the availability and/or quality of habitat for this species adjacent to the site through the introduction of weeds or pathogens during construction or operation. The construction of urban and industrial development may also result in modification of adjacent habitat as a result of overshading, altered hydrology and dumping of fill, rubbish and or garden waste. Mitigation measures would be implements to minimise the potential impacts of weeds, waste and water runoff on adjacent potential habitat and as such it is unlikely that the proposal would modify, destroy, remove isolate or decrease the availability of quality of habitat to such an extent that the species would decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
There is potential that the construction and/or operation of the proposal would result in the establishment of weeds within areas of potential habitat for this species located adjacent the subject site. The introduction of weeds into these areas may result in competition for resources such as light, space and/or nutrients and consequently decrease the value of this habitat. Mitigation measures would be implemented to limit the potential impacts of weeds on adjacent vegetation during construction and operation of the proposal.
Introduce disease that may cause the species to decline
The proposed action in not likely to result in the introduction of any diseases that may cause the species to decline.
Interfere substantially with the recovery of the species
There is no adopted or made Recovery Plan for this species.
Conclusion of Assessment of Significance
On consideration of the above criteria, the proposed action has potential to have a significant effect on Small-flower Grevillea given that: • The proposal may lead to a long-term decrease in an important population • The proposal would result in a small reduction in the area of occupancy for an important population

Bynoe's Wattle (*Acacia bynoeana*) – vulnerable

Distribution

Bynoe's Wattle is endemic to NSW and is found in central eastern NSW, from the Hunter District (Morisset) south to the Southern Highlands and west to the Blue Mountains. The species is known from about 30 locations, with the size of most populations being very small (between 1 to 5 plants). The total population size has been estimated at less than 2000 individuals. The species occurs in heath or dry sclerophyll forest on sandy soils where it is often found growing in open slightly disturbed sites such as trail margins, roadsides and recently burnt patches (DPIE 2022b). Due to the fragmented nature of the populations, small sizes and proximity to urbanisation, the species is susceptible to catastrophic events and localised extinction (NSW Scientific Committee 1999).

In the Kurri Kurri area, Bynoe's Wattle has been recorded at Heddon Greta immediately east of the subject site. It has also been recorded adjacent to the Hunter Express Way, to the south of the site (DPIE 2022b). It is likely that the plants that have been recoded near Heddon Greta are part of the same population as those previously recorded within the subject site as they occur in close proximity within contiguous vegetation.

Occurrence within the subject site

A total of six *Acacia bynoeana* (Bynoe's Wattle) individuals have been previously recorded within the subject site during surveys completed in 2015 (ELA 2016). These plants are located within a patch of PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area located to the east of the former Hydro Smelter Site. Multiple targeted surveys completed in 2020 were unable to relocate any of these individuals or verify their occurrence within the site. For the purpose of this assessment it has been assumed that there is potential habitat within the site for Bynoe's Wattle and that the species may persist within the soil seed bank of the site.

The proposed action would potentially result in the clearing of six Bynoe's Wattle individuals (although their presence could not be confirmed during recent surveys). These plants would be considered to be part of an important population as due to the small and fragmented nature of populations, all individuals are likely to be important for maintaining genetic diversity of the species.

EPBC Act - Assessment of Significance - *Acacia bynoeana* (Bynoe's Wattle)
According to the DotE (2013c) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of a species
A total of six *Acacia bynoeana* (Bynoe's Wattle) individuals have previously been recorded within the subject site (ELA 2016). These individuals were recorded within a patch of PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland located to the east of the former Hydro Smelter Site during surveys completed during 2015. Multiple targeted surveys completed in 2020 were unable to relocate any of these individuals. For the purpose of this referral it has been assumed that these individuals may still be present at the site. These individual plants are considered to form part of a small population that extends off the site to the east within a small patch of vegetation bordering the Heddon Greta residential housing subdivision. Due to the small size of the population, there is potential that the removal of these individuals could lead to a long term decrease in the size of an important population.
Reduce the area of occupancy of an important population
The proposal would result in the removal of approximately 40.7 ha of potential habitat for Bynoe's Wattle within areas of Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland within the subject site. There is also potential that the proposal would impact additional areas of occupancy where this species may be present within the stored soil seed bank. Of the 40.7 ha of potential habitat within the site it has been determined based on extensive targeted survey and the site would contain no more than 2.7 ha of occupied habitat for this species (based on past records and application of 30 metre buffer).

EPBC Act - Assessment of Significance - *Acacia bynoeana* (Bynoe's Wattle)
Fragment an existing important population into two or more populations
The individuals potentially impacted by the proposal are located at the margins of the known local population (DPIE 2022a). The removal of these individuals would therefore not result in the fragmentation of the population into two or more populations.
Adversely affect habitat critical to the survival of the species
There are no areas of habitat that have been declared or are known to be critical to the survival of Bynoe's Wattle.
Disrupt the breeding cycle of an important population
Bynoe's Wattle flowers in from September to March with pods forming in November through to March. The species is thought to be pollinated by native bees and wasps (DEWA 2020b). Plants generally produce small numbers of seeds and there is little local dispersal. Bynoe's Wattle is also known to be capable of spreading vegetatively via underground stems. The proposal has the potential to remove six individuals from the small local population (although their presence has not been confirmed on site) and as such may result in a reduction in the abundance of pollen available to other individuals within the population. The proposal would not impact on mechanisms for pollination of the species.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove an estimated 2.7 ha of occupied habitat for Bynoe's Wattle. The proposal also has the potential to modify or decrease the availability and/or quality of habitat for this species adjacent to the site through the introduction of weeds or pathogens during construction or operation. The construction of urban and industrial development may also result in modification of adjacent habitat as a result of overshading, altered hydrology and dumping of fill, rubbish and or garden waste. Mitigation measures would be implements to minimise the potential impacts of weeds, waste and water runoff on adjacent potential habitat and as such it is unlikely that the proposal would modify, destroy, remove isolate or decrease the availability of quality of habitat to such an extent that the species would decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
There is potential that the construction and/or operation of the proposal would result in the establishment of weeds within areas of potential habitat for this species located adjacent the subject site. The introduction of weeds into these areas may result in competition for resources such as light, space and/or nutrients and consequently decrease the value of this habitat. Mitigation measures would be implemented to limit the potential impacts of weeds on adjacent vegetation during construction and operation of the proposal.
Introduce disease that may cause the species to decline
The proposed action in not likely to result in the introduction of any diseases that may cause the species to decline.
Interfere substantially with the recovery of the species
There is no adopted or made Recovery Plan for this species.
Conclusion of Assessment of Significance
On consideration of the above criteria, the proposed action is unlikely to have a significant effect on Bynoe's Wattle given that: • The proposal would not result in the fragmentation of an important population. • The proposal would remove a small amount of habitat for the species however this habitat does not contain any confirmed recent occurrences of the species. • The proposal would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. • It is unlikely that the proposal would result in invasive species that are harmful to Bynoe's Wattle becoming established in the species habitat. • The proposal is unlikely to introduce disease that may cause the species to decline. • The proposal is not likely to substantially interfere with the recovery of the species.

Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*) – vulnerable

Distribution

Parramatta Red Gum is a small smooth barked tree to 15 m tall (although generally around 7 m). The species is endemic to the Hunter Region where it occurs within two distinct meta populations, one occurring on the Tomago Sandbeds and one within Cessnock-Kurri Kurri region (Bell 2006). Within the Cessnock-Kurri Kurri region, 15 sub-populations of the species have been identified, with an estimated total abundance of 2,500 to more than 8,000 individuals (Bell 2006). This estimate was based on the number of BioNet Atlas Records as is unlikely to be a true representation of the number of individuals within the population. Assessments completed on the Hydro Lands indicate that the population in the Kurri Kurri area is much larger, with some assessments indicating that population within the Hydro land alone is between 23,000 and 54,000 individuals (the majority of which occur within land surrounding the subject site that would be conserved within a biodiversity stewardship site) (ELA 2016).

Habitat requirements

Parramatta Red Gum generally occupies deep, low-nutrient sands, and often those subject to periodic flooding or where the water table is high (OEH, 2019). This subspecies occurs often as a dominant component of dry sclerophyll woodland with an understorey of dry heath, or as an emergent in dry or wet heath (OEH 2019).

Occurrence within the subject site

The proposed action would result in the clearing of 3224 (including 1064 adults, 1612 juveniles and 548 seedlings). Parramatta Red Gum individuals within 47.2 ha of occupied habitat. These plants are considered to be part of an important population due to the endemic nature of the species which indicates that the entire Kurri Kurri/Cessnock regional population is likely to be considered an important population for maintaining genetic diversity of the species within the region.

A large number of Parramatta Red Gum individuals are also known to occur within approximately 250 ha of Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland that occurs within the 770 ha biodiversity stewardship site located adjacent to the development site that would be and conserved to offset the impacts of the proposal.

EPBC Act - Assessment of Significance - Parramatta Red Gum (*Eucalyptus parramattensis subsp decadens*)
According to the DotE (2013c) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will: **Lead to a long-term decrease in the size of an important population of a species**
A total of 3224 (including 1064 adults, 1612 juveniles and 548 seedlings) Parramatta Red Gum individuals occur within the subject site within PCT 1633 (Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area) Within the subject site there is approximately 49.5 ha of PCT 1633, in which Parramatta Red Gum is the dominant canopy species. PCT 1633 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland extends to the east and south of the subject site. Within this area the community forms a 300 ha contagious patch, as well as several smaller fragmented patches. Parramatta Red Gum individuals within the subject site form part of this local sub-population that is characteristic of this PCT. Regional vegetation mapping indicates that there is approximately 2,330 ha of PCT 1633 within 10 km of the subject site and approximately 7,320 ha within the Hunter IBRA sub-region. The removal of 47.2 ha of occupied habitat would represent impacts to approximately 2.1 percent of the known habitat within 10 km of the site and less than 0.7 % in the Hunter IBRA sub-region. With consideration of the above removal of 3224 (including 1069 adults, 1604 juveniles and 548 seedlings) individuals within the site may lead to a decrease in the size of an important population of Parramatta Red Gum.

EPBC Act - Assessment of Significance - Parramatta Red Gum (*Eucalyptus parramattensis subsp decadens*)
Reduce the area of occupancy of an important population
The proposal would result in the removal of approximately 49.5 ha of habitat for *Eucalyptus parramattensis* subsp *decadens* within areas of Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland within the subject site. The known area of occupancy of the species has been calculated to include all areas of PCT 1633 within the subject site. There is also potential that proposal could impact additional areas of occupancy where this species may be present within the stored soil seed bank. This likely decrease in occupancy for Parramatta Red Gum represents an approximate 2.1 percent decrease in the area of occupancy within 10 km of the site and less than 0.7 % decrease in the area of occupancy within the Hunter IBRA sub-region.
Fragment an existing important population into two or more populations
The individuals proposed to be impacted by the proposal are located at the margins of the known local population. The removal of these individuals would therefore not result in the fragmentation of the population into two or more populations.
Adversely affect habitat critical to the survival of the species
There are no areas of habitat that have been declared or are known to be critical to the survival of *Eucalyptus parramattensis* subsp *decadens*.
Disrupt the breeding cycle of an important population
Parramatta Red Gum flowers from November to January and seed dispersal is mainly by wind. Pollination is mostly likely to occur by the foraging activities of bats, birds and insects (House 1997 cited in DECCW NSW 2009). Parramatta Red Gum germinates easily and readily re-sprouts after bushfire or other disturbance (Bell 2006). The proposal would remove 3224 (including 1069 adults, 1604 juveniles and 548 seedlings) individuals from a much larger local population and as such would result in a small reduction in the abundance of pollen available to other individuals within the population. The proposal would not impact on mechanisms for pollination of the species. Considering the above it is unlikely that the proposal would disrupt the breeding cycle of an important population of Parramatta Red Gum.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove approximately 47.2 ha of known habitat Parramatta Red Gum. The proposal also has the potential to modify or decrease the availability and/or quality of habitat for this species adjacent to the site through the introduction of weeds or pathogens during construction or operation. The construction of urban and industrial development may also result in modification of adjacent habitat as a result of overshading, altered hydrology and dumping of fill, rubbish and or garden waste. Mitigation measures would be implemented to minimise the potential impacts of weeds, waste and water runoff on adjacent potential habitat and as such it is unlikely that the proposal would modify, destroy, remove isolate or decrease the availability of quality of habitat to such an extent that the species would decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
There is potential that the construction and/or operation of the proposal would result in the establishment of weeds within areas of potential habitat for this species located adjacent the subject site. The introduction of weeds into these areas may result in competition for resources such as light, space and/or nutrients and consequently decrease the value of this habitat. Mitigation measures would be implemented to limit the potential impacts of weeds on adjacent vegetation during construction and operation of the proposal.
Introduce disease that may cause the species to decline
The proposed action in not likely to result in the introduction of any diseases that may cause the species to decline.
Interfere substantially with the recovery of the species
There is no adopted or made Recovery Plan for this species.

EPBC Act - Assessment of Significance - Parramatta Red Gum (*Eucalyptus parramattensis subsp decadens*)
Conclusion of Assessment of Significance
On consideration of the above criteria, the proposed action has the potential to have a significant effect on *Eucalyptus parramattensis* subsp. *decadens* given that: – The proposal would remove approximately 3224 (including 1069 adults, 1604 juveniles and 548 seedlings) individuals which would represent about 0.7 % of the population within the Hunter IBRA sub-region. This may lead to a very small decrease in the size and area of occupancy of an important population of Parramatta Red Gum.

Threatened fauna

Grey-headed Flying-fox (*Pteropus poliocephalus*) – vulnerable

Distribution

The Grey-headed Flying-fox population throughout Australia is spatially structured into colonies (Parry-Jones & Wardle 2004). However, no separate or distinct populations occur due to the constant genetic exchange and movement between camps over the entire species' geographic range, indicating one single interbreeding population (Webb & Tidemann 1995; DSE 2005).

In winter, the species congregates in coastal lowlands north of the Hunter Valley and is occasionally found on the south coast of NSW (associated with flowering Spotted Gum (*Corymbia maculata*) and on the northwest slopes (generally associated with flowering White Box (*Eucalyptus albens*) or Mugga Ironbark (*Eucalyptus sideroxylon*)) (NSW DECCW 2010).

Habitat requirements

The Grey-headed Flying-fox roosts in congregations (camps) typically located near water, such as lakes, rivers or the coast (van der Ree et al. 2005). Camps can occur in a variety of vegetation types including rainforest, Melaleuca stands, mangroves and riparian vegetation (Nelson 1965; Ratcliffe 1931). The species is also known to roost and forage in highly modified urban areas (Birt et al. 1998; Tidemann & Vardon 1997; van der Ree et al. 2005).

The Grey-headed Flying-fox is a canopy-feeding frugivore and nectarivore, which primarily feeds on blossom from Myrtaceous species (Eby 1998). The species is highly mobile and utilises a range of vegetation including rainforests, open forests, closed and open woodlands, Melaleuca swamps and Banksia woodlands. The species is also known to feed on introduced tree species in urban areas and commercial fruit crops. None of the species the Grey-headed Flying-fox feed on flower continuously throughout the year. As a result the species developed complex migration behaviours due to ephemeral and patchy food resources (Duncan et al. 1999; Eby 1996, 1998; Nelson 1965; Parry-Jones & Augee 1992; Spencer et al. 1991).

The species has historically been subject to culling as a result of impacts to commercial fruit crops. However, in more recent times non-lethal methods of crop protection are used such as full exclusion netting have been used to prevent damage to crops (OEH 2015).

The primary food source is blossom from Eucalyptus and related genera but in some areas, it also utilises a wide range of rainforest fruits (Eby 1998). None of the vegetation communities used by the Grey-headed Flying-fox produce continuous foraging resources throughout the year. As a result, the species has adopted complex migration traits in response to ephemeral and patchy food resources (Duncan et al. 1999; Eby 1996, 1998; Nelson 1965; Parry-Jones & Augee 1992; Spencer et al. 1991).

Habitat within subject site

The subject site contains foraging habitat for this species. This habitat includes a number of tree species that would provide food for this species at certain times of the year when in fruit/flower including *Eucalyptus moluccana* (Grey box) and *Eucalyptus tereticornis* (Forest Red Gum) which have been identified as significant feed species (Peggy & Law 2008). PCTs that occur within the subject site that are associates with the Grey-headed Flying-fox are PCT 1600 and PCT 1633. Within areas of PCT 1600 and PCT 1633 there is suitable habitat for the species within vegetation zones 1,2,3,8,9 and 10. The total area of potential foraging habitat for this species within the subject site is 84.1 ha.

EPBC Act - Assessment of Significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
According to the DotE (2013) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:
Lead to a long-term decrease in the size of an important population of a species
The Grey-headed Flying fox feeds on nectar and pollen from flowers of canopy trees and fleshy fruits from rainforest trees and vines. The species generally moves through the landscape feeding on suitable trees when they come into flower/fruit. The proposal would involve the removal of approximately 84.1 ha of potential foraging habitat for this species. This habitat includes a number of tree species that would provide food for this species at certain times of the year when in fruit/flower including *Eucalyptus moluccana* (Grey box) and *Eucalyptus tereticornis* (Forest Red Gum) which have been identified as significant feed species (Peggy & Law 2008). The Grey-headed Flying-fox has been recorded foraging within and adjacent to the subject site), Grey-headed Flying-fox camps are known to occur within the locality at, East Cessnock, Lorn, Maitland (Hannan St), Stockington. The closet known Grey-headed Flying-fox camp is located at East Cessnock. This camp is mapped on the National Flying-fox monitoring viewer as a nationally important camp and lies approximately 10 km south-west of the subject site (DotE 2020). Given the high mobility of this species and the proximity of large areas of native vegetation containing foraging habitat in the locality (including Mt Sugarloaf Flora and Fauna Reserve, Lower Hunter National Park, Cessnock State Forrest and Werakata National Park), impacts from the proposal area are very unlikely to lead to a long-term decrease in the size of the Grey Headed Flying Fox population. The proposal would not isolate any areas of habitat or cause significant habitat fragmentation that would affect the breeding, foraging or dispersive movements of this highly mobile species. Given that the proposal would not impact on any roosting or breeding sites for this species and the large areas of native vegetation in the locality that would provide foraging habitat for this species, the removal of 84.1 ha of potential foraging habitat for the proposal would be unlikely to lead to a long-term decrease in the size of the population.
Reduce the area of occupancy of an important population
The proposal would not reduce the area of occupancy of this highly mobile species. The 84.1 ha of potential foraging habitat that would be impacted would constitute a very small proportion of the available foraging habitat within the locality and would not create any barriers to movement or isolate any areas of habitat for this mobile species.
Fragment an existing important population into two or more populations
The proposal would not isolate or fragment the existing population of this highly mobile species. The Grey-headed Flying-fox is a highly mobile species that is capable of accessing isolated patches of foraging habitat within urban areas. The species is known to regularly travel distances of 50 kilometres from roost sites to access seasonal foraging resources (Eby 1996). At a local scale, the proposal may widen some existing gaps in vegetation, however the resulting gap in vegetation cover would be readily traversed by these highly mobile, aerial species. The proposed action would not impact on any camp/roost sites for this species. The action would not prevent Grey-headed Flying-fox individuals from travelling between camps and foraging habitat. It is therefore highly unlikely that the proposal would cause fragmentation of the Grey-headed Fox population into two or more populations.

EPBC Act - Assessment of Significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
Adversely affect habitat critical to the survival of the species
The Grey-headed Flying fox requires a temporal sequence of productive foraging habitats linked by migration corridors or stopover habitats combined with suitable roosting habitat in close proximity to foraging areas (DoEE 2017). Habitats within the subject site contain myrtaceous species (Broad-leaved Paperbark *Melaleuca quinquenervia*) and a small number of *Eucalyptus robusta* (Swamp Mahogany). Both of these species have been identified as significant food plants for Grey-headed Flying Fox (Peggy and Law 2008). The draft recovery plan for Grey-headed Flying-fox, identifies important winter and spring habitats and include vegetation communities containing *Eucalyptus robusta* (Swamp Mahogany). and *Eucalyptus moluccana* (DoEE 2017). Habitats within the subject site contain winter flowering myrtaceous species including *Eucalyptus moluccana* (Grey box), *Eucalyptus tereticornis* (Forest Red Gum) and a small number of *Eucalyptus robusta* (Swamp Mahogany). The resources present in the subject site, however, occur in very low abundance and are minor in comparison to available similar foraging resources in nearby areas, including 6,560 km^2 of potential foraging habitat (Yengo and Wollemi National Parks) located to the south-west. In this context the removal of 84.1 ha of potential foraging habitat is unlikely to adversely affect critical habitat for the Grey-headed Flying fox within the region.
Disrupt the breeding cycle of an important population
Grey-headed Flying-foxes are seasonal breeders with a single breeding event per-year. Females generally reach sexual maturity in their second year and pregnant females will give birth to a single pup generally between October to December (DoEE 2017). Flying–foxes have been known to abort foetuses and have premature births in response to environmental stress (DoEE 2017). There are three Grey-headed Flying-fox camps known to support breeding females (maternity camps) within or close by the locality; East Cessnock, Lorn, Maitland (Hannan St), Stockington. Of these camps, East Cessnock is known to support breeding females (maternity camp) and is mapped as critical for survival of the species. However, no camps occur within the subject site. The subject site is likely to be used by the Grey-headed Flying-foxes from the surrounding camps for foraging habitat. However, the foraging habitat within the locality (Mt Sugarloaf Flora and Fauna Reserve, Lower Hunter National Park, Cessnock State Forrest, Werakata National Park) would likely provide sufficient ample foraging resources. Considering this, the proposal is unlikely to disrupt the breeding cycle of the Grey-headed Flying-fox. Furthermore, the proposal would not create a barrier to migratory or dispersal movements for this species that could interfere with breeding behaviours.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove 84.1 ha of potential foraging habitat for the Grey Headed Flying-fox. The proposal would not isolate any areas of habitat for this highly mobile species. Due to the large area of potential alternative foraging habitat within the locality, and the highly mobile nature of the species, the removal of 86.3 ha of potential foraging habitat it is considered unlikely to result in the decline of the species.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Slight increases in the incidence of weeds in adjacent vegetation may occur as a result of vegetation clearing. Weed control measures would be implemented to mitigate this risk. The introduction and/or spread of weeds is not likely to decrease the value of potential foraging habitat for this species as there is already a high abundance of weeds within the area and the introduction on new infestations is not likely to impact on the foraging resources available to Grey-headed Flying-fox. Invasive fauna species, including predators such as cats and foxes, are already present within the subject site and locality. The proposed action is unlikely to result in changes that would favour feral animals, nor is the proposed action likely to increase the incidence of invasive predators or introduce new invasive species in the area.

EPBC Act - Assessment of Significance - Grey-headed Flying-fox (*Pteropus poliocephalus*)
Introduce disease that may cause the species to decline
Grey-headed Flying-foxes are reservoirs of a number of diseases including Australian bat lyssavirus, Hendra virus and Menangle virus. Although lyssavirus can cause clinical disease and mortality in Grey-headed Flying-foxes the incidence of disease in populations is generally low (<1%) and the virus is thought to be generally in equilibrium with the population (DECCW 2007). It has however been noted that when flying-foxes are exposed to significant ecological stress the incident of lyssavirus can increase and the population can be impacted (DECCW 2007). The proposed action is unlikely to result in ecological stresses to any of the nearby flying-fox populations such that the instances of lyssavirus would significantly increase. There are no clinical disease or mortality in flying-foxes associated with Hendra or Menagle virus, regardless the proposal is not likely to lead to an increase in either of these viruses within the Grey-headed Flying-fox population. Construction activities have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) and Myrtle Rust (*Uredo rangelii*) into areas of adjacent foraging habitat for this species. These pathogens could result in a decline in health and/or mortality of flying fox feed trees. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Mitigation measures, including strict hygiene protocols for plant and machinery, and restrictions on imported fill would be implemented to prevent the introduction of Phytophthora and/or Myrtle Rust. No diseases that may cause the species to decline are likely to become established in the subject site as a result of the proposed action.
Interfere substantially with the recovery of the species
As discussed above, foraging habitat within the subject site is consistent with the definition of habitat critical to the survival of the Grey-headed Flying-fox as it contains winter flowering feed trees. The proposal is therefore inconsistent with one of the stated objectives of the draft recovery plan (DoEE 2017), which is to '*identify and protect foraging habitat critical to the survival of Grey-headed Flying-foxes throughout their range'*. With clearing of vegetation containing winter flowering feed trees of particular concern. Although the study site contains winter flowering species *Eucalyptus moluccana* (Grey box), *Eucalyptus tereticornis* (Forest Red Gum) and *Eucalyptus robusta* (Swamp Mahogany) that could be utilised by Grey-headed Flying-fox these species occur in very low numbers through the site and. The 120 ha of potential foraging habitat within the study site is minor in proportion of available foraging habitat for this highly mobile species within the locality. It is considered unlikely, therefore, that the proposed action would substantially interfere with the recovery of the species.
Conclusion of Assessment of Significance
On consideration of the above criteria, the proposed action is unlikely to have a significant effect on the Grey-headed Flying-fox given that: • Vegetation to be removed comprises a negligible proportion of potential foraging habitat present in surrounding areas and the broader locality. • The proposed action would not form a barrier to the movement of this highly mobile species. • The proposed action would not affect movements between nearby campsites and foraging habitat that occurs within the locality. • No known breeding or roosting habitat would be removed or adversely affected by the proposed action. • This species is highly mobile and the proposed action would not isolate any areas of habitat.

Large-eared-Pied Bat (*Chalinolobus dwyeri*) - vulnerable

Distribution

The Large -eared Pied Bat (*Chalinolobus dwyeri*) is a small to medium sized bat that is mainly found within areas with extensive cliffs and caves. The species has a discontinuous distribution that ranges from Rockhampton in Queensland to Bungonia in the NSW southern highlands (DPIE 2022b). The species is listed as vulnerable under both the EPBC Act and BC Act.

Habitat Requirements

Large-eared Pied Bats are known to mostly roost in caves and overhangs in sandstone cliffs where they will forage in nearby high-fertility forest or woodland near watercourses (Pennay 2008). They are also known to utilise abandoned mine tunnels and disused fairy martin nests for roosting (DPIE 2022b).

Habitat in the subject site

Calls of the Large-eared Pied Bat (*Chalinolobus dwyeri*) were recorded within the subject site on an Anabat Express Zero Crossing detector (Titley Scientific). This species is likely to be utilising the site for foraging habitat only as there is no suitable breeding habitat (i.e. caves, scarps, cliffs, rock overhangs or disused mines) present within or nearby to the subject site (within 2 km).

The TSDC identifies that of the PCTs that occur within the subject site Large-eared Pied Bat habitat is known to be associated with PCT 1600 and 1633 (DPIE 2022a) Approximately 84.1 ha of woodland and forest vegetation within the subject site would provide potential foraging habitat for this species.

Large-eared Pied Bats that are utilising the subject site for foraging are not likely to be part of an important population as the site is not located near the limit of the species range and are not likely to be part of a key source population of breeding or a population necessary for maintaining genetic diversity.

Important habitat for the Large-eared Pied Bat has been identified as roosting areas within foraging habitats (vegetated riparian corridors) in close proximity. As roosting habitat does not occur within or surrounding the subject site. As such the subject site is not considered important habitat for the species.

EPBC Act - Assessment of Significance – Large-eared Pied Bat (Chalinolobus dwyeri)
According to the DotE (2013) 'significant impact criteria' for vulnerable species, an action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will: **Lead to a long-term decrease in the size of an important population of a species**
The Large-eared Pied Bat has the potential to forage throughout the vegetated parts of the subject site however no evidence of roosting habitat was observed within or adjacent to the site. The removal of approximately 84.1 ha of potential foraging habitat for this species represent only a very small proportion of alternative foraging habitat for this species in the locality. It is likely that the species occurs within the subject site on a transitory basis only. As noted above Large-eared Pied Bats that are utilising the subject site for foraging are not likely to be part of an important population as the site is not located near the limit of the species range and are not likely to be part of a key source population of breeding or a population necessary for maintaining genetic diversity. Given there would be no impact on roosting and breeding habitat, and potential foraging habitat to be removed is not located near sandstone cliffs and fertile wooded valley habitat within close proximity of each other, the proposal is unlikely to lead to a long-term decrease in the size of an important population of a species.

EPBC Act - Assessment of Significance – Large-eared Pied Bat (Chalinolobus dwyeri)
Reduce the area of occupancy of an important population
An important population of Large-eared Pied Bat does not occur within the subject site or immediate surrounds. Therefore the proposal would not reduce the area of occupancy for an important population of Large-eared Pied Bat. The proposal would not substantially reduce the area of occupancy of this highly mobile species as the 84.1 of potential foraging habitat that would be impacted would constitute a very small proportion of the available foraging habitat within the locality. The large-eared pied bat is known from Shoalwater Bay, north of Rockhampton, QLD, south to the vicinity of Ulladulla in NSW, and west to the Pilliga The proposal would not create any barriers to movement or isolate any areas of habitat for this highly mobile species. For the reasons above it is unlikely that the proposal would reduce the area of occupancy of an important population of Large-eared Pied Bat.
Fragment an existing important population into two or more populations
The proposal would not isolate or fragment the existing population of Large-eared Pied Bat. The species is a highly mobile and capable of traveling large distances to forage. At a local scale, the proposal may widen some existing gaps in vegetation, however the resulting gap in vegetation cover would be readily traversed by these highly mobile, aerial species. The proposed action would not impact on any roost sites for this species or prevent individuals from travelling between roosts and foraging habitat. On the basis of the above, the proposal would not result in the fragmentation of a population of Large-eared Pied Bat into two or more populations.
Adversely affect habitat critical to the survival of the species
The Large-eared Pied Bat is dependent on the presence of diurnal roosts for shelter which they utilise during the day and also at night when not feeding as well as for raising young (DERM 2011). Roost sites include caves, overhangs, disused mine shafts and abandoned fairy martin nests. The draft recovery plan for the Large-eared Pied Bat, identifies critical habitat for the species to be maternity roosts and any sandstone cliffs and fertile wooded valley habitat within close proximity of each other (DERM 2011). The subject site is does not contain and/or occur nearby to any roosting habitat that could provide maternity roosts for the species, nor is it in close proximity to any sandstone cliffs. The proposal is therefore unlikely to affect habitat critical to the survival of the Large-eared Pied Bat.
Disrupt the breeding cycle of an important population
An important population of Large-eared Pied Bat does not occur within or in close proximity to the subject site. Over most of its range, the large-eared pied bat appears to roost predominantly in caves and overhangs in sandstone cliffs and forage in nearby high-fertility forest or woodland near watercourses. The structure of maternity roosts appears to be very specific (arch caves with dome roofs) (DERM 2011). Caves need to be high and deep enough to allow juvenile bats to learn to fly safely inside and have indentations in the roof. Roosting bats cluster in these indentations, presumably to allow the capture of heat. These physical characteristics are very uncommon in the landscape and their scarcity presumably poses an important limiting factor in the distribution of the species (Pennay 2008, DERM 2011). The subject site does not contain any breeding habitat for the Large-eared Pied Bat. Therefore it is very unlikely that the proposal would disrupt the breeding cycle of the Large-eared Pied Bat
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove 84.1 ha of potential foraging habitat for the Large-eared Pied Bat. The proposal would not impact any breeding sites or isolate any areas of habitat for this highly mobile species. Due to the large area of alternative potential foraging habitat that occurs within the locality the removal of 86.3 ha of potential foraging habitat it is considered unlikely to result in the decline of the species.

EPBC Act - Assessment of Significance – Large-eared Pied Bat (Chalinolobus dwyeri)
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat
Slight increases in the incidence of weeds in adjacent vegetation may occur as a result of vegetation clearing. Weed control measures would be implemented to mitigate this risk. The introduction and/or spread of weeds is not likely to decrease the value of potential foraging habitat for this species as there is already a high abundance of weeds within the area and the introduction on new infestations is not likely to impact on the foraging resources available to Large-eared Pied Bat. Invasive fauna species, including predators such as cats and foxes, are already present within the subject site and locality. The proposed action is unlikely to result in changes that would favour feral animals, nor is the proposed action likely to increase the incidence of invasive predators or introduce new invasive species in the area. A 770 ha biodiversity stewardship site would be established adjacent to the subject site. This site would be actively managed for conservation purposes and include a feral animal control program and as such the incidence of invasive fauna species that could be harmful to the Large-eared Pied Bat is likely to be reduced.
Introduce disease that may cause the species to decline
Australian bats are known to be susceptible to a number of diseases including Australian bat lyssavirus, Hendra virus and Menangle virus. There is no literature that indicates that Large-eared Pied Bats carry these diseases however there is a possibility that they could carry these diseases. The proposed action is unlikely to result in ecological stresses to any of the nearby Large-eared Pied Bat populations such that the instances of any of these viruses would increase. Construction activities have the potential to introduce or spread pathogens such as Phytophthora (*Phytophthora cinnamomi*) and Myrtle Rust (*Uredo rangelii*) into areas of adjacent foraging habitat for this species. These pathogens could result in a decline in health and/or mortality of additional areas of Large-eared Pied Bat foraging habitat. There is little available information about the distribution of these pathogens within the locality, and no evidence of these pathogens was observed during surveys. Mitigation measures, including strict hygiene protocols for plant and machinery, and restrictions on imported fill would be implemented to prevent the introduction of Phytophthora and/or Myrtle Rust. No diseases that may cause the species to decline are likely to become established in the subject site as a result of the proposed action.
Interfere substantially with the recovery of the species
As discussed above, foraging habitat within the subject site is not considered to be habitat critical to the survival of the Large-eared Pied Bat as it does not contain or occur in close proximity to any roosting habitat or maternity site. The proposal does not conflict with any of the specific recovery objective specified in the recovery plan for this species (DERM 2011). It is considered unlikely, therefore, that the proposed action would substantially interfere with the recovery of the species.
Conclusion of Assessment of Significance
On consideration of the above criteria, the proposed action is unlikely to have a significant effect on the Large-eared Pied Bat given that: • An important population does not occur within or adjacent to the subject site. • No roosting or breeding habitat would be impacted by the proposal. • Vegetation to be removed comprises a negligible proportion of potential foraging habitat present in surrounding areas and the broader locality. • The proposed action would not form a barrier to the movement of this highly mobile species. • The species is highly mobile and the proposed action would not isolate any areas of habitat. • The proposal would not substantially interfere with the recovery of the species.

Swift Parrot (*Lathamus discolor*) - critically endangered

Distribution

The Swift Parrot breeds in Tasmania during the summer and the entire population migrates north to mainland Australia for the winter, with the majority being found in Victoria and NSW (DEE 2019b).

Habitat Requirements

While on the mainland, Swift Parrots are nomadic, spending weeks or months at some sites and only a few hours at others, determined by the supply of nectar (Parks 2010). On the mainland they occur in areas where eucalypts are flowering profusely or where there are abundant lerp (from sap-sucking bugs) infestations (EES 2019b). Favoured feed trees include winter flowering species such as Swamp Mahogany (*Eucalyptus robusta)*, Spotted Gum (*Corymbia maculata*), Red Bloodwood (*Corymbia gummifer*a), Forest Red Gum (*Eucalyptus tereticornis)*, Mugga Ironbark (*Eucalyptus sideroxylon)*, and White Box (*Eucalyptus albens*) (EES 2019b). Commonly used lerp infested trees include Inland Grey Box (*Eucalyptus microcarpa*), Grey Box (*Eucalyptus. moluccana)*, Blackbutt (*Eucalyptus pilularis*) and Yellow Box (*Eucalyptus melliodora)*. The Swift Parrot returns to some foraging sites on a cyclic basis depending on food availability (EES 2019b).

The extent of habitat use in each region varies according to food availability and competition, with Swift Parrots briefly passing through some habitats feeding opportunistically, and remaining in other habitats foraging for several days, weeks or months. The Hunter Valley has been identified as providing important winter foraging resources for the Swift Parrot.

Habitat in the subject site

No Swift Parrot individuals have been recorded within the subject site during any of the many surveys that have been completed within the Hydro site.

Of the PCTs that occur within the site PCT 1600 and PCT 1633 are known to provide habitat for the Swift Parrot. Within the subject site vegetation zones 1, 2, 8, 9 and 10 may provide potential foraging habitat for this species. A total of 84.1 ha of potential foraging habitat would be impacted by the proposal of which 66.6 ha is mapped as important habitat by DPIE and has therefore been used to create a species polygon for the purpose of species credit calculations in this BCAR (noting that impacts to the remaining 17.3 ha of foraging habitat would be offset through the retirement of ecosystem credits). An assessment by a species expert has identified 47.55 ha of important habitat within the site and as such this smaller area has been quoted in this assessment of significance (Crates 2022 Refer to Appendix F).

The potential foraging habitat within the subject site includes areas in poor condition due to clearing and under-scrubbing for agricultural purposes to more intact, good quality remnants. The vegetation types present contain several important feed tree species for the Swift Parrot including *Eucalyptus tereticorni*s (Forest Red Gum), *Eucalyptus robusta* (Swamp Mahogany), *Eucalyptus moluccana* (Grey Box), and *Corymbia maculata* (Spotted Gum). All of these tree species occur in low densities through the subject site.

According to the DotE (2013) 'significant impact criteria' for critically endangered species, an action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will:

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

The EPBC Act defines a 'population of a species' as an occurrence of the species in a particular area which includes but is not limited to geographically distinct regional populations or collections of local populations or a population, or collection of populations, that occur within a particular bioregion" (DotE 2013).

The Swift Parrot occurs as single, migratory population that disperses widely in Victoria and New South Wales. Small numbers of this species are often observed in the Australian Capital Territory and south-eastern Queensland and less often in south-eastern South Australia. (Saunders and Tzaros 2011). All individuals are considered to be part of the one population.

The Swift Parrot has not been recorded during any of the numerous ecological assessments that have been completed within the Hydro site. The closest record of the species is from approximately 2 km south of the subject site within the township of Kurri Kurri. There are also numerous records from approximately 4 km south-west of the site within a large patch of native vegetation that forms part of the Hunter Economic Zone (HEZ).

There is a total of 84.1 ha of potential foraging habitat for the Swift Parrot within the subject site, most of this habitat contains a low abundance of key foraging resources for the species. Of the 84.1 ha of potential foraging habitat within the site 47.55 ha has been identified as important habitat by a species expert. The proposal would not remove any known breeding habitat for the species

Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 46,565 ha of habitat that contains key foraging species for the Swift Parrot. The removal of 84.1 ha of potential foraging habitat of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.2 percent. This habitat loss will decrease the availability of winter forage for individual birds that disperse throughout the area during winter. It is unlikely however that this small reduction in potential foraging habitat would lead to a long-term decrease in the size of the Swift Parrot Population.

Reduce the area of occupancy of a population

The distributional range of the Swift Parrot extends from Tasmania through parts of Victoria and NSW to southeast Queensland. Within this range, the area of occupancy for the species would include breeding grounds in Tasmania, migration routes and foraging habitats on mainland Australia.

The proposal would result in the removal of 84.1 ha of potential foraging and breeding habitat which includes known feed species such as Spotted Gum (*Corymbia maculata*), *Eucalyptus moluccana* (Grey Box) and Swamp Mahogany (*E. robusta*). Of the potential foraging habitat within the site 47.55 has been identified as important (low to moderate) by a species expert (Crates 2022).

No Swift Parrots have been recorded utilising the subject site during any of the numerous surveys that have been completed through the Hydro site over many years. There is no evidence that the site forms part of the areas of occupancy for the species.

Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 46,565 ha of habitat that contains key trees species for the Swift Parrot. The removal of 84.1 ha of potential habitat containing a low abundance of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.2 percent. It is therefore unlikely that this reduction in potential habitat would substantially reduce the area of occupancy of this highly mobile species.

Fragment an existing population into two or more populations

The Swift Parrot is a highly mobile species that routinely traverses large expanses of open water and open country, including Bass Straight, agricultural land and other clearings during its annual migration. The Swift Parrot would rely on 'steppingstones' of suitable foraging and roosting habitat during migrations and is thought to prefer 'corridors' of woodland vegetation over which to traverse. While the proposal would, in places widen an existing gap, dispersal or movement of the Swift Parrot across the landscape is unlikely to be affected as clearings created by the proposal would not be of a scale that would isolate habitat with respect to this species. As such, the proposal would not fragment the existing population into two or more populations.

Appendix F

Adversely affect habitat critical to the survival of the species

The *Recovery Plan for the Swift Parrot* (Swift Parrot Recovery Team 2001) notes the important breeding habitats for the species within Tasmania and important foraging habitats within mainland Australia.

As proposal will remove 68.6 ha of vegetation mapped as important habitat by DPIE of which 47.55 ha has been identified as important habitat by a species expert (Crates 2022 (Appendix F)), the proposal is likely to impact on habitat critical to the survival of the species.

Disrupt the breeding cycle of a population

Breeding does not occur on mainland Australia. Adult birds would only occur within the subject site as part of seasonal foraging behaviour during winter.

Habitat loss could decrease the availability of winter forage for individuals that may disperse throughout the region during winter. The reduced availability of foraging habitat, particularly during poor flowering seasons and/or drought periods, could theoretically reduce the health and condition of adult birds, which could in turn, lead to poor condition and reduced breeding success. However due to the relatively low abundance of key feed species within the subject site it is unlikely that the condition and health of individuals that may forage in the subject site on occasion would be compromised to the extent that breeding success of individuals would be affected. Furthermore, the proposed action would not fragment a population of the Swift Parrot or create a barrier to local or regional movements of the species between foraging and breeding areas.

Given the above points, the proposal is unlikely to disrupt the breeding cycle of a population of Swift Parrot

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

The removal of 84.1 ha of potential foraging habitat will not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline. Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 46,565 ha of habitat that contains key trees species for the Swift Parrot. The removal of 84.1 ha of potential habitat containing a low abundance of foraging resources would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.2 percent

Within the Hunter region potential foraging resources occur within a number of reserves including Mt Sugarloaf Flora and Fauna Reserve, Lower Hunter National Park, Cessnock State Forrest, Werakata National Park) and further throughout the region (Yengo and Wollemi National Parks).

This species is highly mobile and has a home range spanning several hundred kilometres. The removal of 84.1 ha of potential foraging habitat represents a small fraction of the potential foraging habitat for the species and is unlikely to cause a decline in the population of Swift Parrot.

Given that no breeding habitat would be impacted and that no areas of habitat would become isolated, it is unlikely that the proposal would result in the overall decline of the species.

Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat

The primary threat associated with clearing of Swift Parrot habitat as a result of the Hydro development are potential increases in the local population of Noisy Miners. Noisy Miners are edge specialists (Piper & Catterall 2003) and can prevent Swift Parrots from occupying potential foraging or breeding habitats when their numbers exceed a threshold density of approximately 0.65 birds per hectare (Thompson et al. 2015). Noisy miners are already present in some areas of mapped important Swift Parrot habitat adjacent to the subject site, but there are some areas of mapped habitat that could become exposed to Noisy Miners as a result of fragmentation of habitats surrounding the subject site.

The proposal is not likely to result in the introduction or establishment of any other invasive species that are harmful to Swift Parrot becoming established.

Introduce disease that may cause the species to decline

Psittacine beak and feather disease is a common and potentially deadly disease of parrots. Susceptibility to the infection may be influenced by environmental factors, such as climate, nutrition, habitat quality and social factors (DEH 2005).

The proposal is unlikely to introduce Psittacine beak and feather disease, however cumulative impacts of further land clearing and impacts on habitat has the potential to increase susceptibility of individuals.

Interfere substantially with the recovery of the species

Habitat loss is a key factor in the current threatened status of the Swift Parrot. The proposal would remove 84.1 ha of potential foraging habitat containing preferred feed species for this species. Of this 47.55 ha has been identified as containing low to moderate value important habitat for the species (Crates 2022).

This habitat loss will decrease the availability of winter forage for individual Swift Parrots that disperse throughout the region during winter. Although there would be no impact on breeding habitat, 47.55 ha of vegetation considered to be important foraging habitat for the species would be impacted. This represents approximately 0.38 percent of the mapped important habitat within the Hunter IBRA subregion. As this represents only a small proportion of the mapped important habitat for the region and the vegetation within the site contains a relatively low abundance of key feed species for the Swift Parrot, the proposal is unlikely to substantially interfere with the recovery of the species.

Conclusion of Assessment of Significance

The proposal may result in a significant impact on the Swift Parrot as:

- Vegetation to be removed comprises a small proportion of potential foraging habitat present in surrounding areas and the broader locality.
- No breeding sites for this species are near the locality.
- The proposed action would not form a barrier to the movement of this highly mobile species.
- The proposed action would not affect movements between nearby foraging habitat.
- This species is highly mobile and the proposed action would not isolate any areas of habitat.
- However the proposal would remove approximately 47.55 ha of vegetation considered to be critical habitat for the species.

Regent Honeyeater (*Anthochaera phrygia*)

Characteristics and distribution

The Regent Honeyeater (*Anthochaera phrygia*) is a medium-sized honeyeater with predominantly black plumage with bright yellow edges to the wing and tail feathers. The distribution of the species is extremely patchy with contractions in the home range of the species having been observed in past decades (Franklin et al. 1989).

The Regent Honeyeater formerly occurred throughout south-eastern Australia in the Adelaide region to 100 km north of Brisbane, Queensland. The population has been continually contracting with the species northern extent primarily restricted to Gore-Karara region south of Brisbane and the species is no longer observed in South Australia (Franklin et al., 1989).

The Regent Honeyeater occurs as a single population with exchanges of individuals between regularly used areas (Garnett *et al*., 2011). The Regent Honeyeater population continues to decline in NSW. Due to the species' life-history attributes of small population size, large range and irregular, long-distance movement patters (Commonwealth of Australia 2016), it is challenging to estimate with confidence the size of the NSW Regent Honeyeater population Best estimates suggest that the NSW Regent Honeyeater population may have halved over the past decade, with a contemporary population comprising between 150 and 300 individuals (Garnett et al. 2021).

Habitat Requirements

There are four known key breeding regions remaining for the Regent Honeyeater: north-east Victoria (Chiltern-Albury), and in NSW at Capertee Valley, the Bundarra-Barraba region near Gunnedah and the Hunter Valley. In NSW the distribution is very patchy and mainly confined to the two main breeding areas and surrounding fragmented woodlands. In some years flocks converge on flowering coastal woodlands and forests (EES 2019a).

The timing of breeding varies between regions and appears to correspond with the flowering of key eucalypt and mistletoe species (Franklin et al., 1989; Geering & French 1998). Breeding mostly occurs during spring and summer, from August to January (Franklin et al., 1989). While nectar flows are important for breeding, some pairs have been recorded to successfully fledge their young using insects and lerps only (Geering & French 1998).

The Regent Honeyeater is a generalist forager, although it feeds mainly on the nectar from a relatively small number of eucalypts that produce high volumes of nectar. Most records of regent honeyeaters come from box-ironbark eucalypt associations, where the species seems to prefer more fertile sites with higher soil water content, including creek flats, broad river valleys and lower slopes. Regent honeyeaters may use different areas in different years depending on food resources (DoE 2016).

Key eucalypt species include Mugga (or Red) Ironbark (*Eucalyptus sideroxylon*), Yellow Box (*Eucalyptus melliodora*), White Box (*Eucalyptus albens*), Yellow Gum (*Eucalyptus leucoxylon*) Spotted Gum (*Corymbia maculata*) and Swamp Mahogany (*Eucalyptus robusta*). Nectar and fruits from Mistletoes including Needle-leaf Mistletoe (*Amyema cambagei*), Box Mistletoe (*Amyema miquelii*) *Amyema pendula* Long-flower Mistletoe (*Dendropthoe vitellina*) are also utilised (EES 2019a). When nectar is scarce lerp and honeydew can comprise a large proportion of the diet. Insects make up about 15% of the total diet and are important components of the diet of nestlings.

Lower Hunter Spotted Gum forests in the Hunter Valley have recently been demonstrated to support regular breeding events of regent honeyeaters (Roderick et al 2014). Flowering of associated species such as thin-leaved stringybark (*Eucalyptus eugenioides*) and other stringybark species, and broad-leaved ironbark (*Eucalyptus fibrosa*) can also contribute important nectar flows at times (DotE 2016).

Habitat within the subject site

Of the PCTs that occur within the subject site the Regent Honeyeater is associated with PCT 1600 (DPIE 2022a) Within the subject site intact and grazed areas of PCT 1600 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter ((VZ 8, VZ 9 and VZ 10) contains occasional *Corymbia maculata* (Spotted Gum) individuals as well as *Eucalyptus fibrosa* (Red Ironbark).

There is at total of approximately 36.4 ha of potential foraging habitat for the Regent Honeyeater within the subject site, of this 34.63 has been identified by a species expert as potential important habitat (Crates 2022).

Due to the very low abundance of mistletoe through the subject site it does not provide any suitable breeding habitat for the Regent Honeyeater (Crates 2022)

The National Recovery Plan for the Regent Honeyeater states that any areas where the species is likely to breed or forage is considered critical habitat for the species. The plan notes that habitat within the Hunter Valley would be critical to the survival of the Regent Honeyeater.

EPBC Act - Assessment of Significance Regent Honeyeater (*Anthochaera phrygia*)
According to the DotE (2013) 'significant impact criteria' for critically endangered species, an action is likely to have a significant impact on a critically endangered species if there is a real chance or possibility that it will: **Lead to a long-term decrease in the size of a population of a species**
The EPBC Act defines a 'population of a species' as an occurrence of the species in a particular area which includes but is not limited to geographically distinct regional populations or collections of local populations or a population, or collection of populations, that occur within a particular bioregion (DotE 2013). The Regent Honeyeater occurs as a single population with exchanges of individuals between regularly used areas (Garnett et al., 2011). The total Regent Honeyeater population is estimated to be no more than 1000 birds, however numbers may be as low as 150-300 individuals (Garnett et al 2021). The Regent Honeyeater has not been recorded during any of the numerous ecological assessments that have been completed within the Hydro site. The closest record of the species is from approximately 3 km south of the subject site within the township of Kurri Kurri. There are also numerous records including observations of breeding from approximately 4 km south-west of the site within a large patch of native vegetation that forms part of the Hunter Economic Zone (HEZ). There is at total of 36.4 ha of potential foraging habitat for the Regent Honeyeater within the subject site, most of this habitat however contains a low abundance of key foraging resources for the Regent Honeyeater. The proposal would not remove any known breeding habitat for the species and an assessment of the site by a species expert has determined that due to the paucity of mistletoe through the site it is not likely to provide breeding habitat for this species (Crates 2022). Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 39,162 ha of habitat that contains key trees species for the Regent Honeyeater. The removal of 36.4 ha of potential habitat would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.1 percent. It is unlikely that this reduction in potential foraging habitat would lead to a long term decrease in the size of the Regent Honeyeater population.

EPBC Act - Assessment of Significance Regent Honeyeater (*Anthochaera phrygia*)
Reduce the area of occupancy of the species
The distributional range of the Regent Honeyeater extends from parts of Victoria, through NSW to southeast Queensland. The area of occupancy is estimated at 300,000 km². The extent of occurrence is likely to be declining based on historical declines and the present status of the species (DoE 2016). The proposal would result in the removal of 36.4 ha of potential foraging habitat. No Regent Honeyeaters have been recorded utilising the subject site during any of the numerous surveys that have been completed through the Hydro site over many years. There is therefore no evidence that the site forms part of the areas of occupancy for the species. Regional vegetation mapping indicates that within the Hunter IBRA subregion there is approximately 39,162 ha of habitat that contains key trees species for the Regent Honeyeater. The removal of 36.4 ha of potential habitat would reduce the available foraging habitat within the Hunter IBRA subregion by about 0.1 percent. It is therefore unlikely that this reduction in potential habitat would substantially reduce the area of occupancy of this highly mobile species.
Fragment an existing population into two or more populations
The Regent Honeyeater occurs as a single population with exchanges of individuals between regularly used areas (Garnett et al., 2011). This species is capable of moving long distances to occupy new locations in response to changing food availability (Roderick et al 2013). There is an estimated 20,985 ha of available potential Regent Honeyeater foraging and breeding habitat in the Hunter IBRA subregion including large areas within close proximity to the subject site. Vegetation proposed to be cleared occurs as small scattered remnants within agricultural paddocks or on the edge of larger patches. Highly mobile species such as the Regent Honeyeater are expected to be less impacted by fragmentation and this species is well-adapted to accessing widely spaced habitat resources given its mobility and preference for seasonal foraging resources. Given the clearing occurs on the edge of patches, the high mobility of the species, and large areas of alternative habitat within the locality, the proposal is unlikely to fragment a population into two or more populations.
Adversely affect habitat critical to the survival of the species
The National Recovery Plan for the Regent Honeyeater specifies that any breeding or foraging habitat in areas where the species is likely to occur (as defined by the distribution map provided in Figure 2 of the Recovery Plan is considered critical to the survival of the species (DotE 2016). The subject site contains tree species that could provide foraging resources for the Regent Honeyeater (*Eucalyptus punctata, E. fibrosa, E. moluccana, E. amplifolia* and occasional *Corymbia maculata)* and is within the area mapped as key breeding habitat within the Hunter Valley on Figure 2 of the Recovery Plan. As such the subject site is meets the definition of critical habitat for the Regent Honeyeater.
Disrupt the breeding cycle of the population
Numerous field surveys of the Hydro site have not found any evidence of Regent Honeyeater breeding (nests or pairs) within the subject site. However, as mentioned above there is known breeding habitat for the Regent Honeyeater within close proximity to the site (4 km to the south). Although it is unlikely that the species would utilise the site for breeding due to the relatively low abundance of mistletoe (Crates 2022), the site however could be contributing to the overall foraging resources of breeding pairs within the locality. However as an assessment of habitat at the site by a species expert has concluded however that Regent Honeyeater habitat within the proposed subject site is considered to be of low to moderate quality, relative to other areas of mapped important habitat within the lower Hunter Valley, such as parts of Werakata National Park and the Hunter Economic Zone and that it would be unlikely that Regent Honeyeaters would utilise habitat within the proposed the subject site it is considered unlikely that the removal of 36.4 ha of potential foraging habitat would disrupt the breeding cycle of the Regent Honeyeater population.

EPBC Act - Assessment of Significance Regent Honeyeater (*Anthochaera phrygia*)
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline
The proposal would remove of 36.4 ha of potential foraging habitat for the Regent Honeyeater. No known or potential breeding habitat would be removed from the site (Crates 2022). The proposal would remove small patches of potential habitat that may contribute to cumulative fragmentation of habitat in the landscape. Given the high mobility of the species however it is unlikely that the proposal would lead to any substantial fragmentation or isolation of any habitat for this species. Given the habitat within the site is considered low to moderate when compared to other habitat within the locality including large areas of known foraging and breeding habitat contained within the Werakata National Park and the Hunter Economic Zone it is unlikely that the removal of 36.4 ha of potential habitat within the subject site would contribute to the decline of the species.
Result in invasive species that are harmful to a critically endangered species becoming established in the critically endangered species' habitat
The primary threat associated with clearing of Regent Honeyeater habitat as a result of the Hydro development are potential increases in the local population of Noisy Miners. Noisy Miners are edge specialists (Piper & Catterall 2003) and can prevent Swift Parrots from occupying potential foraging or breeding habitats when their numbers exceed a threshold density of approximately 0.65 birds per hectare (Thompson et al. 2015). Noisy miners are already present in the subject site, however as the proposal would result in new exposed edges around the periphery of the site there is potential that this could result in an increase in the Noisy Miner population within retained vegetation adjacent to the site. These potential edge effect impacts would be managed through ongoing management of the Biodiversity Stewardship site that would be established on lands adjacent to the site. .
Introduce disease that may cause the species to decline
No diseases are likely to be introduced as part of the proposal. A detailed assessment of the disease risk to the Regent Honeyeater was conducted by Jakob-Hoff et al. (2014) and identified the release of birds in captive breeding programs as the main vector for the transmission of diseases into the wild population. As no captive Regent Honeyeaters are being released as part of this proposal it is unlikely that any diseases that would affect the local wild population would occur.
Interfere substantially with the recovery of the species
The proposal would result in the clearing of 36.4 ha of habitat mapped critical to the survival of the Regent Honeyeater. As there is no evidence that the Regent Honeyeater utilises the site for breeding or foraging it is unlikely that the removal of 36.4 ha of low to moderate value habitat would substantially interfere with the recovery of the species.
Conclusion of Assessment of Significance
The proposal may result in a significant impact on the Regent Honeyeater as: • The proposal will result in the clearing of 36.4 ha of Regent Honeyeater habitat with potential to be critical to the survival of the species.

Assessment of Significance for Migratory Species potentially impacted by proposed action

White-bellied Sea-Eagle (*Haliaeetus leucogaster*)

The White-bellied Sea-eagle (*Haliaeetus leucogaster*) is a large raptor with a wingspan of up to 220 cm. It feeds mainly off aquatic animals including fish, turtles crustaceans and sea snakes but will also opportunistically feed on birds, mammals and carrion (del Hoyo et al. 1994; Ferguson-Lees & Christie 2001; Marchant & Higgins 1993; Rose 2001).

Some White-bellied Seas-Eagles may travel several hundred kilometres in order to find foraging and breeding habitat with reports of one individual being recorded travelling around 3000 km from its natal territory at Cowell, South Australia to Fraser Island, Queensland (Marchant & Higgins 1993).

The main threats to the White-bellied Sea-Eagle are the loss of habitat due to land development, and the disturbance of nesting pairs by human activity (DotE 2020).

Migratory Species
The Significant Impact Guidelines 1.1 (DotE 2013) lists criteria which are used to determine whether an action is likely to have a significant impact on migratory species. An action is considered likely to result in a significant impact on migratory species if there is a real chance or possibility that it will:
Substantially modify and/or destroy an area of important habitat for a migratory species
An area of 'important habitat' for a migratory species is defined in the Significant Impact Guidelines (DotE 2013) as: 'Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species'. The White-bellied Sea-eagle generally forages and breeds in habitats near the coast and within coastal lowland areas. The subject site provides some marginal foraging habitat for this species with mammal and reptile species occurring within the subject site. However, the subject site is unlikely to support a significant proportion of the total population of this species. The proposed action would reduce the area of potential foraging habitat for these species by a small amount (84.1 ha) relative to the potential habitat within the locality. No breeding habitat for this species would be impacted by the proposal. Habitat within the proposed action site is not considered critical during the lifecycle of the White-bellied Sea-eagle (*Haliaeetus leucogaster*). 'Habitat utilised by a migratory species which is at the limit of the species range'. Habitat within the proposed action site is not at the limit of the species range. Distribution of habitat for this species extends well beyond (north, south, east and west) the location of the study site. 'Habitat within an area where the species is declining'. Populations of the White-bellied Sea-Eagle are considered relatively stable (DAWE 2020a and DAWE 2020b). The proposal would therefore not impact on habitat of a species that is in decline.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species
The proposed action would not seriously disrupt the lifecycle of an ecologically significant proportion of the population of the White-bellied Sea-Eagle. Given the relatively small area of marginal foraging habitat that would be impacted by the proposal (84.1 ha) it is unlikely that it would support an ecologically significant proportion of the population of either of these species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species
It is possible that the proposed action would result in slight increases in the incidence of weeds in vegetation immediately surrounding the subject site. The Construction Environmental Management Plan (CEMP) for the proposal would include measures to prevent the spread of weeds, including hygiene procedures for equipment, footwear and clothing, and weed disposal protocols. This would minimise the potential for invasive species to establish in potential foraging habitat for these species.

Migratory Species
Conclusion of Assessment of Significance

Consideration of the DotE (2013) 'significant impact criteria' indicates that the proposed action is unlikely to impose a significant impact on the White-bellied Sea-eagle (*Haliaeetus leucogaster*) as it would not:

- Substantially modify and/or destroy an area of important habitat for these species.
- The subject site is not considered to be important habitat for White-bellied Sea-eagle (*Haliaeetus leucogaster*)
- Vegetation within the subject site is only likely to represent marginal foraging habitat for these species. Given the extensive other areas of forging habitat in the locality it is unlikely that impacts from the proposal would be significant to this species.
- Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of any of these species.
- Result in an invasive species that is harmful to any of these species becoming established in an area of important habitat.

Appendix I – Biodiversity credit reports

BAM Biodiversity Credit Report (Like for like)

Proposal Details

Assessment Id
00016379/BAAS17098/19/00016384

Proposal Name
Kurri Kurri Hydro

BAM data last updated *
24/11/2021

Assessor Name

Assessor Number

BAM Data version *
50

Proponent Names

Report Created
06/06/2022

BAM Case Status
Finalised

Assessment Revision
10

Assessment Type
Biocertification

Date Finalised
06/06/2022

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		

Species
Lathamus discolor / Swift Parrot
Anthochaera phrygia / Regent Honeyeater

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Calidris tenuirostris / Great Knot
Irediparra gallinacea / Comb-crested Jacana
Limicola falcinellus / Broad-billed Sandpiper
Limosa limosa / Black-tailed Godwit
Xenus cinereus / Terek Sandpiper
Calidris ferruginea / Curlew Sandpiper

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

BAM Biodiversity Credit Report (Like for like)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
1633-Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion	47.7	1417	15	1432
1594-Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	10.8	170	193	363
1591-Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	15.0	111	152	263
1600-Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	36.4	861	65	926
1737-Typha rushland	Not a TEC	0.9	0	35	35

1591-Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	1591_Intact	Yes	111	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	1591_Underscrubbed	No	152	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1594-Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region

	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 686, 828, 835, 941, 1108, 1109, 1212, 1228, 1293, 1318, 1326, 1386, 1504, 1556, 1594, 1618, 1720, 1794	-	1594_Intact	Yes	170	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 686, 828, 835, 941, 1108, 1109, 1212, 1228, 1293, 1318, 1326, 1386, 1504, 1556, 1594, 1618, 1720, 1794	-	1594_Underscrubbed	No	193	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1600-Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter

Like-for-like credit retirement options

Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_Underscrubbed	No	65	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_regeneration	Yes	301	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_Intact	Yes	560	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1633-Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	**Like-for-like credit retirement options**					
	Name of offset trading group	Trading group	Zone	HBT	Credits	IBRA region
	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	1633_Intact	Yes	1235	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	1633_Underscrubbed	Yes	182	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	1633_Regrowth	No	15	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1737-Typha rushland	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

	Coastal Freshwater Lagoons This includes PCT's: 781, 783, 1071, 1290, 1735, 1736, 1737, 1740, 1741, 1742	Coastal Freshwater Lagoons >=70% and <90%	1737_Intact	No	35	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Acacia bynoeana / Bynoe's Wattle	**1633_Intact**	2.7	87.00
Anthochaera phrygia / Regent Honeyeater	**1633_Intact, 1633_Underscrubbed, 1594_Intact, 1594_Underscrubbed, 1591_Intact, 1591_Underscrubbed, 1600_Intact, 1600_regeneration**	50.3	2383.00
Callistemon linearifolius / Netted Bottle Brush	**1633_Intact, 1591_Intact**	400.0	601.00

Eucalyptus parramattensis subsp. decadens / Eucalyptus parramattensis subsp. decadens	**1633_Intact, 1633_Underscrubbed, 1594_Intact, 1591_Intact, 1633_Regrowth, 1600_Intact**	3224.0	6448.00
Grevillea parviflora subsp. parviflora / Small-flower Grevillea	**1633_Intact, 1594_Underscrubbed, 1633_Regrowth, 1600_Intact, 1600_regeneration**	10.9	348.00
Lathamus discolor / Swift Parrot	**1633_Intact, 1633_Underscrubbed, 1594_Intact, 1594_Underscrubbed, 1591_Intact, 1591_Underscrubbed, 1600_Underscrubbed, 1600_Intact, 1600_regeneration**	66.3	2899.00
Myotis macropus / Southern Myotis	**1633_Intact, 1633_Underscrubbed, 1633_Regrowth, 1600_Underscrubbed, 1600_Intact, 1600_regeneration**	27.0	699.00

Petaurus norfolcensis / Squirrel Glider	**1633_Intact, 1633_Underscrubbed, 1633_Regrowth, 1594_Intact, 1594_Underscrubbed, 1591_Intact, 1591_Underscrubbed, 1600_Underscrubbed, 1600_Intact, 1600_regeneration**	84.5	2420.00

Credit Retirement Options

Like-for-like credit retirement options

Acacia bynoeana / Bynoe's Wattle	Spp	IBRA subregion
	Acacia bynoeana / Bynoe's Wattle	Any in NSW
Anthochaera phrygia / Regent Honeyeater	Spp	IBRA subregion
	Anthochaera phrygia / Regent Honeyeater	Any in NSW
Callistemon linearifolius / Netted Bottle Brush	Spp	IBRA subregion
	Callistemon linearifolius / Netted Bottle Brush	Any in NSW
Eucalyptus parramattensis subsp. decadens / Eucalyptus parramattensis subsp. decadens	Spp	IBRA subregion

	Eucalyptus parramattensis subsp. decadens / Eucalyptus parramattensis subsp. decadens	Any in NSW
Grevillea parviflora subsp. parviflora / Small-flower Grevillea	Spp	IBRA subregion
	Grevillea parviflora subsp. parviflora / Small-flower Grevillea	Any in NSW
Lathamus discolor / Swift Parrot	Spp	IBRA subregion
	Lathamus discolor / Swift Parrot	Any in NSW
Myotis macropus / Southern Myotis	Spp	IBRA subregion
	Myotis macropus / Southern Myotis	Any in NSW
Petaurus norfolcensis / Squirrel Glider	Spp	IBRA subregion
	Petaurus norfolcensis / Squirrel Glider	Any in NSW

BAM Biodiversity Credit Report (Variations)

Proposal Details

Assessment Id
00016379/BAAS17098/19/00016384

Proposal Name
Kurri Kurri Hydro

BAM data last updated *
24/11/2021

Assessor Name

Assessor Number

BAM Data version *
50

Proponent Name(s)

Report Created
06/06/2022

BAM Case Status
Finalised

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10

Assessment Type
Biocertification

Date Finalised
06/06/2022

* Disclaimer: BAM data last updated may indicate either complete or partial update of the BAM calculator database. BAM calculator database may not be completely aligned with Bionet.

Potential Serious and Irreversible Impacts

Name of threatened ecological community	Listing status	Name of Plant Community Type/ID
Nil		

Species
Lathamus discolor / Swift Parrot
Anthochaera phrygia / Regent Honeyeater

Additional Information for Approval

PCT Outside Ibra Added

None added

PCTs With Customized Benchmarks

PCT
No Changes

Predicted Threatened Species Not On Site

Name
Calidris tenuirostris / Great Knot
Irediparra gallinacea / Comb-crested Jacana
Limicola falcinellus / Broad-billed Sandpiper
Limosa limosa / Black-tailed Godwit
Xenus cinereus / Terek Sandpiper
Calidris ferruginea / Curlew Sandpiper

Ecosystem Credit Summary (Number and class of biodiversity credits to be retired)

Name of Plant Community Type/ID	Name of threatened ecological community	Area of impact	HBT Cr	No HBT Cr	Total credits to be retired
1633-Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion	47.7	1417	15	1432.00
1594-Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions	10.8	170	193	363.00
1591-Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions	15.0	111	152	263.00

1600-Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions	36.4	861	65	926.00
1737-Typha rushland	Not a TEC	0.9	0	35	35.00

1591-Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter

Like-for-like credit retirement options

Class	Trading group	Zone	HBT	Credits	IBRA region
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	1591_Intact	Yes	111	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions This includes PCT's: 1591, 1598, 1603, 1605, 1691, 1692, 1749	-	1591_Underscrubbed	No	152	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region
Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1591_Intact	Yes (including artificial)	111	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1591_Underscrubbed	No	152	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1594-Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 686, 828, 835, 941, 1108, 1109, 1212, 1228, 1293, 1318, 1326, 1386, 1504, 1556, 1594, 1618, 1720, 1794	-	1594_Intact	Yes	170	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions This includes PCT's: 686, 828, 835, 941, 1108, 1109, 1212, 1228, 1293, 1318, 1326, 1386, 1504, 1556, 1594, 1618, 1720, 1794	-	1594_Underscrubbed	No	193	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options					
	Formation	Trading group	Zone	HBT	Credits	IBRA region
	Forested Wetlands	Tier 3 or higher threat status	1594_Intact	Yes (including artificial)	170	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Forested Wetlands	Tier 3 or higher threat status	1594_Underscrubbed	No	193	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1600-Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region

Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_Underscrubbed	No	65	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_regeneration	Yes	301	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Lower Hunter Spotted Gum Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions This includes PCT's: 1590, 1592, 1593, 1600, 1602	-	1600_Intact	Yes	560	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region

	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1600_Underscrubbed	No	65	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1600_regeneration	Yes (including artificial)	301	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Dry Sclerophyll Forests (Shrub/grass sub-formation)	Tier 3 or higher threat status	1600_Intact	Yes (including artificial)	560	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

1633-Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	1633_Intact	Yes	1235	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Kurri Sand Swamp Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	1633_Underscrubbed	Yes	182	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Kurri Sand Swamp Woodland in the Sydney Basin Bioregion This includes PCT's: 1633, 1635, 1650	-	1633_Regrowth	No	15	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Variation options

Formation	Trading group	Zone	HBT	Credits	IBRA region
Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 3 or higher threat status	1633_Intact	Yes (including artificial)	1235	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 3 or higher threat status	1633_Underscrubbed	Yes (including artificial)	182	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

	Dry Sclerophyll Forests (Shrubby sub-formation)	Tier 3 or higher threat status	1633_Regrowth	No	15	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
1737-Typha rushland	**Like-for-like credit retirement options**					
	Class	Trading group	Zone	HBT	Credits	IBRA region
	Coastal Freshwater Lagoons This includes PCT's: 781, 783, 1071, 1290, 1735, 1736, 1737, 1740, 1741, 1742	Coastal Freshwater Lagoons >=70% and <90%	1737_Intact	No	35	Hunter,Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
	Variation options					
	Formation	Trading group	Zone	HBT	Credits	IBRA region
	Freshwater Wetlands	Tier 2 or higher threat status	1737_Intact	No	35	IBRA Region: Sydney Basin, or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Species Credit Summary

Species	Vegetation Zone/s	Area / Count	Credits
Acacia bynoeana / Bynoe's Wattle	**1633_Intact**	2.7	87.00

Anthochaera phrygia / Regent Honeyeater	**1633_Intact, 1633_Underscrubbed, 1594_Intact, 1594_Underscrubbed, 1591_Intact, 1591_Underscrubbed, 1600_Intact, 1600_regeneration**	50.3	2383.00
Callistemon linearifolius / Netted Bottle Brush	**1633_Intact, 1591_Intact**	400.0	601.00
Eucalyptus parramattensis subsp. decadens / Eucalyptus parramattensis subsp. decadens	**1633_Intact, 1633_Underscrubbed, 1594_Intact, 1591_Intact, 1633_Regrowth, 1600_Intact**	3224.0	6448.00
Grevillea parviflora subsp. parviflora / Small-flower Grevillea	**1633_Intact, 1594_Underscrubbed, 1633_Regrowth, 1600_Intact, 1600_regeneration**	10.9	348.00
Lathamus discolor / Swift Parrot	**1633_Intact, 1633_Underscrubbed, 1594_Intact, 1594_Underscrubbed, 1591_Intact, 1591_Underscrubbed, 1600_Underscrubbed, 1600_Intact, 1600_regeneration**	66.3	2899.00
Myotis macropus / Southern Myotis	**1633_Intact, 1633_Underscrubbed, 1633_Regrowth, 1600_Underscrubbed, 1600_Intact, 1600_regeneration**	27.0	699.00

Petaurus norfolcensis / Squirrel Glider	**1633_Intact, 1633_Underscrubbed, 1633_Regrowth, 1594_Intact, 1594_Underscrubbed, 1591_Intact, 1591_Underscrubbed, 1600_Underscrubbed, 1600_Intact, 1600_regeneration**	84.5	2420.00

Credit Retirement Options

Like-for-like options

Acacia bynoeana/ Bynoe's Wattle	Spp	IBRA region	
	Acacia bynoeana/Bynoe's Wattle	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Flora	Endangered	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Anthochaera phrygia/ Regent Honeyeater	Spp	IBRA region	

	Anthochaera phrygia/Regent Honeyeater *Note: Variation rules do not apply for Critically Endangered species and impacts on Commonwealth listed entities that are a controlled action.*		Any in NSW
Callistemon linearifolius/ Netted Bottle Brush	Spp		IBRA region
	Callistemon linearifolius/Netted Bottle Brush		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Flora	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Eucalyptus parramattensis subsp. decadens/ Eucalyptus parramattensis subsp. decadens	Spp		IBRA region
	Eucalyptus parramattensis subsp. decadens/Eucalyptus parramattensis subsp. decadens		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing	IBRA region

		under Part 4 of the BC Act shown below	
	Flora	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Grevillea parviflora subsp. parviflora/ Small-flower Grevillea	Spp	IBRA region	
	Grevillea parviflora subsp. parviflora/Small-flower Grevillea	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Flora	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Lathamus discolor/ Swift Parrot	Spp	IBRA region	

	Lathamus discolor/Swift Parrot		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Endangered	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Myotis macropus/ Southern Myotis	Spp		IBRA region
	Myotis macropus/Southern Myotis		Any in NSW
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region

	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.
Petaurus norfolcensis/ Squirrel Glider	Spp	IBRA region	
	Petaurus norfolcensis/Squirrel Glider	Any in NSW	
	Variation options		
	Kingdom	Any species with same or higher category of listing under Part 4 of the BC Act shown below	IBRA region
	Fauna	Vulnerable	Hunter, Ellerston, Karuah Manning, Kerrabee, Liverpool Range, Peel, Tomalla, Upper Hunter, Wyong and Yengo. or Any IBRA subregion that is within 100 kilometers of the outer edge of the impacted site.

Appendix J – Detailed credit staging breakdown

Table H-1 Ecosystem credit calculations for staged offsetting of development

Veg Zone ID	Vegetation zone	Total area	Total credits	Stage 1 area (ha)	Stage 1 credits	Stage 2 area (ha)	Stage 2 credits	Stage 3 area (ha)	Stage 3 credits	Stage 4 area (ha)	Stage 4 credits
	Cleared	48.57	0	0.01		1.47		33.70		13.39	
	Mixed grassland	104.11	0	60.14		4.16		19.09		20.72	
	Water / Swamp	6.02	0	0.00		0.00		6.02		0.00	
1	Zone 1 - PCT1633, Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area intact condition	38.80	1235	0.00	0	12.74	406	12.94	412	13.12	418
2	Zone 2 - PCT1633, Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area underscrubbed/grazed condition	8.04	182	0.00	0	0.00	0	0.30	7	7.74	175
3	Zone 3 - PCT1633, Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area regrowth condition	0.88	15	0.00	0	0.00	0	0.88	15	0.00	0
	PCT1633	**47.72**	**1432**	**0.00**	**0**	**12.74**	**406**	**14.12**	**434**	**20.86**	**593**
4	Zone 4 - PCT1594, Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter intact condition	4.28	170	0.08	3	0.00	0	2.98	118	1.22	49
5	Zone 5 - PCT1594, Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter underscrubbed/grazed condition	6.56	193	1.30	38	1.04	31	4.21	124	0.00	0
	PCT1594	**10.84**	**363**	**1.38**	**42**	**1.04**	**31**	**7.19**	**242**	**1.22**	**49**
6	Zone 6 - PCT1591, Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter intact condition	4.87	111	0.00	0	0.00	0	4.58	104	0.28	6
7	Zone 7 - PCT1591, Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter underscrubbed/grazed condition	10.12	152	0.00	0	2.86	43	0.97	15	6.28	94
	PCT1591	**14.99**	**263**	**0.00**	**0**	**2.86**	**43**	**5.55**	**119**	**6.57**	**101**

Veg Zone ID	Vegetation zone	Total area	Total credits	Stage 1 area (ha)	Stage 1 credits	Stage 2 area (ha)	Stage 2 credits	Stage 3 area (ha)	Stage 3 credits	Stage 4 area (ha)	Stage 4 credits
8	Zone 8 - PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter underscrubbed/grazed condition	4.99	65	4.58	59.7	0.00	0	0.41	5.3	0.00	0
9	Zone 10 - PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter - regenerating	14.23	301	3.88	82.0	10.35	219	0.00	0.0	0.00	0
10	Zone 11 - PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter intact condition	17.17	560	0.46	14.9	13.13	428	3.04	99.2	0.54	18
	PCT 1600	**36.39**	**926**	**8.91**	**156.6**	**23.48**	**647**	**3.45**	**104.6**	**0.54**	**18**
11	Zone 12 - PCT1737, Typha rushland poor condition	**0.90**	35		0		0	0.90	35		0
	PCT1737	**0.90**	**35**					**0.90**	**35**		
	Total native vegetation	**110.84**	**3019**	**10.29**	**199**	**40.13**	**1126**	**31.21**	**934**	**29.19**	**760**
	Total area	**269.55**	**3019**	**70.45**		**45.76**		**90.02**		**63.30**	

Appendix K – Biodiversity Conservation Strategy

Introduction

Section 6.13(b) of the BC Act requires that the BCAR specify the number and class of biodiversity credits to be retired to offset the impacts as determined in accordance with the Biodiversity Assessment Method (BAM).

Biodiversity offsets would be required for impacts associated with development on the land proposed for biodiversity certification (Section 8). In accordance with the offset rules associated with the BOS and established under the *Biodiversity Conservation Regulation 2017,* there are various means by which offset obligations described in Sections 8.1.1 and 8.1.2 can be met. These include:

- Retiring the appropriate credits from an established stewardship site
- Monetary payment directly into the Biodiversity Conservation Fund (BCF) or
- Funding an approved biodiversity action (note this mechanism is only available to actions listed in the ancillary rules for biodiversity conservation actions (DPIE 2020a and therefore is not relevant to this site)

In addition to the retirement of biodiversity credits, the BC Act enables an applicant of a strategic biodiversity certification to access additional approved conservation measures including:

- Reservation of land under the National Parks and Wildlife Act 1974 (NPW Act)
- Adoption of development controls under the Environmental Planning and Assessment Act 1979 (EP&A Act) that conserve or enhance the natural environment
- State infrastructure contributions under the EP&A Act (as per s7.24) that conserve or enhance the natural environment
- Any other measure determined to be an approved conservation measure by the Minister for Energy and Environment.

As these measures are only available for strategic BCARs and do not apply to this proposal. All offset requirements would therefore be achieved through a combination of retirement of appropriate credits for established stewardship sites/s and payment into the BCF.

This Biodiversity Conservation Strategy provides an outline of how biodiversity offset requirements for the proposal will be met.

Summary of offset requirements of the proposal

Impacts requiring offsets

Impacts associated with development on the land proposed for biodiversity certification that will require biodiversity offsets comprise the removal of 110.84 hectare of native vegetation and associated habitat for threatened biota.

Ecosystem credits would be required to offset impacts on five plant community types (PCTs) and associated predicted threatened species. The proposal would also impact on eight species credit species which would require offsets. Species credits species that have been assessed by direct stem counts include Parramatta Red Gum and Netted Bottlebrush. All other species credit species have been assessed using an area polygon in accordance with the requirements of the BAM as listed in the threatened biodiversity data collection.

Impacts requiring offsetting are summarised in Table I-1 and Table I 2 below.

Table I-1 Impacts to PCTs requiring biodiversity offsets

Vegetation zone	Plant community type	PCT ID	Condition	Area in subject site (ha)	Conservation status (BC Act)
1 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (intact)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	Good	38.80	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC
2 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (underscrubbed)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	Poor	8.04	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC
3 Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area (regrowth)	Parramatta Red Gum – Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	Moderate	0.88	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC
4. Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (intact)	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	1594	Good	4.28	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner bioregions EEC
5 Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter (underscrubbed)	Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	1594	Moderate	6.56	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and Southeast Corner bioregions EEC
6 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (intact)	Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	1591	Good	4.87	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC

Vegetation zone	Plant community type	PCT ID	Condition	Area in subject site (ha)	Conservation status (BC Act)
7 Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter (underscrubbed)	Grey Gum –Rough-braked Apple shrubby open forest of the lower Hunter	1591	Poor	10.12	Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC
8 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (underscrubbed)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	1600	Poor	4.99	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC
9 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (melaleuca regrowth)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	1600	Poor	14.23	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC
10 Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter (intact)	Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub grass open forest of the lower Hunter	1600	Good	17.17	Lower Hunter Spotted Gum – Ironbark Forest in the Sydney Basin and NSW North Coast Bioregions EEC
11. Typha rushland	Typha rushland	1737	Moderate	0.9	Not listed
Total area native vegetation				**110.84**	

Table I-2 Impacts to species credit species requiring offsets

Species		Area of Habitat (ha)	Stem Count
Acacia bynoeana	*Bynoe's Wattle*	2.72	-
Callistemon linearifolius	Netted Bottlebrush	-	400
Eucalyptus parramattensis subsp. *decadens*	Parramatta Red Gum	-	3224 (including 1064 adults, 1612 juveniles and 548 seedlings)
Grevillea parviflora subsp. *parviflora*	Small-flower Grevillea	10.87	-
Myotis macropus	Southern Myotis	26.97	-
Petaurus norfolcensis	Squirrel Glider	84.49	-
Lathamus discolor	Swift Parrot	66.6	-
Anthochaera phrygia	Regent Honeyeater	50.27	

Ecosystem Credits

Ecosystem credits that would be required to offset the impacts from the conferral of biodiversity certification are shown in Table I 3.

Table I 3 Ecosystem credits required to offset impacts of the proposal

Vegetation zone	Total direct impact area(ha)	BC Act status[1]	Ecosystem credits required	Indirect impact area (ha)	Ecosystem credits required
PCT1633, Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	47.19	Kurri Sand Swamp Woodland in the Sydney Basin Bioregion EEC	1416	2.36	73
PCT1594, Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	10.83	River-Flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South-east Corner bioregions EEC	363	2.25	74
PCT1591, Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	14.97	Hunter Lowland Red Gum Forest in the Sydney Basin and New South Wales North Coast Bioregions EEC	263	0.72	14
PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	36.38	Central Hunter Ironbark—Spotted Gum—Grey Box Forest in the New South Wales North Coast and Sydney Basin Bioregions EEC	926	0.37	12
PCT1737, Typha rushland	0.90	Not a TEC	35	0	0
TOTAL	**110.27**		**3003**	**5.7**	**173**

EEC = endangered ecological community, TEC = threatened ecological community

Species Credits

Species credits that would be required to offset the impacts from the conferral of biodiversity certification are shown in Table I 4.

Table I 4 Species credits required to offset impacts associated with biodiversity certification

Species		Area of Habitat (ha)	Stem Count	Species Credits Required
Acacia bynoeana	*Bynoe's Wattle*	2.7	-	87
Callistemon linearifolius	Netted Bottlebrush	-	400	601
Eucalyptus parramattensis subsp. decadens	Parramatta Red Gum	-	3224 (including 1069 adults, 1604 juveniles and 548 seedlings)	6448
Grevillea parviflora subsp. parviflora	Small-flower Grevillea	10.9	-	348
Myotis macropus	Southern Myotis	26.97	-	699
Petaurus norfolcensis	Squirrel Glider	84.49	-	2420
Lathamus discolor	Swift Parrot (important habitat)	66.6	-	2899
Anthochaera phrygia	Regent Honeyeater (important habitat)	50.27		2383

Proposed mechanisms for delivering conservation measures

Hydro's preferred approach to offset the residual impacts of the proposed development is to secure and retire appropriate credits from a proposed Biodiversity Stewardship Site (BSS), located on Hydro land adjacent to the subject site. The proposed BBS, referred to as the Regrowth BSS contains approximately 770 ha of land located at Loxford, NSW (refer to Figure 1-1). This land comprises a large area of predominantly contiguous vegetation to the north and east of the former Hydro aluminium smelter. It also includes land located along Swamp Creek to the east of the former smelter site.

Assessment of the proposed BSS has commenced and vegetation mapping at the site has determined that the proposed BSS contains similar PCTs to those that would be impacted by the proposal. The threatened species credit species *Grevillia parviflora subsp parviflora* (Small-flowered Grevillea), *Eucalyptus parramattensis* (Parramatta Red Gum), *Callistemon linearifolius* (Netted Bottlebrush), *Petaurus norfolcensis* (Squirrel Glider) and *Myotis macropus* (Southern Myotis) have all been recorded within the proposed stewardship site. The site would also provide habitat, included mapped important habitat for *Lathamus discolor* (Swift Parrot) and *Anthochaera phrygia* (Regent Honeyeater)

Draft calculations of the number of ecosystem and species credits that would be generated from the proposed Regrowth BSS are provided in Table I-5 and Table I-6.

Once the BSS has been established appropriate like for like credits to offset impacts of the proposed development would be finalised and retired from the BSS accordingly.

Any residual credit shortfalls would be secured from other stewardship site/s that provide biodiversity credits that comply with the trading rules of the BOS. These credits may be available on the existing credit market for purchase or could be generated from land acquisition and subsequent BAM assessment and registration as a Biodiversity Stewardship Agreement (BSA).

A payment to the Biodiversity Conservation Fund (BCF) would be considered to meet the residual credit requirements if the suitable number and type of biodiversity credits are not able not be secured from third parties.

Further detailed regarding the proposed mechanisms for delivering the proposed conservation measures is provided in Chapter 9 of the BCAR.

Table I 5 Summary of ecosystem credits proposed to be retired at Regrowth BSS

Vegetation types (ecosystem credits)	PCT No.	Area in regrowth BSS (ha)	Credits generated	Direct impact area site (ha)	Credits required	Indirect impact area (ha)	Credits required	Credit deficit	Surplus credits	Comment
Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	1633	291.4	1678	47.2	1416	2.36	73	0	189	100% of credit requirement proposed to be retired at regrowth BSS
Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	1600	9.2	2728	36.4	926	2.62	86	0	1716	PCTs 1600, 1593 and 1592 are in same offsets trading group. 100% of credit requirement proposed to be retired at regrowth BSS
Red Ironbark - Spotted Gum - Prickly-leaved Paperbark shrubby open forest of the Lower Hunter	1593	319.8		0	0		0			
Spotted Gum - Red Ironbark - Grey Gum shrub - grass open forest of the Lower Hunter	1592	33.2		0	0		0			
Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	1594	34.2	108	10.8	363			-255		Deficit credits proposed to be purchased through BCF
Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	1591	14.3	82	15	263	0.72	14	-195		Deficit credits proposed to be purchased through BCF
Water Couch - Tall Spike Rush freshwater wetland of the Central Coast and lower Hunter	1736	2	15	0	0	0	0	-20		Deficit credits proposed to be purchased through BCF
Typha rushland	1737	1.2		0.9	35					

Table I 5 Summary of species credits proposed to be retired at Regrowth BSS

Species credit species	Count in BSS	Area in BSS (ha)	Credits generated	Area/number in BCAR site (ha)	Credits required BCAR	Deficit	Surplus	Comment
Acacia bynoeana		0.00	0	2.70	87	-87	0	87 species credits would be purchased through open market or BCF
Callistemon linearifolius	2299	N/A	1909	400	601	0	1308	
Grevillea parviflora subsp parviflora		21.60	126	10.90	348	-222	0	222 species credits would be purchased through open market or BCF
Eucalyptus parramattensis	19000	N/A	13488	3224	6448	0	7040	
Regent Honeyeater		644.40	4236	50.30	2383	0	1853	
Swift Parrot		204.00	1181	66.55	2899	-1718	0	1718 species credits would be purchased through open market or BCF (note that species expert has mapped 603 ha of important habitat for swift parrot within regrowth BSS therefore additional credits may be generated)
Southern Myotis		440.00	2893	26.97	699	0	2194	
Squirrel Glider		661.00	4416	84.50	2420	0	1996	

Responsibility for Delivery

The company who will be responsible for delivery of the proposed conservation measures is McCloy Loxford Land Pty Ltd (ABN 46 624 968 092). Contact details for this company are provided with the BCAR application.

Timing of implementation of proposed conservation measures

The proposal will be developed in four separate stages (refer to Figure 8-1 of BCAR). In accordance with the requirements under the BC Act, the approach to the provision of offsets will be to retire the biodiversity credits associated with each stage before construction on each separate stage commences.

A summary of the biodiversity credits to be retired along with staged development and offsetting of the area proposed for biocertification is presented in Table 3 (ecosystem credits) and Table 4 (species credits) below.

Table I 5 Ecosystem credits to be retired along with staged offsetting of development

Vegetation zone	Total direct impact area(ha)	Total credits	Stage 1 area (ha)	Stage 1 credits	Indirect impact area (ha)	Indirect impact credits	Stage 2 area (ha)	Stage 2 credits	Stage 3 area (ha)	Stage 3 credits	Stage 4 area (ha)	Stage 4 credits
PCT1633, Parramatta Red Gum - Narrow-leaved Apple - Prickly-leaved Paperbark shrubby woodland in the Cessnock-Kurri Kurri area	47.72	1432	0	0	2.61	81	12.74	406	14.12	434	20.86	593
PCT1594, Cabbage Gum-Rough-barked Apple grassy woodland on alluvial floodplains of the lower Hunter	10.84	363	1.38	42	2.39	77	1.04	31	7.19	242	1.22	49
PCT1591, Grey Gum - Rough-barked Apple shrubby open forest of the lower Hunter	14.99	263	0.00	0	0.65	13	2.86	43	5.55	119	6.57	101
PCT1600, Spotted Gum - Red Ironbark - Narrow-leaved Ironbark - Grey Box shrub-grass open forest of the lower Hunter	36.39	926	8.91	157	0.37	12	23.48	647	3.45	104	0.54	18
PCT1737, Typha rushland	0.90	35	0	0	0	0	0	0	0.90	35	0	0
TOTAL	**110.84**	**3019**	**10.29**	**199**	**6.02**	**183**	**40.12**	**1127**	**31.21**	**934**	**29.19**	**761**

Table I 6 Species credits to be retired along with staged offsetting of development

Species	Impact unit	Total impact	Total credits	Stage 2 area (ha)	Stage 2 credits	Stage 3 area (ha)	Stage 3 credits	Stage 4 area (ha)	Stage 4 credits	Stage 5 area (ha)	Stage 5 credits
Bynoe's Wattle (*Acacia bynoeana*)	area (ha)	2.7	87	0	0	2.7	87	0	0	0	0
Netted Bottlebrush (*Callistemon linearifolius*)	stems (count)	400	601	0	0	7.0	11	214.0	322	179.0	269
Parramatta Red Gum (*Eucalyptus parramattensis* subsp. *decadens*)	stems (count)	3224	6448	0	0	491.0	982	1763.0	3526	970.0	1940
Small-flower Grevillea (*Grevillea parviflora* subsp. *parviflora*)	area (ha)	10.9	348	0	0	4.4	140	5.1	163	1.4	45
Southern Myotis (*Myotis macropus*)	area (ha)	27.0	699	6.3	163	11.0	285	9.5	246	0.2	4
Squirrel Glider (*Petaurus norfolcensis*)	area (ha)	84.5	2420	1.9	54	30.2	865	27.4	785	25.0	716
Swift Parrot (*Lathamus discolor*)	area (ha)	66.6	2899	0.5	20	28.4	1236	17.1	734	20.6	898
Regent Honeyeater (*Anthochaera phygia*)	area (ha)	50.3	2383	0.1	5	23.4	1108	17.1	811	9.7	460

Funding sources for delivery of conservation measures

McCloy Loxford Land Pty Ltd (ABN 46 624 968 092) would be responsible for establishing and managing the stewardship site/s at which credits to offset the impact of proposal would be generated. Any additional credits that would need to be purchased either through the open market of the BTF would be funded by McCloy Loxford Land Pty Ltd (ABN 46 624 968 092).

Monitoring and reporting requirements of the proposed conservation measures

Offset delivery reports will be prepared confirming that biodiversity credits appropriate to offset impacts associated with each of the four proposed development stages have been secured and retired before construction on each separate stage commences. The majority of like for like credits to offset impacts of the proposed development would be retired from the Hydro BSS accordingly. Any residual credit shortfalls would be secured from other stewardship site/s or payments to the BCF and documented in offset delivery reports along with necessary supporting information such as application of the variation rules of the BAM as required.

Following the retiring of credits at the proposed Loxford BSS there would be ongoing ecological monitoring and reporting regarding conservation measures implemented within the proposed stewardship site/s in accordance with the Biodiversity Conservation Trust Ecological Monitoring Module (EMM) requirements (BCT 2021).

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22-SO-209341823-78/https://projects.ghd.com/oc/Newcastle3/hydrobiodiversityass/Delivery/Documents/2220284-REP-Biodiversity Certification Assessment Report.docx

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Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
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5	A Quin	K Crosby		M Kiejda		18/08/2022
6	A Quin	K Crosby		M Kiejda		29/08/2022

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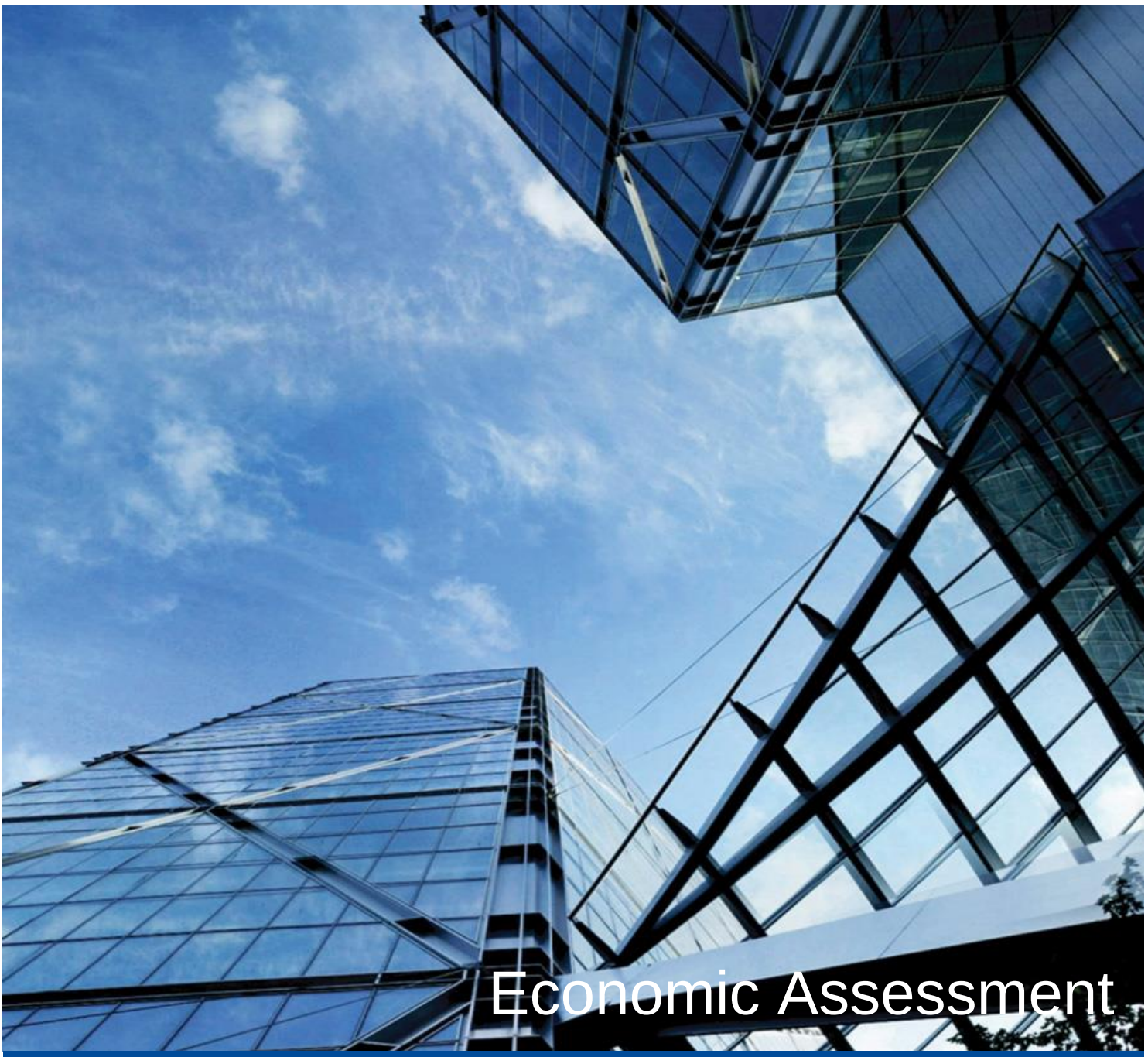
Appendix C

Economic Assessment Report



Economic Assessment

Hydro Aluminium, Kurri Kurri

June 2015

urbis

URBIS STAFF RESPONSIBLE FOR THIS REPORT WERE:

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Report Number	Final

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Executive Summary

The redevelopment of the Hydro Aluminium smelter at Kurri Kurri provides an opportunity for the release and development of a substantial amount of residential and employment generating uses.

The redevelopment of the smelter will provide approximately 375 hectares of additional developable land, and reserve 1,300 hectares as environmental conservation land.

This report considers the economic benefits of the proposed masterplan for the Hydro Aluminium smelter.

In summary, there appears to be a need for additional housing and employment land development within the Lower Hunter Region, to meet the housing and job targets outlined in the Lower Hunter Regional Strategy (LHRS) of:

- Provision of up to 115,000 new dwellings for a projected 160,000 new residents to 2031
- 69,000 of these new dwellings are targeted to be in greenfield locations
- Provide capacity to accommodate a projected 66,000 new jobs in the LHR by 2031.

It is estimated that the proposed masterplan for the Hydro smelter redevelopment will contribute the following housing and jobs to the LHRS targets:

- 2,100 new housing lots, representing 3% of the LHRS' detached housing target
- 6,900 new jobs, representing 10.5% of the LHRS' jobs target.

In addition to aligning with the LHRS targets above, there are a number of other underlying drivers for the land uses proposed in the masterplan. These reflect market conditions, and the demand for the different land uses in the proposed master plan.

The key drivers of residential demand on the subject site include:

- Primarily family households with children will demand the detached housing type within Cessnock and Maitland
- Strong population growth will underpin demand for housing
- The LHR population is expected to grow from 541,950 people in 2011 to 663,700 people in 2031
- The total increase in dwellings for the LHR to 2031 is forecast to be 63,600 (26.7%) or 3,180 new dwellings per annum.

The key drivers of employment land demand on the subject site include:

- Easy access to recently completed infrastructure such as the Hunter Expressway and F3 Freeway with access to the South Maitland Railway
- The network of TAFEs identified will also provide access to a workforce with qualifications compatible with the type of jobs accommodated on employment lands
- Poor take up of HEZ due to poor access to connecting infrastructure indicates that it is unable to support future jobs growth within the Cessnock LGA, requiring alternative englobo industrial land for development
- The Cessnock worker education and employment profile is highly compatible with industrial jobs development, which is reflected in Cessnock's existing employment base which consists mainly of manufacturing, mining and accommodation and food services

- Of the 45,459 new jobs expected to be created in the Lower Hunter between 2011 and 2031, approximately 3,528 of these are expected to be in industrial based sectors, with 902 of these jobs forecast for Cessnock LGA

- This will result in the take up of 176 hectares (8.8 hectares per annum) of additional industrial land in the LHR, 45 hectares (2.25 hectares per annum) of which are expected to be in the Cessnock LGA by 2031

- The 198 hectares of industrial zoned land on the subject site exceeds the Cessnock LGA's demand for industrial stock by 2031, as such the subject site's development will need to be staged over a period of time longer than the official employment forecasts

- Urbis estimates 5.3 - 8.4 (net) ha per annum is a feasible take up rate, resulting in a development timeframe of 24-37 years development timeframe as the subject will offer employment opportunities for residents in the whole of the LGA and potentially adjacent LGAs given the regional role the subject is likely play

- Given the site's location adjacent to the Hunter Expressway, ability to offer flexible lot sizes (due to its consolidated land ownership) the proposed employment lands on the site will likely cater to broader LHR demand for employment land (as opposed to purely local Cessnock businesses).

The economic benefits associated with the redevelopment of the Hydro Aluminium smelter at Kurri Kurri provides an opportunity for the release and development of a substantial amount of residential and employment generating uses:

- Ongoing jobs expansion of approximately 6,900 jobs

- Expansion of ongoing jobs will result in an additional $411 million worker income per annum

- Expansion of residential housing supply of up to 2,100 (according to the Draft Subdivision plan for the site)

- The expansion in population from the delivery of new housing and subsequent population growth is expected to expand local retail spend by $58.5 million at full development.

Introduction

The output of this assessment will be used to demonstrate the benefits of the development of the masterplan. The structure of this assessment is as follows:

- **Section 1** review the proposed masterplan, the site's locational context and surrounding land uses
- **Section 2** identifies and reviews the relevant policy documents pertinent to the redevelopment of the subject site
- **Section 3** analyses the drivers of demand for housing, and potential benefits associated with the development of additional housing on the subject site
- **Section 4** analyses the drivers of employment land development, and the subject site's characteristics that are compatible with employment land uses
- **Section 5** will provide indicative staging of the masterplan and the economic benefits from the project over time
- **Section 6** will provide a summary of the report and its findings.

1 Proposal, Site and Location

1.1 SUBJECT SITE

The subject site is located on Hart Road, Kurri Kurri, in the Lower Hunter Region (LHR) of New South Wales (NSW). The subject site contains the Hydro Aluminium Pty Ltd aluminium smelter, which ceased operations in September 2012 with long-term closure and decommissioning providing the opportunity to redevelop the smelter and associated buffer land.

The smelter began operations in 1969, and was a major employer within the Kurri Kurri community. While the closure of the smelter has resulted in loss of local jobs within Kurri Kurri, there is potential for future industrial land to attract businesses that will employ local workers.

The site encompasses approximately 60ha of disused smelter plant and some 2,000ha of buffer lands located on the border of both Maitland and Cessnock Local Government Areas (LGA).

1.2 PROPOSED REDEVELOPMENT

At completion the proposed redevelopment will yield the following housing and employment land outcomes.

The maximum potential employment benefits stemming from the redevelopment of the subject site are derived from both the ongoing operations of employment generating land uses and the construction of the land uses outlined in Table 1.1 below:

Ongoing Employment and Housing Benefits

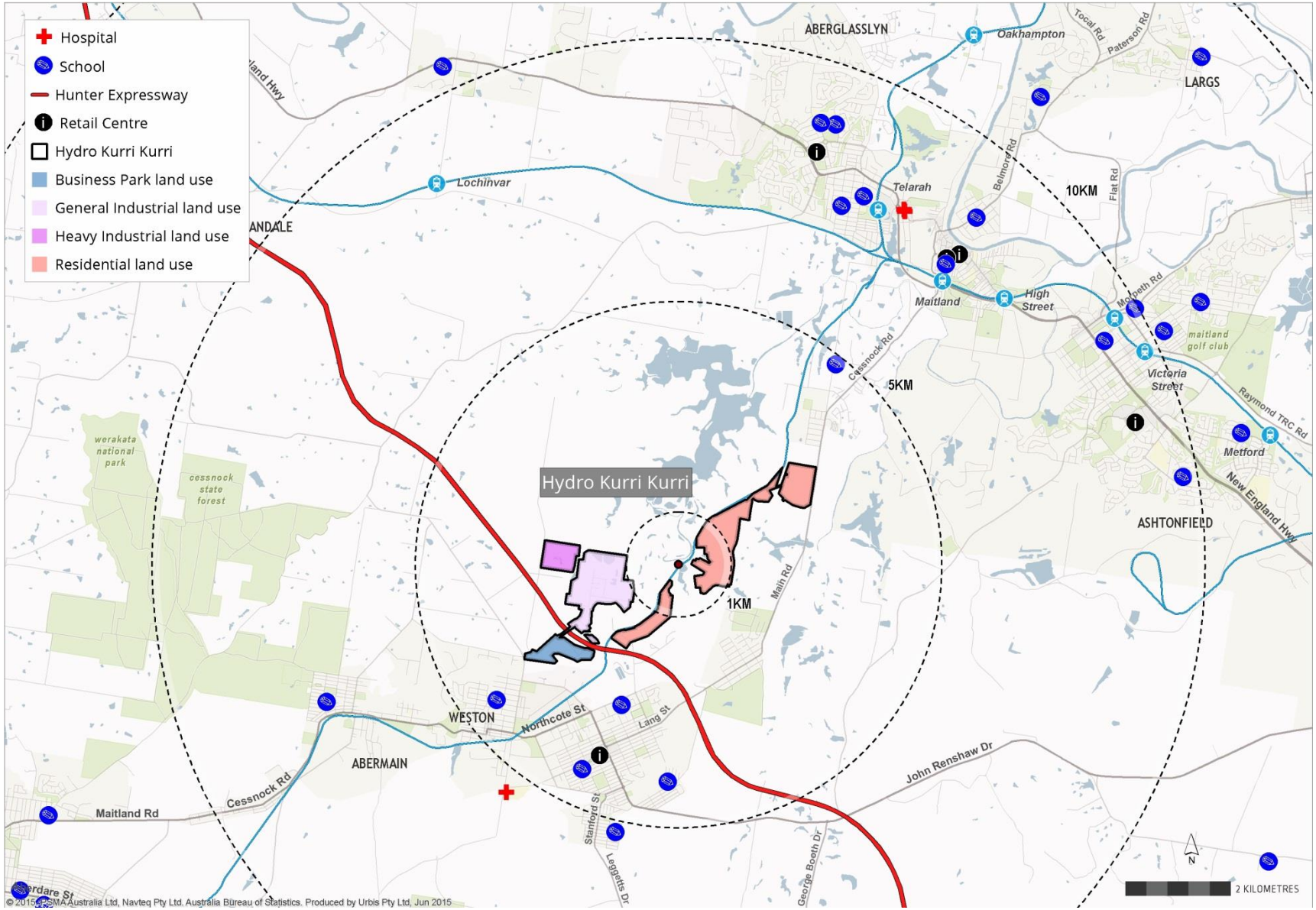
HYDRO ALUMINIUM MASTERPLAN — TABLE 1.1

LAND USE	LAND SIZE	GFA (SQM)	SQM PER JOB[1]	ONGOING EMPLOYMENT	HOUSING
Heavy Industrial	34.38ha	120,330	200	600	N/a
General Industrial	125.5ha	439,250	150	2,900	N/a
Business Park	38.18ha	133,630	40.5	3,300	N/a
Residential	128ha	1,275,700	N/A	N/a	2,100
Neighbourhood Centre	5,046m^2	2,523	25	100	N/a
Total				**6,900**	**2,100**

Source: Urbis; Hydro Aluminium; ABS

Urbis have estimated future population to be 5,460 based on Cessnock's 2011 household size of 2.6 applied to the 2,100 lots associated with the residential component of the proposed masterplan.

Map 1.1 highlights the spatial distribution of the proposed land uses, and the existing land uses surrounding the subject site.


Hospital
School
Hunter Expressway
Retail Centre
Hydro Kurri Kurri
Business Park land use
General Industrial land use
Heavy Industrial land use
Residential land use
ABERGLASSLYN
Oakhampton
Tocal Rd
Paterson Rd
LARGS
Lochinvar
Telarah
Belmont Rd
10KM
Flat Rd
Maitland
High Street
Mcbeth Rd
maitland golf club
Victoria Street
Cessnock Rd
5KM
Raymond TRC Rd
Metford
New England Hwy
ASHTONFIELD
werakata national park
cessnock state forest
Hydro Kurri Kurri
1KM
Main Rd
WESTON
Northcote St
Lang St
ABERMAIN
John Renshaw Dr
Maitland Rd
Cessnock Rd
Stanford St
Leggetts Dr
George Booth Dr
N
2 KILOMETRES
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2 Employment and Housing Policy

The following section provides an overview of key policy documents relevant to the subject site at both a regional and local level.

2.1 LOWER HUNTER REGIONAL STRATEGY

The Lower Hunter Regional Strategy (LHRS) was released by the New South Wales Government (NSWG) in 2006 and sets the current strategic direction for the LHR between 2006 and 2031. This strategy is currently under revision and the revised strategy is forecast to be released later this year (2015).

The LHRS provides a 25 year land use strategy to inform and guide the five Local Government Areas (LGAs) within the LHR on their decisions relating to service and infrastructure delivery to ensure sufficient provision of housing and employment land. These LGAs include the areas of Cessnock, Lake Macquarie, Maitland, Newcastle, and Port Stephens.

The redevelopment of the Hydro Aluminium smelter at Kurri Kurri will contribute to the achievement of the LHRS, by delivering:

- 10.5% of the jobs outlined in the LHRS
- 3% of the new release housing outlined in the LHRS.

Lower Hunter Regional Strategy

2031 TARGET VS. HYDRO HOUSING AND JOBS YIELD TABLE 2.1

POLICY TARGETS	2031 TARGET	CONCEPT PLAN'S YIELD	PERCENTAGE OF LHRS TARGET
Housing (in new release areas)	69,000	2,100[1]	3%
Jobs	66,000	6,900[2]	10.5%

Source: LHRS 2006; Urbis

[1]New lots produced

[2]Ongoing jobs (excludes construction jobs)

HOUSING OVERVIEW

The LHRS sets out targets for the LHR's housing requirements to 2031:

- Provision of up to 115,000 new dwellings for a projected 160,000 new residents to 2031
- 60% of new dwellings to be provided in new release areas, whilst the remaining 40% to be provided within existing urban areas.

JOBS AND EMPLOYMENT CENTRES OVERVIEW

In addition to housing the LHRS identifies jobs and a subsequent requirement for additional employment lands by 2031:

- Provide capacity to accommodate a projected 66,000 new jobs in the LHR by 2031
- Foster the development of regional centres to improve access to employment, retail, sustainable transport, and utilisation of established infrastructure
- Strengthening of the existing hierarchy of centres, in which Newcastle is identified as a regional city of national and international importance, and the major regional centres include Charlestown, Maitland, Raymond Terrace, Cessnock, Glendale (emerging), and Morisset (emerging). Subsequent to this hierarchy will be specialised centres, ton centres, and neighbourhood centres
- Identification of five key renewal corridors which link key centres and are situated along strategic transport routes. These corridors include Maitland Road, Tudor Street, Brunker Road, Main Road (Edgeworth), and the Pacific Highway.

2.1.1 ENVIRONMENT OVERVIEW

- Identification of two major green corridors: The Watagan to Stockton Corridor, and the Wallarah Peninsula Corridor
- These corridors have been deemed by the NSWG as having significant environmental value and they will be managed for conservation purposed
- Waterways within the LHR are aimed to be enhanced through the implementation of stormwater management plans derived from the Catchment Action Plan developed by the Department of Environment and Conservation
- Additions to these reserves will be achieved through the transfer of government lands for management under the National Parks and Wildlife Act, as well as through the dedication by major landholders of significant additional lands.

2.2 CESSNOCK 2023 COMMUNITY STRATEGIC PLAN

Cessnock City Council (CCC) undertook community consultation during 2010 to develop Cessnock's original Community Strategic Plan (Cessnock 2020 Community Plan). During 2013 the vision, outcomes and objectives from the original document were confirmed with the community and the Cessnock 2023 Community Strategic Plan (CCSP). The document provides a plan for the future of the Cessnock LGA and it the strategic directions for the region over the next 10 years.

Cessnock 2023 identified five desired outcomes as the priorities for the local community:

- A connected, safe and creative community: Developing safe and connected neighbourhoods that support healthy and fulfilling lifestyles for all ages
- A sustainable and prosperous economy: Achieving long term economic security through a mix of diverse business and employment options
- A sustainable and healthy environment: Promoting a sustainable balance between development and preserving our natural environment
- Accessible infrastructure, services and facilities: Increasing the range and accessibility of the services we need along with investment in improved infrastructure
- Civic leadership and effective governance: Ensuring strong leadership and good governance and fostering community participation in decision-making.

3 Residential Analysis

In considering the need for additional housing in Cessnock, Maitland and the broader LHR, Urbis have reviewed the key drivers of housing demand as they relate to the redevelopment of the subject site.

We have identified four key drivers of residential housing demand relevant to the development.

Table 3.1provides a brief description of these drivers and implications for the subject site, which include broadly:

- Access to local amenities
- The profile and demographics of the LHR, Cessnock and Maitland LGA, and implications for housing demand
- Benefits of locating residential land with strong access to employment opportunities and road network
- Future population growth, which will impact underlying demand for housing.

Based on the following analysis, the subject site appears to have the fundamental elements which drive demand for residential development, and is suitable to accommodate the LHR's growing population.

Residential Development Drivers

CESSNOCK AND LHR

TABLE 3.1

FACTORS	COMMENTS	IMPLICATIONS FOR THE SUBJECT SITE
1. Access to amenities	Locations that have easy access to services, infrastructure, education and open space are sought after as residential locations.	There are a number of existing infrastructure assets and services that would help support residential development on the subject site. These include: ▪ 16 schools (within 10 km of the centre of the subject site) ▪ Maitland Hospital ▪ Kurri Kurri Hospital ▪ Retail centres in Kurri Kurri and Cessnock ▪ The recently constructed Hunter Expressway, improving the connection with Newcastle ▪ Cessnock Road, providing a connection to Maitland and other employment centres. New masterplanned communities of scale to a large extent bring their own amenity with them, building in community facilities and schools. This has the potential to add amenity to the local area.
2. Demographics	The residential market's demographic profile has significant ramifications for housing demand. It affects its location, type, design and price. It also has socio-economic implications relating to affordability.	▪ Cessnock and Maitland LGAs have a large proportion of 'Youth' (0-15) residents, indicating the presence of family households, with children ▪ Cessnock has a higher proportion of families with children than the LHR, indicating a greater need for detached housing ▪ This type of family profile typically requires larger detached housing, suitable for growing families and larger household sizes, the lack of supply of this type of housing usually results in families moving elsewhere to start families which impacts the retention of workers and local retail markets

FACTORS	COMMENTS	IMPLICATIONS FOR THE SUBJECT SITE
		▪ The majority of Cessnock workers are drawn within Cessnock and Maitland ▪ This indicates that a worker market for the residential release component of the masterplan potentially exist in both Maitland and Cessnock ▪ This will likely increase as the employment uses in the masterplan are developed and additional workers are employed within and beyond Cessnock.
3. Population growth	Population growth is a key indicator of demand for housing.	▪ The LHR population is expected to grow from 541,950 people in 2011 to 663,700 people in 2031, between 0.9% and 1% per annum ▪ Cessnock is expected to grow above the LHR average annual growth rate, between 1.1% and 1.3% per annum.
4. Housing Demand	Forecasting population and household size provides an indication of housing demand. Compared to the residential yield associated with the masterplan illustrates the need for additional housing to support population growth.	▪ Dwellings in the LHR are forecast to grow from 238,000 dwellings in 2011 to 301,600 dwellings in 2031 ▪ Cessnock is expected increase its demand for dwellings from 22,250 in 2011 to 28,950 in 2031, an increase of 6,700 dwellings ▪ The subject site will be able to accommodate approximately 3.3% of the regions housing demand moving forward, and 31% of Cessnock's housing demand (based on existing forecasts).

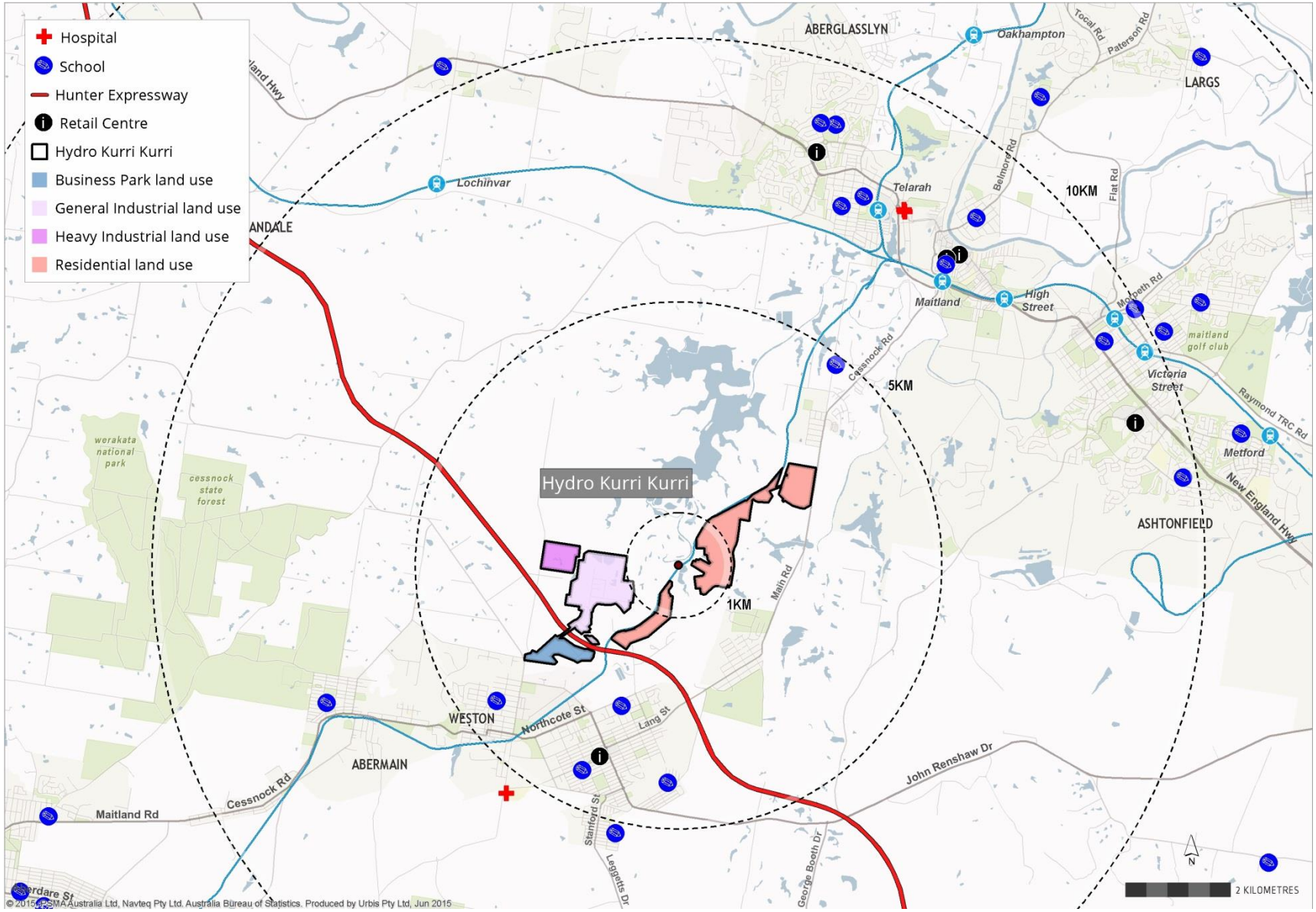
3.1 RESIDENTIAL AMENITY

New masterplanned communities to a large extent bring their own amenity with them, building in community facilities and schools. The Subdivision Design report prepared by PCB indicates the need to provide an additional:

- Schools
- Commercial and retail
- Community centre
- Open space for both active and passive uses.

The default open space rate is 2.83Ha per 1000 people, of which 1.81Ha per 1000 people is required for active open space for the likes of formal sports grounds and courts. Based on an estimated population of roughly 5,400 persons residing in the development, approximately 15ha of open space has been targeted for this subdivision.

In addition to this, there are a number of existing infrastructure and services that would support residential development on the subject site. These are outlined overleaf in Map 3.1, and include:


Hospital
School
Hunter Expressway
Retail Centre
Hydro Kurri Kurri
Business Park land use
General Industrial land use
Heavy Industrial land use
Residential land use
ABERGLASSLYN
Oakhampton
Tocal Rd
Paterson Rd
LARGS
Lochinvar
Telarah
Belmont Rd
Flat Rd
10KM
Maitland
High Street
Mcbeth Rd
maitland golf club
Victoria Street
Cessnock Rd
5KM
Raymond TRC Rd
Metford
New England Hwy
ASHTONFIELD
werakata national park
cessnock state forest
Hydro Kurri Kurri
1KM
Main Rd
WESTON
Northcote St
Lang St
ABERMAIN
Cessnock Rd
Maitland Rd
John Renshaw Dr
Stanford St
Leggetts Dr
George Booth Dr
N
2 KILOMETRES
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3.2 RESIDENT POPULATION DEMOGRAPHICS

3.2.1 POPULATION PROJECTIONS

The LHR population is expected to grow from 541,950 people in 2011 to 663,700 people in 2031. The table below outlines how each LGA within the LHR will grow.

- Lake Macquarie LGA is projected to remain the most populated LGA within the LHR, albeit the LGA is not forecast to grow as quickly as other LGA's
- Maitland LGA is projected to have the highest level of growth in population, registering a compounding annual growth rate (CAGR) for the period between 2001 and 2031 of 1.8 per cent
- Newcastle is projected to see the biggest nominal increase in population, with an estimated 34,500 new residents by 2031
- Maitland and Cessnock are expected to consistently grow above the LHR average, between 1.1% and 1.3% per annum.

Population Projections
LOWER HUNTER REGION
TABLE 3.2

Nominal	2011	2016	2021	2026	2031
Cessnock	52,500	55,900	59,550	63,000	66,400
Lake Macquarie	196,800	201,500	207,500	212,800	217,850
Maitland	69,900	77,900	85,250	92,750	100,500
Newcastle	155,550	164,400	173,350	181,850	190,050
Port Stephens	67,200	73,850	79,150	84,200	88,900
LHR	541,950	573,550	604,800	634,600	663,700

Change		2011 - 2016	2016 - 2021	2021 - 2026	2026 - 2031
Cessnock	-	3,400	3,650	3,450	3,400
Lake Macquarie	-	4,700	6,000	5,300	5,050
Maitland	-	8,000	7,350	7,500	7,750
Newcastle	-	8,850	8,950	8,500	8,200
Port Stephens	-	6,650	5,300	5,050	4,700
LHR	-	31,600	31,250	29,800	29,100

CAGR		2011 - 2016	2016 - 2021	2021 - 2026	2026 - 2031
Cessnock	-	1.3%	1.3%	1.1%	1.1%
Lake Macquarie	-	0.5%	0.6%	0.5%	0.5%
Maitland	-	2.2%	1.8%	1.7%	1.6%
Newcastle	-	1.1%	1.1%	1.0%	0.9%
Port Stephens	-	1.9%	1.4%	1.2%	1.1%
LHR	-	1.1%	1.1%	1.0%	0.9%

Source: BTS; Urbis

3.2.2 AGE DISTRIBUTION

The table below illustrates the age distribution within each LGA across the LHR. Whilst the distribution is relatively consistent across the LGA, Newcastle has a higher proportion of residents aged between 20 and 29 years of age.

Age Distribution

LOWER HUNTER REGION TABLE 3.3

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
0-4 years	7.5%	6.0%	7.5%	6.1%	6.4%	6.4%
5-9 years	6.8%	6.0%	7.2%	5.6%	6.4%	6.2%
10-14 years	7.1%	6.6%	7.3%	5.4%	6.7%	6.4%
15-19 years	6.7%	6.9%	7.2%	6.1%	6.5%	6.6%
20-24 years	6.1%	5.7%	6.2%	8.7%	5.2%	6.6%
25-29 years	6.2%	5.2%	6.3%	8.0%	4.7%	6.1%
30-34 years	6.2%	5.2%	6.5%	6.9%	4.9%	5.9%
35-39 years	6.6%	6.2%	7.1%	6.8%	6.1%	6.5%
40-44 years	6.6%	6.6%	7.1%	6.6%	6.4%	6.7%
45-49 years	6.4%	6.8%	6.8%	6.6%	7.0%	6.8%
50-54 years	6.9%	7.1%	6.7%	6.6%	6.7%	6.8%
55-59 years	6.5%	6.7%	6.0%	5.9%	6.6%	6.3%
60-64 years	6.4%	6.5%	5.4%	5.3%	7.0%	6.1%
65-69 years	4.6%	5.4%	4.0%	4.1%	6.4%	4.9%
70-74 years	3.2%	4.2%	3.0%	3.3%	4.8%	3.8%
75-79 years	2.6%	3.4%	2.4%	2.8%	3.5%	3.0%
80-84 years	2.0%	2.8%	1.8%	2.6%	2.5%	2.5%
85-89 years	1.2%	1.8%	1.1%	1.8%	1.5%	1.6%
90-94 years	0.4%	0.6%	0.4%	0.7%	0.5%	0.6%
95-99 years	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
100 years +	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

The table below provides an indication of the relative size of different age cohorts in the LHR. Lake Macquarie and Newcastle accommodate the highest number of retiree (65+) residents. Port Stephens, Cessnock and Maitland have the largest proportion of 'Youth' (0-15) residents, indicating the presence of family households, with children. This type of age demographic typically requires larger detached housing, suitable for growing families and larger household sizes. The lack of supply of this type of housing usually results in families moving elsewhere to start families which impacts the retention of workers and local retail markets. The significant distribution of youth will lead to strong employment demand over the next 10-20 years.

Age Cohorts

LOWER HUNTER REGION TABLE 3.4

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
0-14 years (Youth)	10,864	35,171	14,822	25,305	12,633	98,795
15-64 years (Working Age)	32,818	118,990	44,097	100,287	39,652	335,844
65 years + (Retiree)	7,158	34,844	8,560	22,942	12,523	86,027
Total	50,840	189,005	67,479	148,534	64,808	520,666

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
0-14 years (Youth)	21.4%	18.6%	22.0%	17.0%	19.5%	19.0%
15-64 years (Working Age)	64.6%	63.0%	65.3%	67.5%	61.2%	64.5%
65 years + (Retiree)	14.1%	18.4%	12.7%	15.4%	19.3%	16.5%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

3.2.3 DWELLING STRUCTURE

The table below outlines the established dwelling structures within across the LHR by LGA.

- Detached dwelling stock is the dominant product within the LHR, representing at least 85 per cent of all stock within each LGA
- Newcastle has the highest proportion of apartment product, registering 14 per cent off all stock within the Newcastle LGA
- Nominally, Lake Macquarie LGA has the most dwellings across the LHR, with 77,030 recorded
- Cessnock has the largest proportion of detached housing, representing 95.9% of its housing stock, reflecting the high proportion of local family households.

Dwelling Structure
LOWER HUNTER REGION — TABLE 3.5

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
House	19,645	71,997	24,958	54,712	24,779	196,091
Unit	602	4,017	1,316	9,127	1,331	16,393
Other	239	1,016	254	565	770	2,844
Total	20,486	77,030	26,528	64,404	26,880	215,328

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
House	95.9%	93.5%	94.1%	85.0%	92.2%	91.1%
Unit	2.9%	5.2%	5.0%	14.2%	5.0%	7.6%
Other	1.2%	1.3%	1.0%	0.9%	2.9%	1.3%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

3.2.4 HOUSEHOLDS

The table below depicts the number of households within each LGA across the LHR by family composition.

- Families with children are the dominant class within the LHR, accounting for a minimum of 38 per cent of households across each LGA
- Cessnock has a higher proportion of families with children than the LHR, indicating a need for detached housing.

Households
LOWER HUNTER REGION — TABLE 3.6

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Other	1,039	2,682	1,059	3,611	1,520	9,911
Group Household	466	1,652	568	3,879	546	7,111
Lone Person	4,348	16,829	5,182	17,268	5,886	49,513
Family with Children	9,496	34,432	12,893	24,425	11,060	92,306
Couple Family with No Children	5,137	21,436	6,825	15,221	7,868	56,487
Total	20,486	77,031	26,527	64,404	26,880	215,328

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Other	5.1%	3.5%	4.0%	5.6%	5.7%	4.6%
Group Household	2.3%	2.1%	2.1%	6.0%	2.0%	3.3%
Lone Person	21.2%	21.8%	19.5%	26.8%	21.9%	23.0%
Family with Children	46.4%	44.7%	48.6%	37.9%	41.1%	42.9%
Couple Family with No Children	25.1%	27.8%	25.7%	23.6%	29.3%	26.2%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

3.2.5 PERSONAL INCOME

The table below depicts the personal income distribution for LGA residents across the LHR.

- The income brackets between $10,400 and $41,599 account for the majority of all personal incomes recorded across the LHR
- There are no major proportionate variations between the income distributions for each LGA.

Personal Income Distribution

LOWER HUNTER REGION TABLE 3.7

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Negative income	0%	0%	0%	0%	0%	0%
Nil income	5%	5%	5%	5%	5%	5%
$1-$199 ($1-$10,399)	6%	6%	6%	6%	6%	6%
$200-$299 ($10,400-$15,599)	10%	10%	9%	9%	10%	10%
$300-$399 ($15,600-$20,799)	10%	10%	9%	10%	10%	10%
$400-$599 ($20,800-$31,199)	10%	11%	9%	10%	11%	10%
$600-$799 ($31,200-$41,599)	8%	8%	8%	8%	8%	8%
$800-$999 ($41,600-$51,999)	5%	6%	6%	7%	6%	6%
$1,000-$1,249 ($52,000-$64,999)	5%	6%	6%	6%	6%	6%
$1,250-$1,499 ($65,000-$77,999)	3%	4%	4%	5%	4%	4%
$1,500-$1,999 ($78,000-$103,999)	4%	5%	6%	6%	4%	5%
$2,000 or more ($104,000 or more)	4%	4%	5%	5%	3%	4%
Not stated	7%	5%	5%	6%	6%	6%
Not applicable	21%	19%	22%	17%	19%	19%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

3.2.6 JOURNEY TO WORK

The table below depicts the relationship between where LHR residents live and work.

- The majority of workers are drawn from Cessnock and Maitland
- Newcastle residents spread furthest from their local LGA, with over 50 per cent of residents working in a neighbouring or interstate LGA
- This indicates that a worker market for the residential release component of the masterplan potentially existing in both Maitland and Cessnock
- This may change as the employment uses in the masterplan are developed and additional workers are employed within Cessnock.

Journey to Work

LOWER HUNTER REGION TABLE 3.8

	LGA of Employment					
LGA of Residence	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Cessnock	64.9%	2.0%	9.2%	2.2%	2.0%	7.3%
Lake Macquarie	7.7%	68.4%	8.3%	30.1%	8.5%	33.5%
Maitland	11.6%	2.7%	56.2%	7.5%	8.6%	12.3%
Newcastle	6.6%	18.0%	11.7%	49.1%	14.9%	29.8%
Port Stephens	2.0%	1.7%	7.5%	6.0%	61.0%	11.1%
Other	7.2%	7.1%	7.0%	5.0%	5.0%	5.9%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

3.3 DWELLING PROJECTIONS

Dwellings in the LHR are forecast to grow from 238,000 dwellings in 2011 to 301,600 dwellings in 2031. The table below outlines how each LGA within the LHR will grow.

- Lake Macquarie currently has the most dwellings of any LGA across the LHR and is forecast to remain so in 2031
- Maitland is forecast to experience the strongest growth in dwellings, with a CAGR of 2.1 per cent to 2031
- Newcastle is predicted to have the largest nominal increase (17,300)
- The total increase in dwellings for the LHR to 2031 is forecast to be 63,600 (26.7%), or 3,180 new dwellings per annum
- The subject site will be able to accommodate approximately 3.3% of the regions housing demand moving forward, and 9.9% of Cessnock and Maitland's combined housing demand.

Dwelling Projections

LOWER HUNTER REGION — TABLE 3.9

Nominal	2011	2016	2021	2026	2031
Cessnock	22,250	23,950	25,700	27,300	28,950
Lake Macquarie	84,150	87,400	90,950	94,100	97,000
Maitland	27,900	31,550	34,950	38,400	41,950
Newcastle	70,750	75,200	79,700	83,900	88,050
Port Stephens	32,950	36,800	39,900	42,850	45,650
LHR	238,000	254,900	271,200	286,550	301,600

Change		2011 - 2016	2016 - 2021	2021 - 2026	2026 - 2031
Cessnock	-	1,700	1,750	1,600	1,650
Lake Macquarie	-	3,250	3,550	3,150	2,900
Maitland	-	3,650	3,400	3,450	3,550
Newcastle	-	4,450	4,500	4,200	4,150
Port Stephens	-	3,850	3,100	2,950	2,800
LHR	-	16,900	16,300	15,350	15,050

CAGR		2011 - 2016	2016 - 2021	2021 - 2026	2026 - 2031
Cessnock	-	1.5%	1.4%	1.2%	1.2%
Lake Macquarie	-	0.8%	0.8%	0.7%	0.6%
Maitland	-	2.5%	2.1%	1.9%	1.8%
Newcastle	-	1.2%	1.2%	1.0%	1.0%
Port Stephens	-	2.2%	1.6%	1.4%	1.3%
LHR	-	1.4%	1.2%	1.1%	1.0%

Source: BTS; Urbis

4 Employment Analysis

4.1 EMPLOYMENT DRIVERS

As discussed in section one there are a number of key development drivers that underpin industrial precinct's success. These include:

- **Infrastructure and surrounding land uses** – allows for efficiency of operations and efficiency of connections throughout the supply chain
  - Infrastructure – improving the precinct's access to customers / end users, connectivity and access to key transport routes (roads, rail, port facilities, suppliers, etc.) and accessibility to a local workforce
  - Surrounding land uses – which may impact the precinct's capacity to leverage economies of scale and operational efficiency.
- **Competing Employment Land** – sites that meet the demands of modern operations and offer an appropriate size and layout to the market and provide opportunities to leverage infrastructure and surrounding uses
- **Population growth and demographics** – this encompasses both the location of the customer base and the workforce
  - Worker demographic characteristics and journey to work patterns
  - Population growth.
- **Employment growth** – the number and type of jobs within the region
- **Future employment land demand** (based on jobs growth).

This section will assess the subject site against these drivers, as well as summarise quantitative measures in Table 4.1 overleaf (e.g. land use forecasts and estimated sales rate).

Employment Land Drivers

CESSNOCK AND LHR

TABLE 4.1

FACTOR	COMMENTS	IMPLICATIONS FOR THE SUBJECT SITE
1. **Infrastructure and Surrounding Land Uses**	Physical infrastructure improves the accessibility of industrial precincts, improving their viability and appeal to tenants. Transport and warehousing tenants especially require this type of infrastructure, given the high volume of heavy vehicles using their sites.	Locations that have easy access to new infrastructure such as the Hunter Expressway and F3 Freeway and access to South Maitland Railway. The network of TAFEs identified will also provide access to a workforce with qualifications compatible with the type of jobs accommodated on employment lands.
2. **Competing Employment Land**	The availability of alternative locations within Cessnock impact the requirement for additional industrial precincts.	Cessnock has two major industrial precincts: ▪ Hunter Economic Zone ▪ Weston. HEZ has experienced poor uptake. Physical/ecological constraints, poor agglomeration (it does not attach to existing industry), poor connectivity and a comparable lack of access by a relevant workforce have been the key drivers behind this. Urbis therefore considers HEZ's lack of competitiveness compared to other industrial precincts within the LHR as a barrier in attracting businesses into the Cessnock LGA. Weston is largely developed, and will not provide the market with the same greenfield industrial product as the subject site. Our analysis indicates that given the site's location adjacent to the Hunter Expressway, ability to offer flexible lot sizes (due to its consolidated land ownership) and the expected growth in the freight and logistics and construction sectors, that the site cater to larger warehouse and distribution operators while also providing smaller sized options aimed at supporting construction and mining.

3.	**Worker Demographics**	There is a strong connection between workforce, resident population and growth in employment / Cessnock's industrial base. Access to an appropriately skilled workforce is a key locational driver for businesses. As such industrial precincts need to be located close to workers or with good access to transport infrastructure that make them accessible.	▪ Cessnock's education profile indicates higher worker demand for blue collar jobs than white collar jobs ▪ Cessnock has a relatively higher proportion of residents with certificates at 20% of the resident population base, compared to other LGAs ▪ Local Cessnock jobs draw workers mainly from Maitland and Cessnock, both of which have mainly a blue collar workforce ▪ The prevalence of local blue collar workers would support the presence of industrial sector businesses rather than higher order white collar based employment ▪ This is reflected in Cessnock's existing employment base which consists mainly of manufacturing, mining and accommodation and food services.
4.	**Employment Growth**	Jobs growth provides an indication of the future demand for additional employment land.	Cessnock is expected to experience the highest annual jobs growth rate out of the LHR LGAs between 2011 and 2031, with 1.3% growth per annum. Accommodating this jobs growth requires appropriately zoned land. The specific type of land required, such as industrial, commercial and mixed use is largely determined by the industry sector that this growth occurs in. As such continued expansion of Cessnock's employment based will be dependent upon the provision of competitive employment lands, can attract additional share of regional employment growth.

5.	**Employment Land Demand**	Converting jobs growth to a specific land requirement provides an indication of the quantum of employment land that could be taken up by the market over time. It also provides an indication to government bodies how much land is required to meet employment policy targets.	Of the 45,459 new jobs expected to be created in the Lower Hunter between 2011 and 2031, approximately 3,528 of these are expected to be in industrial based sectors, with 902 of these jobs forecast for Cessnock LGA. This will result in the take up of 176 ha (8.8 ha per annum) of additional industrial land in the LHR, 45 ha (2.25 ha per annum) of which are expected to be by resident of Cessnock LGA by 2031. The 198 hectares of industrial zoned land on the subject site exceeds the LHR's Cessnock LGA's demand for industrial stock by 2031, however will be able to provide employment for the whole LHR given its strong connectivity. As such staged release of the precinct will likely occur over a period of time longer than the official employment forecasts. Urbis estimates between 5.3 - 8.4 hectares could be taken up per annum, resulting in a 24-37 years development timeframe. This is roughly in line with what was observed in the Cardiff Business Park, where 135 ha of industrial land took 20 years to be taken up (Subdivision Design Report, Hydro Aluminium Kurri Kurri 2013).

4.2 INFRASTRUCTURE AND SURROUNDING LAND USES

The subject site is poised to benefit from significant infrastructure projects existing, planned or under construction currently in the LHR.

Physical infrastructure and capital investment can provide a catalyst to the development of industrial precincts and the demand from industrial operators. It impacts a number of drivers associated with the success of industrial precincts:

- Access to customers/end users
- Connectivity and access to key transport routes (road, rail, port facilities, suppliers, etc.)
- Accessibility by workforce and population growth.

Physical infrastructure has a significant impact on these factors, providing greater accessibility to customers and workforce and reducing journey times. This section outlines relevant infrastructure that will service the subject site's employment lands.

These including:

- The Hunter Expressway (opened March 2014)
- South Maitland Railway.

In addition to this, there is a number of 'soft-infrastructure' or 'social infrastructure' assets that support the broader LHR economy. This primarily consists of the network of TAFEs throughout the LHR, including the Kurri Kurri campus located directly adjacent the subject site on McLeod Road, which contains a specialised Plant and Heavy Vehicle training centre.

Proximity to this infrastructure is a key factor in the successful redevelopment of the subject site within the LHR.

Given the site's location adjacent to the Hunter Expressway, ability to offer flexible lot sizes (due to its consolidated land ownership) and the expected growth in the freight and logistics and construction sectors, that the site cater to larger warehouse and distribution operators while also providing smaller sized options.

As such the combination of flexible lot sizes and transport infrastructure will increase the site's draw, and means it will likely cater to broader LHR demand for employment land (as opposed to purely local Cessnock businesses).

4.3 COMPETING EMPLOYMENT LANDS

The Cessnock LGA historically had a modest amount of industrial land. These were largely used for various urban services. More recently the addition of the Hunter Economic Zone (HEZ) has injected a large amount of vacant industrial zoned land into the LGA.

The major industrial areas in the Cessnock LGA are:

- Hunter Economic Zone
- Weston.

While most industrial zoned land is used for the purpose, the occupied lots in the B7 Business Park zoned area near Cessnock are currently being used for bulky goods retail, including a Bunnings Trade and auto servicing.

It is possible that not all of the current and proposed supply is seen as being suitable for servicing the demand which is expected to come mainly from the transport and storage, construction and mining

industries. These businesses typically require large land parcels, and access to transport routes is of course a key requirement for transport and storage, and mining businesses.

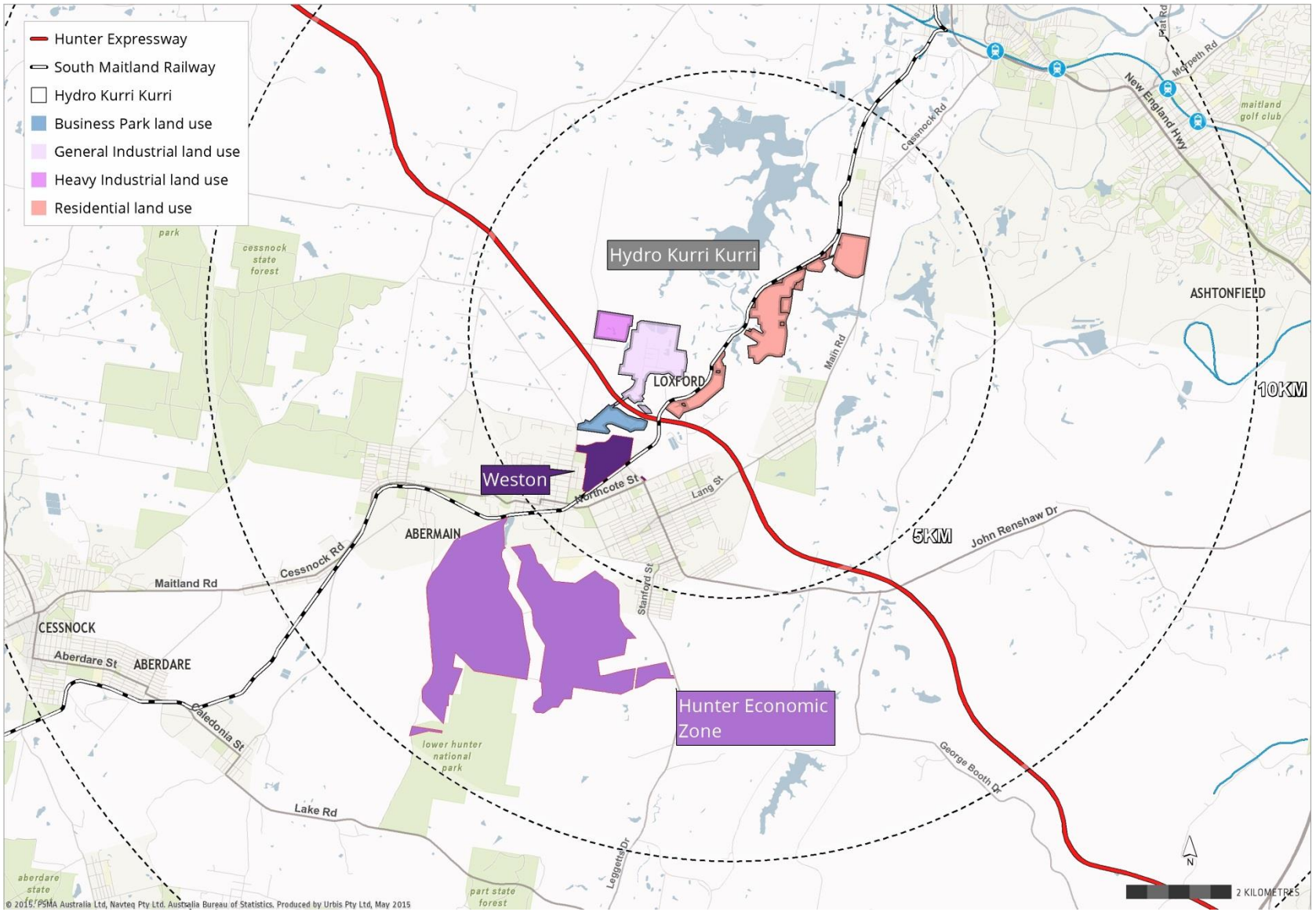
HEZ, due to its potential to provide large lots, was thought to be suitable to manufacturing and large logistics users. Despite this it has experienced poor uptake. Physical/ecological constraints, poor agglomeration (it does not attach to existing industry), poor connectivity and a comparable lack of access by a relevant workforce have been the key drivers behind this.

Urbis therefore considers HEZ's lack of competitiveness compared to other industrial precincts within the LHR as a barrier in attracting businesses into the Cessnock LGA.

Given the identified infrastructure and location attributes identified above in Section 4.2 the vacant HEZ industrial land is unlikely to compete significantly with the proposed industrial precinct at the subject site.

As such the existing employment lands within Cessnock may not have the attributes to attract sufficient industrial and business park tenant interest to sustain jobs growth within Cessnock or the broader LHR. This has economic development implications for the Cessnock LGA, and its capacity to attract additional industrial tenants.

By comparison the Hydro Aluminium site has a stronger connection to the Hunter Expressway, which makes it more accessible to workers, customers and other key pieces of infrastructure such as the Port of Newcastle.



Source: Hydro Aluminium Pty Ltd; Urbis

4.4 WORKER DEMOGRAPHICS

There is a strong connection between workforce, resident population and growth in employment / Cessnock's industrial base.

This subsequently has an impact on both the total quantum and type of employment land within Cessnock.

As such a review of the historic and forecast demographic profile of Cessnock and Lower Hunter workers will provide an indication of the type and required provision of employment lands within the LHR and Cessnock, to support ongoing economic development.

This section analyses worker's located within each LGA across the LHR and drivers behind demand for different types of land uses. It provides an indication of the type of workers available to the subject site.

4.4.1 AGE DISTRIBUTION

The table below illustrates the age distribution of workers within each LGA across the LHR.

- The majority of workers within the LHR are aged between 35 and 54 years of age (45.8%)
- Cessnock has the highest proportion of workers aged over 55 years of age (18.6%)
- Lake Macquarie has the highest proportion of workers aged under 24 years of age (19.5%), whilst Newcastle has the least (15.5%)
- 2.6 per cent of LHR workers are of retirement age (65 years) or older.

Age Distribution of Workers

LOWER HUNTER REGION TABLE 4.2

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
15-19 years	7.5%	8.9%	8.9%	5.3%	7.2%	7.0%
20-24 years	9.6%	10.6%	10.3%	10.2%	9.8%	10.3%
25-29 years	9.4%	9.3%	9.9%	10.7%	10.2%	10.1%
30-34 years	9.2%	8.6%	9.6%	10.3%	9.6%	9.6%
35-39 years	10.8%	10.2%	11.3%	11.3%	11.0%	11.0%
40-44 years	11.8%	10.9%	11.3%	11.8%	11.9%	11.5%
45-49 years	11.8%	11.6%	11.2%	11.9%	12.0%	11.8%
50-54 years	11.2%	11.5%	11.1%	11.9%	11.2%	11.6%
55-59 years	9.6%	9.6%	8.5%	9.1%	8.8%	9.2%
60-64 years	6.2%	5.7%	5.2%	5.1%	5.6%	5.4%
65-69 years	2.0%	2.0%	1.7%	1.6%	1.9%	1.8%
70-74 years	0.6%	0.6%	0.4%	0.5%	0.6%	0.5%
75-79 years	0.2%	0.2%	0.2%	0.2%	0.2%	0.2%
80-84 years	0.1%	0.1%	0.1%	0.0%	0.1%	0.1%
85-89 years	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
90-94 years	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
95-99 years	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
100 years +	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

4.4.2 WORKER EDUCATION

The table below depicts the highest year of school completed by workers of each LGA across the LHR.

- The majority of worker's across the LHR either completed year 12 (49.0%) or year 10 (34.2%)
- Newcastle has the highest proportion of workers who have completed year 12 (54.4%), whilst Cessnock has the least (40.4%).

Highest Year of School Completed (workers)

LOWER HUNTER REGION TABLE 4.3

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Year 12 or equivalent	40.4%	45.2%	45.2%	54.4%	45.8%	49.0%
Year 11 or equivalent	7.6%	7.8%	8.0%	6.5%	8.8%	7.4%
Year 10 or equivalent	39.3%	36.3%	36.7%	31.0%	35.8%	34.2%
Year 9 or equivalent	8.4%	7.2%	6.7%	5.2%	6.5%	6.3%
Year 8 or below	2.4%	1.9%	1.9%	1.4%	1.8%	1.7%
Did not go to school	0.1%	0.1%	0.0%	0.1%	0.0%	0.1%
Not stated	1.8%	1.5%	1.4%	1.3%	1.3%	1.4%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

The table below depicts non-school qualifications completed by workers of each LGA across the LHR.

- 28.4 per cent of workers across the LHR have completed certificate training, with Port Stephens recording the highest certificate training completed (34.4%)
- 20.4 per cent of workers across the LHR have completed a bachelor degree or higher, with Newcastle having the highest bachelor degree or higher training (25.4%), and Cessnock having the least (14.7%)
- Cessnock has the lowest level of postgraduate qualifications completed (1.9%), whilst Newcastle has the highest (4.9%)
- This education profile indicates higher worker demand for industrial jobs than white collar jobs.

Non-School Qualifications

LOWER HUNTER REGION TABLE 4.4

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Postgraduate Degree	1.9%	2.4%	2.6%	4.9%	2.4%	3.5%
Graduate Diploma and Graduate Certificate	1.4%	1.7%	1.8%	2.1%	1.2%	1.8%
Bachelor Degree	11.3%	13.0%	13.7%	18.4%	11.3%	15.1%
Advanced Diploma and Diploma	9.0%	9.3%	9.5%	10.8%	10.3%	10.1%
Certificate	29.9%	29.4%	29.0%	25.9%	34.0%	28.4%
Inadequately described	1.3%	1.3%	1.1%	1.3%	1.3%	1.3%
Not stated	3.1%	2.6%	2.6%	2.3%	2.4%	2.5%
Not applicable	41.9%	40.3%	39.6%	34.3%	37.1%	37.3%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

4.4.3 RESIDENT EDUCATION

The table below depicts the highest year of school completed by residents of each LGA across the LHR:

- Nominally, Newcastle and Lake Macquarie have the most year 12 graduates
- Cessnock has the lowest number of year 12 graduates both nominally (9,688) and proportionately (19%).

Highest Year of School Completed (Residents)

LOWER HUNTER REGION — TABLE 4.5

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Year 12 or equivalent	19%	28%	26%	37%	25%	29%
Year 11 or equivalent	6%	5%	6%	5%	6%	5%
Year 10 or equivalent	29%	28%	28%	22%	28%	26%
Year 9 or equivalent	11%	9%	8%	7%	9%	9%
Year 8 or below	6%	5%	5%	4%	5%	5%
Did not go to school	0%	0%	0%	1%	0%	0%
Not stated	8%	6%	6%	7%	7%	6%
Not applicable	21%	19%	22%	17%	19%	19%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

The table below depicts non-school qualifications completed by residents of each LGA across the LHR:

- LGAs with a higher proportion of white collar based employment contain residents with higher education attainment, with 16 per cent of Newcastle and 11 per cent of Lake Macquarie residents having a bachelor degree (or higher)
- By comparison, 5 per cent of Cessnock residents hold a bachelor degree or higher, reflecting the higher proportion of its employment base in blue collar industry sectors
- Cessnock has a relatively higher proportion of residents with certificates at 20% of the resident population base, compared to other LGAs.

Non-School Qualifications

LOWER HUNTER REGION — TABLE 4.6

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Postgraduate Degree	1%	2%	1%	3%	1%	2%
Graduate Diploma and Graduate Certificate	1%	1%	1%	1%	1%	1%
Bachelor Degree	4%	8%	7%	12%	6%	8%
Advanced Diploma and Diploma	4%	6%	6%	6%	6%	6%
Certificate	20%	19%	19%	16%	20%	19%
Inadequately described	1%	1%	1%	1%	1%	1%
Not stated	9%	7%	7%	8%	8%	8%
Not applicable	61%	55%	59%	52%	56%	56%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

4.4.4 INDUSTRY OF EMPLOYMENT

The table below depicts the industry of employment for LHR residents by LGA.

- Health care and social assistance is the largest industry of employment within the LHR due to large employment in both Lake Macquarie and Newcastle
- Manufacturing and retail trade are consistently large employment industries across the LHR
- Cessnock's workforce is focused on manufacturing, mining and accommodation and food services
- Manufacturing jobs may be skewed upwards slightly as the numbers were counted prior to the smelter shutting down.

Industry of Employment
LOWER HUNTER REGION TABLE 4.7

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Agriculture, Forestry and Fishing	0.7%	0.1%	0.5%	0.1%	0.5%	0.3%
Mining	4.2%	1.2%	3.0%	0.8%	0.7%	1.5%
Manufacturing	5.1%	4.6%	5.4%	4.3%	4.3%	4.6%
Electricity, Gas, Water and Waste Services	0.5%	0.9%	0.7%	0.8%	0.4%	0.7%
Construction	3.1%	4.0%	3.8%	3.1%	3.5%	3.6%
Wholesale Trade	1.1%	1.4%	1.4%	1.3%	1.1%	1.3%
Retail Trade	4.7%	5.2%	5.3%	4.9%	4.8%	5.0%
Accommodation and Food Services	4.0%	2.8%	3.1%	3.7%	3.6%	3.3%
Transport, Postal and Warehousing	1.6%	1.9%	2.1%	1.9%	2.2%	1.9%
Information Media and Telecommunications	0.2%	0.4%	0.4%	0.6%	0.3%	0.4%
Financial and Insurance Services	0.6%	1.5%	1.0%	1.6%	0.8%	1.3%
Rental, Hiring and Real Estate Services	0.6%	0.6%	0.7%	0.7%	0.8%	0.7%
Professional, Scientific and Technical Services	1.4%	2.4%	2.3%	3.5%	1.9%	2.6%
Administrative and Support Services	1.4%	1.3%	1.5%	1.4%	1.3%	1.4%
Public Administration and Safety	1.7%	2.5%	2.7%	3.2%	4.3%	2.9%
Education and Training	2.0%	3.8%	3.3%	4.5%	2.6%	3.6%
Health Care and Social Assistance	4.5%	6.4%	5.4%	7.5%	4.6%	6.2%
Arts and Recreation Services	0.5%	0.5%	0.5%	0.7%	0.6%	0.5%
Other Services	2.1%	1.9%	2.3%	1.7%	1.8%	1.9%
Inadequately described	0.5%	0.5%	0.5%	0.4%	0.5%	0.5%
Not stated	0.5%	0.4%	0.4%	0.4%	0.4%	0.4%
Not applicable	58.9%	55.8%	53.8%	52.7%	58.9%	55.3%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

4.4.5 OCCUPATION

The table below depicts the occupation of LHR residents by LGA.

- Lake Macquarie, Maitland, and Newcastle have a much higher level of professionals than Cessnock and Port Stephens
- The majority of Cessnock and Port Stephens residents are employed in blue collar industries
- Technicians and trade workers is the highest employment industry for Cessnock, Maitland and Port Stephens
- The higher proportion of technicians and trade workers in the Cessnock LGA reflects the education outcomes noted previously, with a higher proportion of residents certificates rather than higher education qualifications.

Occupation

LOWER HUNTER REGION TABLE 4.8

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Managers	3.6%	4.3%	4.5%	4.7%	4.6%	4.4%
Professionals	4.4%	8.4%	7.7%	12.2%	5.8%	8.7%
Technicians and Trades Workers	7.8%	7.4%	8.4%	6.5%	7.7%	7.3%
Community and Personal Service Workers	4.3%	4.4%	4.2%	5.0%	4.6%	4.6%
Clerical and Administrative Workers	4.7%	6.7%	6.5%	6.7%	5.5%	6.3%
Sales Workers	4.0%	4.7%	4.6%	4.7%	4.4%	4.6%
Machinery Operators and Drivers	6.0%	3.3%	4.8%	2.8%	3.4%	3.6%
Labourers	5.5%	4.4%	4.8%	4.2%	4.4%	4.5%
Inadequately described	0.4%	0.4%	0.4%	0.4%	0.3%	0.4%
Not stated	0.4%	0.3%	0.3%	0.3%	0.3%	0.3%
Not applicable	58.9%	55.8%	53.8%	52.7%	58.9%	55.3%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

4.4.6 JOURNEY TO WORK

The table below depicts the relationship between where LHR residents live and work.

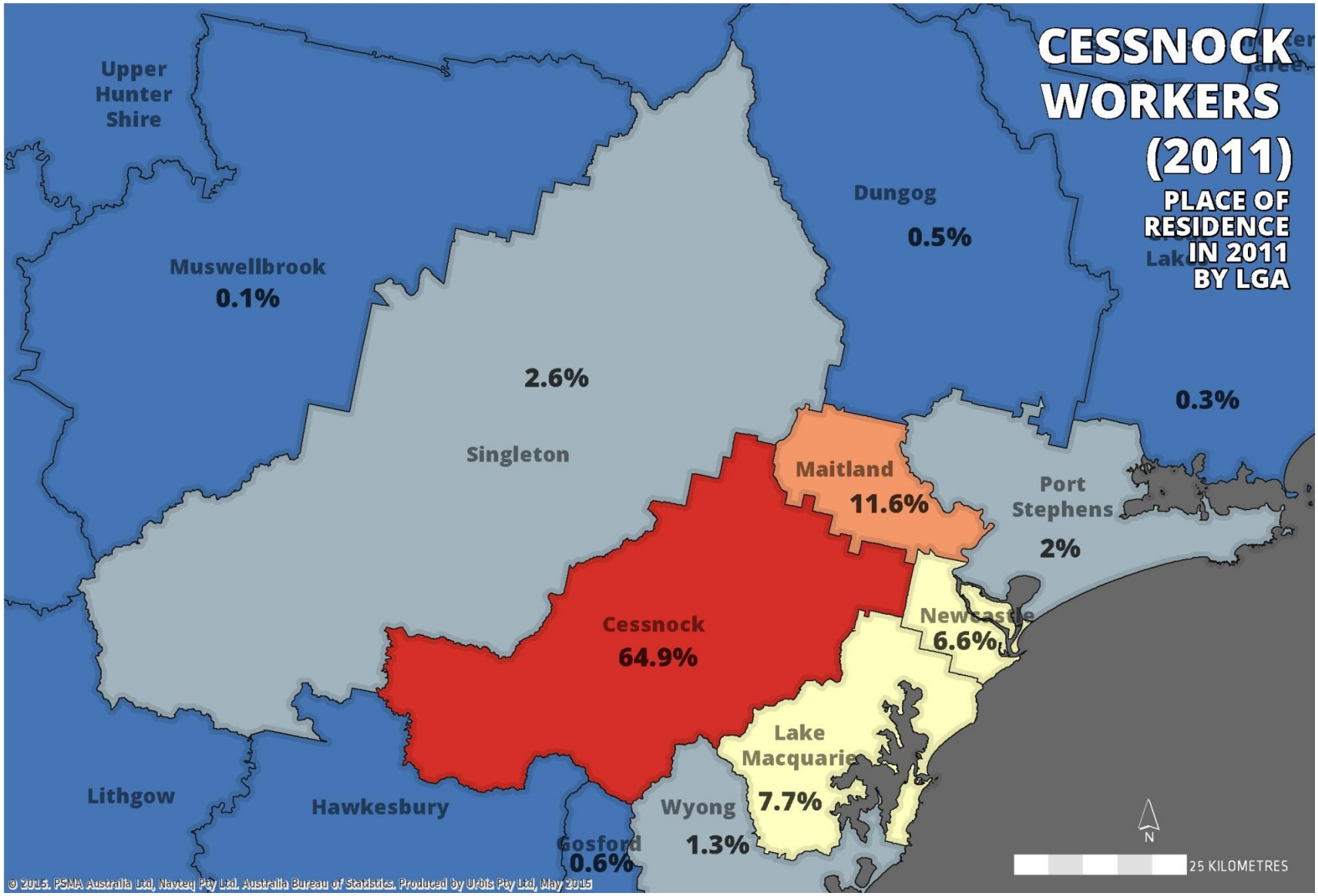
- The majority of residents work within their local LGA
- Newcastle residents spread furthest from their local LGA, with over 50 per cent of residents working in a neighbouring or interstate LGA
- This has ramifications for potential uses on the subject site for accessing a workforce, which will likely draw on a local workforce. This may preclude certain uses that rely on workers with higher education or typical 'white collar' backgrounds. The prevalence of local blue collar workers would support the presence of industrial sector businesses rather than higher order white collar based employment.

Journey to Work

LOWER HUNTER REGION TABLE 4.9

	LGA of Employment					
LGA of Residence	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Cessnock	64.9%	2.0%	9.2%	2.2%	2.0%	7.3%
Lake Macquarie	7.7%	68.4%	8.3%	30.1%	8.5%	33.5%
Maitland	11.6%	2.7%	56.2%	7.5%	8.6%	12.3%
Newcastle	6.6%	18.0%	11.7%	49.1%	14.9%	29.8%
Port Stephens	2.0%	1.7%	7.5%	6.0%	61.0%	11.1%
Other	7.2%	7.1%	7.0%	5.0%	5.0%	5.9%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis


CESSNOCK WORKERS (2011)
PLACE OF RESIDENCE IN 2011 BY LGA
Upper Hunter Shire
Muswellbrook
0.1%
2.6%
Singleton
Dungog
0.5%
0.3%
Maitland
11.6%
Port Stephens
2%
Newcastle
6.6%
Cessnock
64.9%
Lake Macquarie
7.7%
Wyong
1.3%
Gosford
0.6%
Lithgow
Hawkesbury
N
25 KILOMETRES
© 2015. PSMA Australia Ltd, Navteq Pty Ltd, Australia Bureau of Statistics. Produced by Urbis Pty Ltd, May 2015

4.5 EMPLOYMENT PROFILE AND PROJECTIONS

The existing profile of Cessnock's employment base can largely be described as 'blue collar', with a large proportion of:

- Labourers (13.2%)
- Machinery operators and drivers (9.0%)
- Manufacturing jobs (12.9%).

These jobs typically require specialised industrial buildings to operate effectively, requiring a provision of appropriately zoned employment land.

In addition to this, community and personal services workers comprise 13.4% of the local job base, reflected in the proportion of jobs in accommodation and food services (14.3%).

While this is exceeded by the traditional blue collar jobs base, it reflects diversity within the local economy that would benefit from a growing resident market brought on by population growth.

4.5.1 EMPLOYMENT PROFILE

The table below depicts the occupation of LHR workers by LGA.

- Whilst professionals are the majority occupation within the LHR (20.4%), this is largely derived from the amount of professionals employed within the Newcastle LGA (22,088; 25.1%)
- Cessnock has the highest proportion of community and personal service workers (13.4%), labourers (13.2%), and machinery operators and drivers (9.0%).

Occupation

LOWER HUNTER REGION TABLE 4.10

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Managers	11.2%	9.8%	10.7%	10.2%	12.2%	10.5%
Professionals	15.2%	17.3%	18.6%	25.1%	14.3%	20.4%
Technicians and Trades Workers	14.6%	15.7%	16.1%	13.1%	22.1%	15.2%
Community and Personal Service Workers	13.4%	11.4%	9.5%	9.5%	10.3%	10.4%
Clerical and Administrative Workers	10.9%	14.2%	15.0%	18.2%	12.6%	15.7%
Sales Workers	11.7%	13.7%	12.7%	8.6%	10.0%	10.8%
Machinery Operators and Drivers	9.0%	6.9%	7.2%	6.4%	8.2%	7.0%
Labourers	13.2%	10.4%	9.5%	8.1%	9.3%	9.3%
Inadequately described	0.6%	0.6%	0.5%	0.7%	0.8%	0.7%
Not stated	0.2%	0.1%	0.2%	0.1%	0.2%	0.1%
Not applicable	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

The table below depicts the industry of employment for LHR workers by LGA.

Cessnock employs one of the largest proportions of blue collar workers within the LHR, with accommodation and food services (14.3%), retail trade (13.7%) and manufacturing (12.9%) being the largest employment contributors.

Industry of Employment

LOWER HUNTER REGION TABLE 4.11

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Agriculture, Forestry and Fishing	2.3%	0.3%	1.0%	0.2%	1.3%	0.6%
Mining	4.2%	3.0%	2.3%	0.7%	0.6%	1.7%
Manufacturing	12.9%	10.2%	9.0%	9.6%	18.8%	11.0%
Electricity, Gas, Water and Waste Services	0.4%	1.3%	1.5%	2.4%	0.7%	1.7%
Construction	7.1%	7.7%	7.9%	5.4%	6.8%	6.6%
Wholesale Trade	1.7%	3.1%	2.5%	3.6%	2.0%	3.0%
Retail Trade	13.7%	15.7%	14.7%	9.3%	10.9%	12.1%
Accommodation and Food Services	14.3%	8.0%	7.2%	6.6%	9.1%	7.8%
Transport, Postal and Warehousing	2.7%	3.2%	4.0%	5.2%	4.4%	4.3%
Information Media and Telecommunications	0.4%	0.7%	0.7%	1.4%	0.5%	1.0%
Financial and Insurance Services	1.1%	3.3%	2.2%	4.2%	1.2%	3.2%
Rental, Hiring and Real Estate Services	1.6%	1.6%	2.2%	1.5%	1.9%	1.7%
Professional, Scientific and Technical Services	3.0%	4.6%	5.8%	8.2%	4.3%	6.2%
Administrative and Support Services	2.6%	2.6%	3.5%	2.7%	2.1%	2.7%
Public Administration and Safety	4.9%	4.3%	5.5%	6.3%	16.7%	6.8%
Education and Training	8.7%	8.8%	8.7%	9.1%	5.5%	8.5%
Health Care and Social Assistance	11.1%	14.6%	13.2%	18.1%	7.0%	14.9%
Arts and Recreation Services	1.4%	1.1%	0.9%	1.1%	1.4%	1.2%
Other Services	4.8%	4.9%	6.2%	3.7%	3.9%	4.4%
Inadequately described	0.9%	0.9%	1.0%	0.8%	0.9%	0.9%
Not stated	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Not applicable	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	100%	100%	100%	100%	100%	100%

Source: ABS; Urbis

4.5.2 EMPLOYMENT PROJECTIONS

While Newcastle and Lake Macquarie Council areas are expected to attract the majority of employment growth amongst LHR LGAs, Cessnock is expected to experience the highest annual growth in jobs growth between 2011 and 2031, with 1.3% growth per annum.

Employment Projections

LOWER HUNTER REGION TABLE 4.12

	2011	2016	2021	2026	2031	Jobs Growth (2011-31)	Annual Growth (2011-31)
Cessnock	17,738	18,905	20,191	21,550	23,062	5,324	1.3%
Lake Macquarie	65,013	66,860	69,456	72,533	75,428	10,415	0.7%
Maitland	27,734	28,311	29,900	31,711	33,425	5,691	0.9%
Newcastle	106,812	111,299	117,363	122,193	125,621	18,809	0.8%
Port Stephens	28,046	28,809	30,172	31,748	33,256	5,210	0.9%
Total	**245,343**	**254,184**	**267,082**	**279,735**	**290,792**	**45,449**	**0.9%**

Source: BTS; Urbis

Accommodating this jobs growth requires appropriately zoned land. The specific type of land required, such as industrial, commercial and mixed use is largely determined by the industry sector that this growth occurs in.

Table 4.13 overleaf illustrates that future jobs growth in Cessnock is focused in services sector, with retail trade (+795 jobs) and accommodation and food services (+923 jobs) comprising the largest growth in jobs.

Despite this there are a number of other industry sectors that would require employment land and business park lands, such as:

- Manufacturing (+373 jobs)

- Construction (+518 jobs)
- Transport, Postal and Warehousing (+327 jobs)
- Professional, Scientific and Technical Services (+303 jobs).

Change in Employment by Industry (Jobs) – 2011 to 2031

LOWER HUNTER REGION TABLE 4.13

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens
Agriculture, Forestry & Fishing	119	-3	42	229	56
Mining	-60	-180	246	-203	-12
Manufacturing	373	849	690	-1,073	358
Electricity, Gas, Water & Waste Services	107	52	88	119	24
Construction	518	1,475	611	1,538	428
Wholesale Trade	160	-289	68	-618	79
Retail Trade	795	967	786	2,098	872
Accommodation & Food Services	923	992	408	2,405	608
Transport, Postal & Warehousing	327	493	214	993	123
Information Media & Telecommunications	18	52	-20	715	12
Financial & Insurance Services	10	499	-9	1,113	-45
Rental, Hiring & Real Estate Services	56	142	42	504	152
Professional, Scientific & Technical Services	303	368	46	3,442	127
Administrative & Support Services	168	322	68	433	183
Public Administration & Safety	324	690	358	2,022	484
Education & Training	334	656	591	1,488	529
Health Care & Social Assistance	516	2,408	1,187	2,457	743
Arts & Recreation Services	6	114	34	300	153
Other Services	266	775	254	850	277
Unclassified	61	34	-10	1	60
Total	5,324	10,416	5,694	18,813	5,211

Green – top third, Yellow – middle third, Red – bottom third (of LGA)

Source: BTS; Urbis

Jobs growth in these sectors however is dependent upon the provision of competitive employment lands, can attract additional share of regional employment growth.

Employment Projections

LOWER HUNTER REGION

TABLE 4.14

	2011		2016		2021		2026		2031		2011 - 2031	
Industry Sector	#	%	#	%	#	%	#	%	#	%	Total Change	Annual Growth
Agriculture, Forestry & Fishing	1,470	0.6%	1,654	0.7%	1,755	0.7%	1,834	0.7%	1,913	0.7%	443	1.3%
Mining	4,522	1.8%	3,912	1.5%	4,058	1.5%	4,191	1.5%	4,313	1.5%	-209	-0.2%
Manufacturing	26,731	10.9%	26,632	10.5%	27,245	10.2%	27,624	9.9%	27,928	9.6%	1,197	0.2%
Electricity, Gas, Water & Waste Services	4,129	1.7%	3,761	1.5%	3,978	1.5%	4,277	1.5%	4,519	1.6%	390	0.5%
Construction	16,997	6.9%	17,969	7.1%	19,135	7.2%	20,324	7.3%	21,567	7.4%	4,570	1.2%
Wholesale Trade	7,235	2.9%	7,278	2.9%	7,036	2.6%	6,829	2.4%	6,635	2.3%	-600	-0.4%
Retail Trade	29,335	12.0%	31,041	12.2%	32,308	12.1%	33,652	12.0%	34,853	12.0%	5,518	0.9%
Accommodation & Food Services	19,421	7.9%	20,536	8.1%	21,997	8.2%	23,359	8.4%	24,757	8.5%	5,336	1.2%
Transport, Postal & Warehousing	10,724	4.4%	10,968	4.3%	11,463	4.3%	12,153	4.3%	12,874	4.4%	2,150	0.9%
Information Media & Telecommunications	2,421	1.0%	2,756	1.1%	3,012	1.1%	3,118	1.1%	3,198	1.1%	777	1.4%
Financial & Insurance Services	7,347	3.0%	7,591	3.0%	7,987	3.0%	8,473	3.0%	8,915	3.1%	1,568	1.0%
Rental, Hiring & Real Estate Services	3,860	1.6%	4,131	1.6%	4,403	1.6%	4,589	1.6%	4,756	1.6%	896	1.0%
Professional, Scientific & Technical Services	14,564	5.9%	15,044	5.9%	16,458	6.2%	17,836	6.4%	18,850	6.5%	4,286	1.3%
Administrative & Support Services	6,717	2.7%	6,987	2.7%	7,387	2.8%	7,619	2.7%	7,891	2.7%	1,174	0.8%
Public Administration & Safety	16,089	6.6%	16,491	6.5%	17,529	6.6%	18,787	6.7%	19,967	6.9%	3,878	1.1%
Education & Training	20,093	8.2%	20,731	8.2%	22,049	8.3%	22,999	8.2%	23,691	8.1%	3,598	0.8%
Health Care & Social Assistance	35,534	14.5%	38,076	15.0%	39,817	14.9%	41,647	14.9%	42,845	14.7%	7,311	0.9%
Arts & Recreation Services	2,794	1.1%	2,994	1.2%	3,117	1.2%	3,265	1.2%	3,401	1.2%	607	1.0%
Other Services	10,518	4.3%	10,869	4.3%	11,501	4.3%	12,224	4.4%	12,940	4.4%	2,422	1.0%
Unclassified	4,833	2.0%	4,758	1.9%	4,848	1.8%	4,938	1.8%	4,979	1.7%	146	0.1%
Total	245,334	100%	254,179	100%	267,083	100%	279,738	100%	290,792	100%	45,458	0.9%

Source: BTS; Urbis

4.6 FUTURE EMPLOYMENT LAND DEMAND

The change in jobs by land use is highlighted below.

Of the 45,459 new jobs expected to be created in the Lower Hunter between 2011 and 2031, approximately 3,528 of these are expected to be in industrial based sectors, with 902 of these jobs forecast for Cessnock LGA.

Change in Employment by Land Use (Jobs) – 2011 to 2031

LOWER HUNTER REGION TABLE 4.15

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Industrial	902	1,084	1,356	-463	649	3,528
Office	1,244	3,113	878	9,069	1,341	15,642
Retail	979	1,061	823	2,365	952	6,180
Education	317	623	561	1,414	502	3,418
Health	465	2,167	1,068	2,211	668	6,580
Other	753	950	380	2,280	637	5,002
Off-site	495	1,180	504	1,443	353	3,977
Home	168	239	124	491	108	1,130

Green – top third, Yellow – middle third, Red – bottom third (of LGA)

Source: BTS; Urbis

This will result in the take up of 176 ha (8.8 ha per annum) additional industrial land in the LHR, 45 ha (2.25 ha per annum) which are expected to be generated by residents of Cessnock LGA by 2031.

The 198 hectares of industrial zoned land (38.2 hectares of Business Park, 34 hectares of heavy industrial, 125.5 hectares of general industrial land) on the subject site exceeds the Cessnock LGA's demand for industrial stock by 2031, however it will play a role in servicing employment demand in the whole LHR.

As such staged release of the precinct will likely occur over a period of time longer than the official employment forecasts.

Change in Required Land Use (Hectares) – 2011 to 2031

LOWER HUNTER REGION TABLE 4.16

	Cessnock	Lake Macquarie	Maitland	Newcastle	Port Stephens	LHR
Industrial	45	54	68	-23	32	176
Office	10	24	7	70	10	120
Retail	12	13	10	30	12	77
Education	6	11	10	26	9	62
Health	5	24	12	25	7	73
Other	11	14	5	33	9	71
Off-site	-	-	-	-	-	-
Home	-	-	-	-	-	-

Green – top third, Yellow – middle third, Red – bottom third (of LGA)

Source: BTS; Urbis

In an Industrial Land Supply Analysis report provided to Hydro Aluminium previously, Urbis estimated the subject site could potentially attract an annual take-up of 5-10 hectares of net area. This translates to approximately 20-40 years to take up, and between 60-95% of the total demand for employment land in the LHR in the previous report.

Since then a revision of employment forecasts by the NSW Bureau of Transport Statistics (BTS) as well as additional analysis of 2011 base period Census Place of Work data has predicted a slower employment growth rate. The impact is likely a take up rate close to the low end range forecast in our previous report.

Maintaining the subject site's share of LHR's of future employment land demand (60-95% as staged on the previous page) estimated previously, this would now result in 5.3-8.4 ha per annum, 24-37 years development timeframe.

This is roughly in line with what was observed in the Cardiff Business Park, where 135 ha of industrial land took 20 years to be taken up (Subdivision Design Report, Hydro Aluminium Kurri Kurri 2013).

This will form the basis of the staging of Urbis' take up rate and staging of economic benefits in the following section of this report.

5 Economic Benefits

This section of the report looks at the economic benefits arising from the redevelopment of the Hydro Aluminium smelter site over time.

The maximum potential employment benefits stemming from the redevelopment of the subject site are derived from both the ongoing operations of employment generating land uses and the construction of the land uses outlined in Table 5.1 below:

Ongoing Employment Per Land Use

HYDRO ALUMINIUM MASTERPLAN TABLE 5.1

LAND USE	LAND SIZE	GFA (SQM)	SQM PER JOB[1]	ONGOING EMPLOYMENT
Heavy Industrial	34.38ha	120,330	200	600
General Industrial	125.5ha	439,250	150	2,900
Business Park	38.18ha	133,630	40.5	3,300
Residential	128ha	1,275,700	N/A	N/a
Neighbourhood Centre	5,046m^2	2,523	25	100
Total				**6,900**

[1]*Urbis employment benchmarks*

Source: Hydro Aluminium; ABS; Urbis

5.1 CONSTRUCTION STAGING

Urbis have identified the following staging assumptions to inform the timeframe outlined in Tables 5.2 and 5.3:

- Employment land take up between 5.3 and 8.2 hectares per annum, derived from the employment projections in Section 4.6. The employment lands are expected to be taken up at the following years:
  - **Low case scenario:** 37 years, at 5.3ha per annum
  - **High case scenario:** 23 years, at 8.2ha per annum.
- Residential take up of between 50 and 80 lots per annum, from comparable residential projects in the LHR. The residential land is expected to be taken up in:
  - **Low case scenario:** 41 years, at 50 lots per annum
  - **High case scenario:** 26 years, at 80 lots per annum.

Residential take up rates take into account the competing residential precincts surrounding Hydro Kurri Kurri, and are in line with sales rates at comparable residential releases areas (e.g. Mirvac's Gillieston Heights project has achieved an average of 70 lots per annum).

The sequencing of the employment land uses being developed is based on the Subdivision Design Report prepared by Pulver, Coopler & Blackley (PCB), where the Business Park land developed in stages

1 and 2, General Industrial in stages 3 to 8 and the Heavy Industrial is developed in stage 9. It is likely that these stages will be run concurrently at different points of time, as the three industrial land uses serve different tenant markets.

Employment Land Take Up

LOW AND HIGH CASE SCENARIO TABLE 5.2

Low Case Scenario 5.3 ha per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**
Heavy Industrial	0	0	0	0	8	16	24	34
General Industrial	13	15	41	67	86	104	123	126
Business Park	13	38	38	38	38	38	38	38
Total	**26**	**53**	**79**	**106**	**132**	**158**	**185**	**198**
High Case Scenario 8.4 ha per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**
Heavy Industrial	0	0	0	4	34	34	34	34
General Industrial	21	46	88	126	126	126	126	126
Business Park	21	38	38	38	38	38	38	38
Total	**42**	**84**	**126**	**168**	**198**	**198**	**198**	**198**

Source: Urbis; BTS

Residential and Neighbourhood Centre Take Up

LOW AND HIGH CASE SCENARIO TABLE 5.3

Low Case Scenario 50 lots per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**	**40-45**
Residential Lots	250	500	750	1,000	1,250	1,500	1,750	2,000	2,072
Resident Population	650	1,300	1,950	2,600	3,250	3,900	4,550	5,200	5,387
Resident Spend ($ million, per annum)	$7.0	$13.9	$20.9	$27.8	$34.8	$41.7	$48.7	$55.6	$57.6
Hectares									
Residential	21	42	64	85	106	127	149	170	176
Neighbourhood Centre	0.0	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5
Total	**21**	**43**	**64**	**85**	**106**	**128**	**149**	**170**	**177**
High Case Scenario 80 lots per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**	**40-45**
Residential Lots	400	800	1200	1600	2000	2072	2072	2072	2072
Resident Population	1,040	2,080	3,120	4,160	5,200	5,387	5,387	5,387	5,387
Resident Spend ($ million, per annum)	$11.1	$22.3	$33.4	$44.5	$55.6	$57.6	$57.6	$57.6	$57.6
Hectares									
Residential	34	68	102	136	170	176	176	176	176
Neighbourhood Centre	0.0	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5
Total	**34**	**68**	**102**	**136**	**170**	**177**	**177**	**177**	**177**

Source: Urbis

5.2 RESIDENTIAL STAGING

The jobs associated with the residential component of the Hydro Aluminium masterplan are derived largely from construction and the ongoing employment in the neighbourhood centres.

Ongoing jobs in the neighbourhood centres have been estimated to be 102 jobs at full development. Under the low case scenario this is expected to occur in year 26, and year 41 under the high case scenario.

Construction jobs are divided into direct jobs and indirect jobs.

Indirect supplier jobs stem from an increased demand for materials, services and products from a whole range of suppliers, as a result of increased consumption generated by the wages of new employees.

In economic terms, it represents the absorption of excess supply in other parts of the economy driven by an increase in aggregate demand in the retail industry.

Indirect employment impacts are measured using employment multipliers derived from the Australian National Accounts Input-Output tables, 1996-97. When using these multipliers, a number of issues need to be kept in mind:

- The multipliers reflect how the economy was structured in 1996-97. Since then, the structure of the economy has changed, and the actual impacts are likely to have changed.
- The multipliers are based on a static view of the economy, and do not consider price changes driven by changes in demand. This means that results from Input-Output multiplier analysis are likely to represent the upper bound of employment impacts.
- The multipliers are national multipliers, not regional. Therefore, while many of the directly created jobs will be filled by locals, many of the indirect jobs are likely to be filled elsewhere.

Urbis have estimated that the capital expenditure associated with the construction of the above uses to be approximately $193 million.

The impact of the two staging scenarios simply affects when the construction jobs will occur. Under the low case scenario, the construction jobs are spread out, while the high case scenario because it is being built faster results in larger construction jobs at any one point of time.

Residential Staging

LOW CASE SCENARIO (CONSTANT $ 2015) TABLE 5.4

Low Case Scenario 50 lots per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**	**40-45**
Residential Lots	250	500	750	1,000	1,250	1,500	1,750	2,000	2,072
Resident Population	650	1,300	1,950	2,600	3,250	3,900	4,550	5,200	5,387
Resident Spend ($ million, per annum)	$7.0	$13.9	$20.9	$27.8	$34.8	$41.7	$48.7	$55.6	$57.6
Hectares									
Residential	21	42	64	85	106	127	149	170	176
Neighbourhood Centre	0.0	0.1	0.2	0.2	0.3	0.4	0.4	0.5	0.5
Total	**21**	**43**	**64**	**85**	**106**	**128**	**149**	**170**	**177**
Gross Floor Area (GFA)									
Residential	13,074	26,149	39,223	52,298	65,372	78,446	91,521	104,595	108,518
Neighbourhood Centre	0	614	922	1,229	1,536	1,843	2,151	2,458	2,550
Total	**13,074**	**26,763**	**40,145**	**53,526**	**66,908**	**80,290**	**93,671**	**107,053**	**111,067**
Ongoing Jobs									
Residential	0	0	0	0	0	0	0	0	0
Neighbourhood Centre	0	25	37	49	61	74	86	98	102
Total	**0**	**25**	**37**	**49**	**61**	**74**	**86**	**98**	**102**
Worker Spend ($ million per annum)	$0.0	$2.2	$3.3	$4.4	$5.5	$6.6	$7.7	$8.8	$9.1
Capital Expenditure ($ million)									
Residential	$23	$23	$23	$23	$23	$23	$23	$23	$7
Neighbourhood Centre	$0.0	$0.9	$0.5	$0.5	$0.5	$0.5	$0.5	$0.5	$0.1
Total	**$23**	**$24**	**$23**	**$23**	**$23**	**$23**	**$23**	**$23**	**$7**
Direct Construction Jobs									
Residential	99	99	99	99	99	99	99	99	30
Neighbourhood Centre	0	4	2	2	2	2	2	2	1
Total	**99**	**103**	**101**	**101**	**101**	**101**	**101**	**101**	**30**
Indirect Construction									
Residential	15	15	15	15	15	15	15	15	4
Neighbourhood Centre	0	1	0	0	0	0	0	0	0
Total	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**15**	**4**

Source: Urbis

Residential Staging

HIGH CASE SCENARIO (CONSTANT $ 2015) TABLE 5.5

High Case Scenario 80 lots per annum	**0-5**	**5-10**	**10-15**	**15-20**	**25-30**	**30-35**
Residential Lots	400	800	1,200	1,600	2,000	2,072
Resident Population	1,040	2,080	3,120	4,160	5,200	5,387
Resident Spend ($ million, per annum)	$11.1	$22.3	$33.4	$44.5	$55.6	$57.6
Hectares						
Residential	34	68	102	136	170	176
Neighbourhood Centre	0.0	0.2	0.3	0.4	0.5	0.5
Gross Floor Area (GFA)						
Residential	20,919	41,838	62,757	83,676	104,595	108,361
Neighbourhood Centre	0	983	1,475	1,966	2,458	2,546
Total	**20,919**	**42,821**	**64,232**	**85,642**	**107,053**	**110,907**
Ongoing Jobs						
Residential	0	0	0	0	1	2
Neighbourhood Centre	0	39	59	79	98	102
Total	**0**	**39**	**59**	**79**	**99**	**104**
Worker Spend ($ million per annum)	$0.0	$2.8	$4.1	$5.5	$6.9	$7.3
Capital Expenditure ($ million)						
Residential	$37	$37	$37	$37	$37	$7
Neighbourhood Centre	$0.0	$1.7	$0.9	$0.9	$0.9	$0.2
Total	**$37**	**$38**	**$37**	**$37**	**$37**	**$7**
Direct Construction Jobs						
Residential	158	158	158	158	158	28
Neighbourhood Centre	0	7	4	4	4	1
Total	**158**	**165**	**161**	**161**	**161**	**29**
Indirect Construction Jobs						
Residential	23	23	23	23	23	4
Neighbourhood Centre	0	1	1	1	1	0
Total	**23**	**24**	**24**	**24**	**24**	**4**

Source: Urbis

5.3 EMPLOYMENT LAND STAGING

The heavy and general industrial areas are expected to support a combined 3,500 jobs. The business park is expected to generate 3,300. In total approximately 6,800 jobs are expected to be accommodated on the subject site's employment lands (in addition to the neighbourhood centre jobs identified above).

The staging of the employment lands has the effect of bringing forward full-employment in the high case scenario at full-development of the subject site in 23 years, while the low case scenario is expected to take 37 years to develop fully.

Employment Land Staging

LOW CASE SCENARIO TABLE 5.6

Low Case Scenario 5.3 ha per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**	**25-30**	**30-35**	**35-40**
Heavy Industrial	0	0	0	0	8	16	24	34
General Industrial	13	15	41	67	86	104	123	126
Business Park	13	38	38	38	38	38	38	38
Total	**26**	**53**	**79**	**106**	**132**	**158**	**185**	**198**
Gross Floor Area (GFA)								
Heavy Industrial	0	0	0	0	27,720	55,440	83,160	120,330
General Industrial	46,200	51,170	143,570	235,970	300,650	365,330	430,010	439,250
Business Park	46,200	133,630	133,630	133,630	133,630	133,630	133,630	133,630
Total	**92,400**	**184,800**	**277,200**	**369,600**	**462,000**	**554,400**	**646,800**	**693,210**
Ongoing Jobs								
Heavy Industrial	0	0	0	0	139	277	416	602
General Industrial	308	341	957	1,573	2,004	2,436	2,867	2,928
Business Park	1,141	3,300	3,300	3,300	3,300	3,300	3,300	3,300
Total	**1,449**	**3,641**	**4,257**	**4,873**	**5,442**	**6,012**	**6,582**	**6,829**
Worker Income ($ 2015 million per annum)	$87.4	$220.7	$256.6	$292.4	$325.5	$358.7	$391.8	$406.2
Capital Expenditure ($ million)								
Heavy Industrial	$0	$0	$0	$0	$28	$28	$28	$37
General Industrial	$46	$5	$92	$92	$65	$65	$65	$9
Business Park	$83	$157	$0	$0	$0	$0	$0	$0
Total	**$129**	**$162**	**$92**	**$92**	**$92**	**$92**	**$92**	**$46**
Direct Construction Jobs								
Heavy Industrial	0	0	0	0	119	119	119	160
General Industrial	199	21	398	398	279	279	279	40
Business Park	358	678	0	0	0	0	0	0
Total	**557**	**699**	**398**	**398**	**398**	**398**	**398**	**200**
Indirect Construction Jobs								
Heavy Industrial	0	0	0	0	44	44	44	59
General Industrial	73	8	145	145	102	102	102	15
Business Park	131	248	0	0	0	0	0	0
Total	**204**	**256**	**145**	**145**	**145**	**145**	**145**	**73**

Source: Urbis; BTS

Employment Land Staging

HIGH CASE SCENARIO — TABLE 5.7

High Case Scenario 8.2 ha per annum	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**
Hectares					
Heavy Industrial	0	0	13	25	34
General Industrial	21	46	75	105	126
Business Park	21	38	38	38	38
Total	**42**	**84**	**126**	**168**	**198**
Gross Floor Area (GFA)					
Heavy Industrial	0	0	44,100	88,200	120,400
General Industrial	73,500	160,370	263,270	366,170	439,250
Business Park	73,500	133,630	133,630	133,630	133,630
Total	**147,000**	**294,000**	**441,000**	**588,000**	**693,280**
Ongoing Jobs					
Heavy Industrial	0	0	221	441	602
General Industrial	490	1,069	1,755	2,441	2,928
Business Park	1,815	3,300	3,300	3,300	3,300
Total	**2,305**	**4,369**	**5,275**	**6,182**	**6,830**
Worker Income ($ 2015 million per annum)	$145.4	$277.1	$341.6	$406.2	$452.4
Capital Expenditure ($ million)	**0-5**	**5-10**	**10-15**	**15-20**	**20-25**
Heavy Industrial	$0	$0	$44	$44	$32
General Industrial	$74	$87	$103	$103	$73
Business Park	$132	$108	$0	$0	$0
Total	**$206**	**$195**	**$147**	**$147**	**$105**
Direct Construction Jobs					
Heavy Industrial	0	0	190	190	139
General Industrial	317	374	443	443	315
Business Park	570	466	0	0	0
Total	**886**	**840**	**633**	**633**	**453**
Indirect Construction Jobs					
Heavy Industrial	0	0	69	69	51
General Industrial	116	137	162	162	115
Business Park	208	170	0	0	0
Total	**324**	**307**	**231**	**231**	**166**

Source: Urbis; BTS

5.4 SUMMARY OF BENEFITS

At full development the Hydro Aluminium masterplan is expected to deliver.

- Ongoing jobs expansion of approximately **6,900 jobs**
- Expansion of ongoing jobs will result in an additional **$448.6 million worker income per annum**
- The expansion in population from the delivery of new housing and subsequent population growth is expected to expand local retail spend by **$58.4 million** at full development.

The low and high case staging will impact when these benefits are realised:

- **37 years** under the low case employment lands, at **5.3 ha per annum**
- **23 years** under the high case employment lands, at **8.4 ha per annum.**

Under the residential staging scenarios, the 2,072 residential lots will be delivered along with the associated neighbourhood centres by:

- **41 years** under the low case residential land at **50 lots per annum**
- **26 years** under the high case residential land at **80 lots per annum.**

6 Conclusion and Summary

The LHRS sets out the need for additional housing and employment land development within the Lower Hunter Region, to meet the housing and job targets outlined in the Lower Hunter Regional Strategy (LHRS) of:

- Provision of up to 115,000 new dwellings for a projected 160,000 new residents from 2011 to 2031
- Provide capacity to accommodate 66,000 new jobs in the LHR from 2011 to 2031.

It is estimated that the proposed masterplan for the Hydro smelter redevelopment will contribute the following housing and jobs to the LHRS targets:

- 2,100 new housing lots, representing 3% of the LHRS' detached housing target
- 6,900 new jobs, representing 10.5% of the LHRS' jobs target.

Of the 45,459 new jobs expected to be created in the Lower Hunter between 2011 and 2031, approximately 3,528 of these are expected to be in industrial based sectors, with 902 of these jobs forecast for Cessnock LGA.

This will result in the take up of 176 ha (8.8 ha per annum) of additional industrial land in the LHR, 45 ha (2.25 ha per annum) of which are expected to be located in the Cessnock LGA by 2031.

The 198 hectares of industrial zoned land on the subject site exceeds the Cessnock LGA's demand for industrial stock by 2031.

Despite this, Urbis' analysis indicates that given the site's location adjacent to the Hunter Expressway, ability to offer flexible lot sizes (due to its consolidated land ownership) and the expected growth in the freight and logistics and construction sectors, that the site cater to larger warehouse and distribution operators while also providing smaller sized options. As such it would be expected to draw on LHR demand for employment land, as it would offer employment opportunities for residents in the whole of the LHR.

While the development of the site will be staged, this will likely occur over a period of time longer than the official employment forecasts.

Urbis expects this to occur at a 5.3 - 8.4 hectare per annum rate, resulting in a 24-37 years development timeframe.

This is roughly in line with what was observed in the Cardiff Business Park, where 135 ha of industrial land took 20 years to be taken up (Subdivision Design Report, Hydro Aluminium Kurri Kurri 2013).

At full development the Hydro Aluminium masterplan is expected to deliver.

- Ongoing jobs expansion of approximately 6,900 jobs
- Expansion of ongoing jobs will result in an additional $448.6 million worker income per annum
- The expansion in population from the delivery of new housing and subsequent population growth is expected to expand local retail spend by $58.4 million at full development.

Under the residential staging scenarios, the 2,072 residential lots will be delivered along with the associated neighbourhood centres by:

- 41 years under the low case residential land at 50 lots per annum
- 26 years under the high case residential land at 80 lots per annum.

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This report has been prepared with due care and diligence by Urbis and the statements and opinions given by Urbis in this report are given in good faith and in the reasonable belief that they are correct and not misleading, subject to the limitations above.

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