emerge ASSOCIATES
Integrated Science & Design

Environmental Assessment Report

North Ellenbrook (East) District Structure Plan

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Executive Summary

Lendlease Communities (Ellenbrook) Pty Ltd have prepared a District Structure Plan (DSP) for the eastern portion of the North Ellenbrook 'Urban Investigation' area, as identified by the Western Australian Planning Commission (WAPC) and Department of Planning, Lands and Heritage in the *North-East Sub-regional Planning Framework*. The DSP extends across 21 freehold land parcels, comprising a total area of approximately 501 hectares ('the site'). This Environmental Assessment Report (EAR) has been prepared as the primary environmental documentation supporting the DSP.

Planning and Environmental Assessment Context

The DSP has been prepared to satisfy the 'detailed planning' requirements for the eastern portion of the North Ellenbrook 'Urban Investigation' area, as outlined in the *North-East Sub-regional Planning Framework*. Should the WAPC be supportive of the DSP, requests to amend the Metropolitan Region Scheme (MRS) and City of Swan (CoS) Local Planning Scheme (LPS) no. 17 will be lodged with the respective state and local authorities to facilitate the proposed future urban development of the site.

Future amendments to the MRS and CoS LPS no. 17 would be referred to the Environmental Protection Authority (EPA) pursuant to Section 48A of the *Environmental Protection Act 1986* (EP Act), who will consider whether implementation of the proposed future urban land use would be likely to result in significant environmental impacts and as such, whether environmental assessment is required.

Based on the outcomes of this EAR, it is considered unlikely that implementation of the proposed urban development within the site (as shown in the DSP) would result in significant residual impacts to the environment, given potential environmental impacts will be appropriately mitigated through a range of proposed impact avoidance, minimisation and rehabilitation measures.

With regard to the proposed Perth Darwin National Highway interchange; whilst potentially suitable locations are limited due to Main Roads interchange spacing requirements, its indicative location shown in the DSP has been strategically sited to minimise potential environmental impacts as much as possible, whilst also utilising existing landforms and topography to minimise basic raw materials requirements for its construction. Notwithstanding this, it is expected that there will still be some residual impacts associated with its construction, the extent of significance of which would be confirmed once detailed design has progressed. It is expected that the specific mechanism to deal with any residual impacts would be referral of a proposal to construct the interchange, pursuant to Section 38 of the EP Act, or alternatively a referral of a separate MRS amendment to establish the road reserve for the interchange, pursuant to Section 48A of the EP Act.

Stakeholder Engagement

Consultation with key stakeholders was undertaken throughout preparation of the DSP and this EAR. With regard to environmental considerations, the key stakeholder consultation completed for the DSP involved a number of meetings held with DWER – EPA Services, prior to lodgement of the DSP. This involved discussion around the proposed environmental assessment approach, the potential environmental impacts of the DSP and their level of significance, and the proposed timing and form of impact mitigation measures to be implemented.

Site-specific Investigations

A range of site-specific investigations have been completed to inform preparation of the DSP:

- *Flora and Vegetation Assessment – Various Lots North Ellenbrook* (Emerge Associates 2019)
- *Flora and Vegetation Survey – Lots 29 & 30 Maralla Road* (PGV Environmental 2019b)
- *Fauna Assessment – Various Lots, Bullsbrook* (BCE 2019)
- *Preliminary Assessment of Listed Aquatic Fauna within Various Lots, North Ellenbrook* (IPE 2019)
- *Black Cockatoo Habitat Assessment – Lots 29 and 30 Maralla Road* (PGV Environmental 2019a)
- *Acoustic Assessment* (HSA 2019).

Key Environmental Factors and Values

The key EPA environmental factors and associated values applicable to the site and DSP include:

Flora and vegetation

- Intact native vegetation representative of the Yanga vegetation complex
- Bush Forever Site 13
- Vegetation representative of the 'Banksia woodlands of the Swan Coastal Plain' threatened ecological community (TEC)
- Vegetation potentially representative of the 'forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain' TEC
- A population of threatened flora species *Grevillea curviloba* subsp. *curviloba*.

Terrestrial fauna

- Various habitat types for native fauna species
- Foraging, potential roosting and potential breeding habitat for threatened species of black cockatoo, specifically Carnaby's black cockatoo and forest red-tailed black cockatoo.
- Small areas of the site that contain 'marginal' or 'suitable' potential habitat for the threatened western swamp tortoise (WST). Whilst no observation or evidence of WST within the site was observed, these areas were identified as potential habitat due to the proximity of the site to the adjacent *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* area. Twin Swamps and Ellen Brook Nature Reserves, which contain the two remaining wild populations of WST, are situated approximately 0.9 km and 1.4 km from the site respectively.

Inland waters

- One mapped conservation category wetland within the site
- Three mapped resource enhancement wetlands within the site
- Intact natural waterways traversing the site, including Sawpit Gully and an unnamed creekline in the north of the site.

Terrestrial environmental quality

- Potential occurrence of acid sulfate soils, based on regional risk mapping.
- A low risk of potential contamination as a result of historical land uses.

Social surroundings

- Mythological Aboriginal heritage values associated with Registered Aboriginal Site DPLH 3525 *Ellen Brook: Upper Swan*.
- Non-indigenous heritage values associated with City of Swan heritage place 283 'The Barnard Springs Trough & Wetland', situated within Lot 8247.
- Surrounding land uses which may impact upon the amenity of the proposed future urban land uses within the site, including:
  - Perth Darwin National Highway (noise)
  - Perth-Geraldton rail freight line (noise)
  - Tree farm (noise)
  - Poultry farms (odour).

Proposed Environmental Mitigation Measures

A range of environmental impact avoidance, minimisation and rehabilitation mitigation measures are proposed to be implemented through the DSP and subsequent stages of the land use planning process. These can be split into two key components, summarised as follows:

- **Spatial responses of the DSP to avoid future impacts to environmental values as a result of urban development**. In this respect, the DSP provides for a future MRS 'Parks and Recreation' reserve and a number of local reserves, which have been strategically located to provide for the future retention of a range of key environmental values across the site. These reserves accommodate the following key environmental values:
  - The entirety of Bush Forever Site 13 and adjacent intact native vegetation, comprising the largest, most consolidated and least disturbed area of vegetation within the site.
  - Intact vegetation representative of the Yanga vegetation complex.
  - The only mapped conservation category wetland within the site and two mapped resource enhancement wetlands.
  - The two primary watercourses traversing the site (Sawpit Gully and the unnamed northern creekline) and associated foreshore areas, which support intact riparian vegetation.
  - Potential Aboriginal heritage values associated with the two watercourses, due to their function as tributaries to Ellen Brook.
  - Identified areas of 'suitable' and 'marginal' WST habitat, associated with Sawpit Gully.
  - Foraging, potential roosting and potential breeding habitat for Carnaby's and forest red-tailed black cockatoos.
  - The identified population of threatened flora species *Grevillea curviloba* subsp. *curviloba*.
  - All vegetation potentially representative of the state-listed TEC 'Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain'.

  In addition, proposed interchange has been strategically sited in the DSP design to minimise potential environmental impacts as much as possible. Specifically, the indicative interchange location shown on the DSP was selected to avoid or minimise impacts to the following values:
  - Bush Forever Site 13
  - Intact Yanga complex vegetation
  - A conservation category wetland
  - Sawpit Gully watercourse and fringing riparian vegetation within its foreshore area.
  - Vegetation representative of the Banksia Woodlands of the Swan Coastal Plain TEC.

- **Proposed local scheme provisions to define future environmental management requirements**. The proposed provisions would be established as part of the future amendment to the CoS LPS 17 and would specify the environmental management requirements to be addressed as part of the future development stages. Implementation of these requirements would occur during the future local structure planning and subdivision stages of development, providing for further environmental impact avoidance, minimisation and rehabilitation measures. The proposed local scheme provisions will be confirmed prior to lodgement of the future CoS LPS 17 amendment, but are proposed to include requirements for:
    - Local structure plans to provide local reserves consistent with those shown in the DSP.
    - Completion of site-specific Aboriginal heritage surveys
    - Preparation of various management strategies and plans, including;
        - Local Water Management Strategy, to outline how groundwater and surface water will be managed consistent with the principles of the District Water Management Strategy, to ensure that retained groundwater dependent ecosystems and natural waterways are maintained and that offsite impacts to WST habitat are avoided.
        - Reserve Management Plan/s, for local reserves which contain conservation values (such as intact Yanga complex vegetation, conservation category and resource enhancement wetlands, natural waterways, threatened flora or threatened ecological communities), to outline the proposed environmental management framework to be implemented.
        - Urban Water Management Plan/s, to outline how groundwater and surface water will be managed during urban development and subdivision works to implement the principles contained in the Local Water Management Strategy.
        - Fauna Management Plan/s, to outline the environmental management framework to mitigate potential risks of fauna interaction during the urban development process.
        - Construction Environmental Management Plan/s, for all construction occurring within 100 m of retained conservation values (such as intact Yanga complex vegetation, conservation category and resource enhancement wetlands, natural waterways, threatened flora or threatened ecological communities) to outline the proposed environmental management requirements to be implemented during construction to ensure retained conservation values are protected. This will include consideration of construction risks such as dieback, disease, weeds, fauna and access management.

Holistic Impact Assessment

Overall, the DSP provides a district-level framework to achieve conservation outcomes for a range of environmental values, to be implemented through future stages of the urban development process. This is primarily achieved through the proposed regional and local reserve network shown in the DSP, which will provide for the future retention of environmental values, as summarised in **Table ES1**.

It is important to note that the retention outcomes presented in **Table ES1** represent a worst-case scenario, as they do not account for any future conservation outcomes that may be achieved through future stages of the land use planning process. In this regard, further opportunities to avoid impacts to environmental values will be provided at the future local structure planning stage, where the location of additional local public open space areas can further consider opportunities to align with existing environmental values, to enable their potential future retention. This may increase the ultimate conservation outcome for a range of environmental values, beyond that shown in the DSP.

DSP Response to Strategic Planning and Environmental Planning Framework

Overall, the DSP provides a range of responses to suitably address the environmental 'key considerations' identified by the WAPC for the North Ellenbrook 'Urban Investigation' area, as outlined in the *North-East Sub-regional Planning Framework*. This is discussed in detail in this EAR.

In addition, the DSP is also consistent with overarching strategic advice of the EPA, specifically in relation to the relevant EPA recommendations outlined in their *Interim Strategic Advice* (EPA 2015a) on the *Draft Perth and Peel @ 3.5 Million* documents, of which the *North-East Sub-regional Planning Framework* is a sub-component. This is discussed in detail in this EAR.

Overall, the DSP provides appropriate mitigation measures and responses to suitably address the key environmental values of the site, such that it is unlikely that the proposed future implementation of urban development within the site in accordance with the DSP would result in significant residual environmental impacts, whilst also addressing the key requirements set out in the overarching strategic environmental planning framework.

Table ES1: Summary of predicted DSP outcomes for key environmental values

Environmental value	Area within site (ha)	Area within DSP reserves (ha)	Proportion within DSP reserves	Area within DSP development footprint (ha)	Proportion within DSP development footprint
Intact native vegetation in 'good' or better condition	44.9	30.5	68%	14.4	32%
Intact native vegetation in 'good' or better condition (Yanga complex)	41.7	30.5	73%	11.2	27%
Bush Forever Site 13	15.7	15.7	100%	0.0	0%
TEC - Banksia woodlands of the SCP	9.3	0.0	0%	9.3	100%
TEC (Potential) - Banksia woodlands of the SCP	3.5	0.0	0%	3.5	100%
TEC (Potential) - Forests and woodlands of deep seasonal wetlands of the SCP	0.6	0.6	100%	0.0	0%
PEC - Banksia dominated woodlands of the SCP IBRA region	5.7	0.0	0%	5.7	100%
TF - *Grevillea curviloba* subsp. *curviloba* population	0.9	0.9	100%	0.0	0%
'High' value CBC foraging habitat	0.0	N/A	N/A	N/A	N/A
'High' value FRTBC foraging habitat	36.1	29.5	82%	6.6	18%
Black cockatoo potential breeding habitat trees	414 trees	185 trees	45%	229 trees	55%
Suitable WST habitat which may possibly be used by species, but not likely	4.6	4.0	87%	0.6	13%
Marginal WST habitat which may possibly be used by species, but not likely	1.4	1.4	100%	0.0	0%
Conservation category wetlands	14.9	14.9	100%	0.0	0%
Resource enhancement wetlands	8.8	5.6	64%	3.2	36%

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North Ellenbrook (East) District Structure Plan (CLE 2019)

Appendix B

Flora and Vegetation Assessment (Emerge Associates 2019)

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Fauna Assessment (BCE 2019)

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Aquatic Fauna Assessment (IPE 2019)

Appendix E

Environmental Assessment Report - Lots 29 & 30 Maralla Road (RPS 2019)

Abbreviation Tables

Table A1: Abbreviations – organisations

Organisations	
DBCA	Department of Biodiversity, Conservation and Attractions
DPLH	Department of Planning, Lands and Heritage
DWER	Department of Water and Environmental Regulation
EPA	Environmental Protection Authority
WAPC	Western Australian Planning Commission

Table A2: Abbreviations – general terms

General terms	
CCW	Conservation category wetland
FCT	Floristic community type
IBRA	*Interim Biogeographic Regionalisation of Australia*
MUW	Multiple use wetland
PEC	Priority Ecological Community
REW	Resource enhancement wetland
TF	Threatened flora
TEC	Threatened ecological community
UFI	Unique feature identifier

Table A3: Abbreviations – legislation

Legislation	
EP Act	Environmental Protection Act 1986
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
EPP	Environment Protection Policy

Table A4: Abbreviations – units of measurement

Units of measurement	
ha	Hectare
m	Metre
m AHD	m in relation to the Australian height datum

1 Introduction

1.1 Background

Lendlease Communities (Ellenbrook) Pty Ltd (Lendlease) have prepared a District Structure Plan (DSP) for the eastern portion of the North Ellenbrook 'Urban Investigation' area, as identified by the Western Australian Planning Commission (WAPC) and Department of Planning, Lands and Heritage (DPLH) in the *North-East Sub-regional Planning Framework* (DPLH 2018b). The DSP is provided in **Appendix A**.

The DSP extends across 21 freehold land parcels and a number of existing road reserves, comprising a total area of approximately 501 hectares (ha) (herein referred to as 'the site'). The site is situated approximately 26 km north-east of the Perth Central Business District and is bound by:

- Warbrook Road to the north.
- A range of rural land uses within the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* area to the east.
- Maralla Road, Bush Forever Site 300 and residential land uses within Ellenbrook, to the south.
- Perth Darwin National Highway to the west.

The location of the site is shown in **Figure 1**.

1.2 Purpose and structure of this document

This Environmental Assessment Report (EAR) has been prepared as the primary environmental documentation supporting the DSP. This EAR documents the environmental considerations relevant to the DSP, which will be assessed by applicable local and state government authorities as part of their consideration of the DSP.

This EAR has been structured to align with the Environmental Protection Authority's (EPA) recommended structure for Environmental Review Documents, to enable it to support subsequent stages of the land use planning process where the EPA have statutory involvement (for example, future Metropolitan Region Scheme amendments). This EAR includes the following sections:

- **Section 1** – which introduces the DSP.
- **Section 2** – which outlines the planning and environmental assessment context applicable to the DSP, in addition to the future stages of the land use planning process.
- **Section 3** – which outlines the stakeholder engagement undertaken to date in relation to environmental considerations applicable to the DSP.
- **Section 4** – which outlines the environmental factors (based on EPA definitions) applicable to the DSP. For each of these factors, the receiving environment, potential impacts of the DSP, mitigation measures and predicted environment outcomes are outlined.
- **Section 5** – which outlines other environmental matters applicable to the DSP which are not addressed through consideration of the EPA environmental factors.
- **Section 6** – which provides a holistic environmental impact assessment for the DSP and associated future urban development of the site.

2 Planning and Environmental Assessment Context

2.1 Existing zoning and reservations

The site is zoned 'Rural' under the Metropolitan Region Scheme (MRS), as shown in **Figure 2**. Whilst not a zoning or reservation, the MRS identifies Bush Forever Site 13 over the western portion of Lot 5, within the north-west section of the site.

The site is zoned 'Rural' under the City of Swan (CoS) Local Planning Scheme No. 17 (LPS 17).

2.2 Perth and Peel @ 3.5 Million - North-East Sub-regional Planning Framework

The Western Australian Planning Commission (WAPC) released the *North-East Sub-regional Planning Framework* in March 2018, which forms part of the *Perth and Peel @ 3.5 Million* suite of strategic planning documents and provides the strategic direction for managing growth and development within Perth's north-east corridor.

The site comprises the eastern portion of the North Ellenbrook 'Urban Investigation' area as identified in the *North-East Sub-regional Planning Framework*. 'Urban Investigation' areas are identified as those requiring detailed planning prior to the WAPC considering rezoning requests under the MRS, as discussed further in **Section 2.3.1**. The *North-East Sub-regional Planning Framework* lists the following 'key considerations' which are required to be addressed as part of the detailed planning for the North Ellenbrook 'Urban Investigation' area:

- Protection of Bush Forever areas and conservation category wetlands
- Protection of high value Carnaby's black cockatoo habitat and vegetation with 10-30% remaining in Perth and Peel regions
- Protection of threatened ecological communities and flora populations
- Offsite impacts on Western Swamp Tortoise habitat (EPP)
- Best practice drainage and nutrient management
- Impacts, risks and management of Gnangara groundwater resources (existing Priority 3 Source Protection Area)
- Pearce Airbase operations (Department of Defence)
- Transition/interface with regional open space areas
- Bushfire risk
- Access to the regional road network
- Basic raw materials – sequential land use allowing for extraction of sand resources.

A summary of how the key considerations (related to environmental matters) have been addressed as part of the DSP is provided in **Section 6.4**, as part of the holistic impact assessment.

The EPA provided *Interim Strategic Advice* (EPA 2015a) on the *Draft Perth and Peel @ 3.5 Million* documents, including the *Draft North-East Sub-regional Planning Framework*. This provided a high level assessment of the anticipated environmental outcomes of the draft frameworks with regard to each of the EPA factors. As part of this, the EPA provided a range of recommendations. Where these are applicable, responses of the DSP to these recommendations are discussed in **Section 6.5**.

2.3 North Ellenbrook (East) District Structure Plan

2.3.1 DSP purpose

The DSP has been prepared to satisfy the 'detailed planning' requirements of the *North-East Sub-regional Planning Framework* for the eastern portion of the North Ellenbrook 'Urban Investigation' area. The DSP demonstrates that the site is able to support future urban land uses and provides a high-level spatial layout of how future development is proposed to be implemented.

As an attachment to the DSP, this EAR outlines how the environmental values within the site can be suitably addressed to enable future urban development of the site, consistent with the spatial layout shown in the DSP.

The DSP will be lodged with DPLH for consideration, and should WAPC be supportive of the DSP, will inform future amendments to the MRS and CoS LPS 17 to enable implementation of the proposed future urban development of the site. This is discussed further in **Section 2.4**.

2.3.2 DSP design and environmental responses

The DSP is provided in **Appendix A** and proposes the following land uses across the site:

- Residential areas.
- An open space network including;
    - A future MRS 'Parks and Recreation' regional reserve, which accommodates Bush Forever Site 13 and will provide for the future retention of a large, consolidated area of intact native vegetation (which contains flora, vegetation, fauna, wetland and watercourse values).
    - Two local reserves, which will provide for the future retention of two mapped resource enhancement wetlands, wetland buffers, an area of potential FCT 15 TEC, a threatened flora population, in addition to other flora, vegetation and fauna habitat values.
    - A local drainage reserve, accommodating Sawpit Gully and an associated waterway and foreshore reserve, in addition to the realigned unnamed northern creekline.
- An arterial road network, including a future interchange with the adjacent Perth Darwin National Highway. The indicative location of the interchange has been selected to minimise potential impacts to significant environmental values (including Bush Forever Site 13, intact Yanga complex vegetation and an existing watercourse supporting intact riparian vegetation).
- A 'neighborhood centre' and smaller 'potential local centre'.
- A future combined high school and primary school site, with adjacent district open space.

Overall, the DSP has been formulated to respond to the identified environmental values within the site. This has primarily been achieved through the proposed provision of various regional and local reserves over areas of the site which were determined to support environmental values, consistent with EPA policies and guidance. These reserves will provide for the future retention of environmental values as part of future urban development. Further measures to mitigate the environmental impacts of the proposed future urban development of the site will be implemented as part of future stages of the land use planning and development process.

The predicted environmental outcomes of the DSP and its implementation are discussed in detail in **Section 4**. A holistic assessment of the predicted environmental impacts is provided in **Section 6**.

2.4 Future land use planning processes

2.4.1 Metropolitan Region Scheme and Local Planning Scheme amendments

As outlined in **Section 2.3.1**, should DPLH and WAPC be supportive of the DSP, requests to amend the Metropolitan Region Scheme and CoS LPS 17 will be lodged with the respective state and local authorities, in order to appropriately rezone the site at a regional and local level to be consistent with the DSP and enable future urban development.

It is anticipated that the future MRS amendment would propose an 'urban' zone over the site, with the exception of the north-western portion of the site where a 'Parks and Recreation' reserve would be proposed, consistent with the DSP. The 'Parks and Recreation' reserve would be the primary environmental mechanism of the MRS amendment and would provide for the future retention of environmental values in this area.

The future CoS LPS 17 amendment would propose a suitable overarching 'development' zone (or similar) across the site (excluding the MRS 'Parks and Recreation' reserve). In addition, the amendment is expected to insert a number of provisions within the scheme text, which will specify the various requirements (including environmental) that would need to be addressed as part of the future development stages applicable to the site (such as local structure planning, subdivision and development). It is anticipated that the scheme text provisions will include a requirement for future local structure plans to accommodate the local reserves, as shown on the DSP, as well as the preparation and implementation of a number of management plans. A summary of the proposed future local scheme provisions is provided in **Section 6.3**.

Future amendments to the MRS and CoS LPS 17 would be referred to the EPA pursuant to Section 48A of the *Environmental Protection Act 1986* (EP Act), to determine if the proposed amendments are likely to result in significant environmental impacts and therefore whether environmental assessment by the EPA is required, which is discussed in detail in **Section 2.5.1**.

2.4.2 Local Structure Plans

Following amendments to the MRS and CoS LPS 17, Local Structure Plans (LSPs) would be prepared for each of the LSP precincts within the site, the boundaries of which are shown indicatively on the DSP. The purpose of each LSP will be to provide a more detailed layout of the proposed urban land uses for that area, and would include identification of features such as residential development cells, local reserves and the local road network. Importantly, LSPs will need to address the requirements of any applicable local scheme provisions included at the CoS LPS 17 scheme amendment stage.

Each LSP would be required to accommodate the local reserves shown in the DSP (where applicable), in addition to the future MRS 'Parks and Recreation' reserve. In addition, further opportunities to accommodate environmental values (outside of the regional and local reserves shown on the DSP) will be explored at the LSP stage. For example, local public open space (POS) areas may be strategically located to align with identified environmental values to enable their future retention, as discussed in **Section 6.2**.

The EPA is not involved in the assessment of LSPs, given they are not able to be referred to the EPA for assessment under either Section 38 or Section 48A of the EP Act.

2.4.3 Subdivision and development

Following approval of an LSP, the area within the LSP will be subdivided and developed for urban land uses. The subdivision application process will need to address the requirements of any relevant local scheme provisions or other requirements included within the approved LSP. Once issued, subdivision approval/s would include a range of conditions, some of which may relate to environmental matters, which will need to be implemented as part of the subdivision and development process, before titles for subdivided lots are issued. Other components of development may be progressed through development approval, for example forward bulk earthworks or other non-subdivisional works.

It is anticipated that all environmental impacts associated with implementation of urban subdivision and development works across the site will be considered by the EPA under Section 48A of the EP Act, at the MRS and CoS LPS 17 scheme amendment stages.

2.4.4 Perth Darwin National Highway interchange

Future construction works for the proposed Perth Darwin National Highway interchange are expected to be undertaken separately to any subdivision or development approvals associated with implementation of residential land uses within the site.

As outlined in **Section 2.3.2**, the indicative location of the interchange shown in the DSP has been strategically sited to minimise potential environmental impacts as much as possible. Notwithstanding this, it is expected that there will still be some residual impacts associated with its construction, the extent of significance of which however would only be confirmed once detailed design has progressed.

In this context, it is unlikely that the potential environmental impacts of the proposed interchange will be considered by the EPA under Section 48A of the EP Act when the MRS and CoS LPS 17 scheme amendments (to establish a suitable urban or development zoning over part or all of the site) are referred to the EPA. As such, it is expected that the specific mechanism to deal with any residual environmental impacts would be referral of a proposal to construct the interchange, pursuant to Section 38 of the EP Act, or alternatively a referral of a separate MRS amendment to establish the road reserve for the interchange, pursuant to Section 48A of the EP Act. This is discussed further in **Section 2.5.2**.

2.5 Future environmental assessment processes

2.5.1 *Environmental Protection Act 1986* – Section 48

All amendments to regional and local planning schemes (such as the MRS and the CoS LPS 17) are required to be referred to the EPA by the responsible authority under Section 48A of the EP Act. The EPA then makes one of the following determinations on the proposed scheme amendment:

- **The proposed scheme amendment should not be assessed by the EPA**, on the basis that it is considered unlikely to result in significant environmental impacts. In making this determination, the EPA may choose to also provide informal advice in relation to how environmental factors are expected to be addressed as part of future stages of the planning and development process.
- **The proposed scheme amendment should be assessed by the EPA**, on the basis that it is considered likely to result in significant environmental impacts. An environmental impact assessment process is then undertaken and the Minister for Environment may then choose to issue a Ministerial Statement allowing the scheme to be implemented.
- **The proposed scheme amendment is by its nature incapable of being made environmentally acceptable.**

The DSP is not a scheme amendment and as such would not be referred to the EPA pursuant to Section 48A of the EP Act. However, the DSP will inform future amendments to the MRS and CoS LPS 17, which will be referred to the EPA by the responsible authority (DPLH or CoS respectively) pursuant to Section 48A of the EP Act in the future. It is expected that the following scheme amendments will be proposed in the future (and thus will be considered by the EPA pursuant to Section 48A of the EP Act) to allow for implementation of the DSP:

- An amendment to the MRS to establish an 'Urban' zone over the site, with the exception of the north-western portion of the site where a 'Parks and Recreation' reserve would be proposed, consistent with the design shown in the DSP. This may include establishment of part or all of a 'Primary Regional Road' reserve for the proposed Perth Darwin National Highway interchange, or alternatively this may be addressed through a separate MRS amendment.
- An amendment to CoS LPS 17 to establish a 'Development' zone (or similar) over the site (excluding the area reserved for 'Parks and Recreation' under the MRS) and to insert a number of scheme text provisions outlining the requirements (including environmental) that would need to be addressed as part of the future stages of the land use planning process for the site.

2.5.2 *Environmental Protection Act 1986* – Section 38

Section 38 of the EP Act enables any person to refer a proposal likely to have a significant impact on the environment to the EPA, who then decide whether or not to assess the proposal.

Section 48I outlines that any proposal likely to have a significant impact on the environment, but which is within an area and for a land use that is subject to an assessed scheme (i.e. a scheme for which a determination has been made by the EPA under Section 48A), is not required to be referred to the EPA under Section 38 of the EP Act. Given the environmental impacts associated with implementation of urban subdivision and development works across the site will be considered by the EPA under Section 48A of the EP Act (at the MRS and CoS LPS 17 scheme amendment stages), it is not anticipated that the implementation of urban development works within the site will be

referred under Section 38 of the EP Act. However, this only applies to proposed works which are consistent with those considered through the Section 48A process and where their potential environmental impacts were considered by the EPA. The EPA may choose to defer assessment of environmental factors to subsequent stages of the planning process, which would mean Section 48I would not apply in such instances.

As discussed in **Section 2.4.4**, potential impacts associated with the proposed Perth Darwin National Highway interchange are unlikely to be known or specifically considered by the EPA when they assess the future MRS and CoS LPS 17 scheme amendments for the site under Section 48A of the EP Act (and therefore Section 48I of the EP Act may not apply) and therefore the EPA may choose to defer assessment of environmental factors applicable to the Perth Darwin National Highway. If this occurs, then the proposal to construct the Perth Darwin National Highway interchange may be referred to the EPA for assessment under Section 38 of the EP Act once detailed design has progressed and the potential environmental impacts are known.

2.5.3 Environment Protection and Biodiversity Conservation Act 1999

Any proposed action which is likely to result in significant impacts to Matters of National Environmental Significance (MNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is required to be referred to the Commonwealth Department of Environment and Energy to determine whether it requires assessment under the EPBC Act.

The site contains occurrences and habitat for a number of MNES, including habitat for threatened species of black cockatoo, an occurrence of threatened flora species *Grevillea curviloba* subsp. *curviloba* and occurrences the Banksia Woodlands of the Swan Coastal Plain threatened ecological community. Based on the DSP design, it is likely that future urban development within the site would result in some direct and indirect impacts to MNES. It is expected that these impacts may require referral under the EPBC Act.

The timing of EPBC Act referrals are not directly linked to the state planning processes. In an urban development context, EPBC Act referrals are typically undertaken once the development layout has been determined (for example, at the local structure planning stage), such that the impacts to MNES can be quantified. As such, it is expected that any EPBC Act referrals determined to be required to enable implementation of the DSP would likely be made at future stages of the land use planning process, subsequent to finalisation of the DSP process.

In addition, due to the large size of the site, there may be multiple proponents implementing urban development within the site in accordance with the DSP. In accordance with the requirements of the EPBC Act, it will be the responsibility of each proponent of development to determine whether EPBC Act referral is required for their proposed action.

2.6 Future offset requirements

Under separate state and commonwealth environmental policy frameworks, if a potential impact to an environmental value cannot be suitably mitigated through avoidance, minimisation and/or rehabilitation measures such that a significant residual impact remains, then environmental offsets may be required to counterbalance the proposed environmental impacts. This principle is applied to the environmental assessment process administered under both state and commonwealth environmental protection legislation (the EP Act and EPBC Act, respectively).

With regard to environmental matters afforded protection under the state EP Act and in the context of future regional and local scheme amendments to be progressed across the site, the DSP is considered to provide suitable mitigation of potential impacts through impact avoidance and minimisation measures, such that there will be no significant residual impacts for each of the relevant environmental factors, discussed in detail in **Section 4**. As such, no offsets are considered likely to be required for environmental matters protected under the EP Act.

A potential exception to the above is the proposed Perth Darwin National Highway intersection, which may have significant residual impacts following implementation of impact mitigation measures, such that it may require offsets for environmental matters protected under the EP Act. This will be determined in the future and if necessary a Section 38 referral and assessment process for the interchange will be progressed, based on the proposed design of the intersection.

With regard to MNES afforded protection under the commonwealth EPBC Act, the DSP provides mitigation of potential impacts to MNES through impact avoidance and minimisation measures. However, implementation of the DSP is likely to result in residual impacts to occurrences and habitat for a number of MNES (including black cockatoos and the Banksia Woodlands of the Swan Coastal Plain threatened ecological community), which may be determined to be significant. As such, any future EBPC Act referrals lodged by individual proponents of future urban development within the site will need to consider impacts to MNES and may need to incorporate offsets into such proposals, if determined to be required. This will be considered and addressed by individual proponents of development.

3 Stakeholder Engagement

3.1 Key stakeholders

The key stakeholders for the DSP, in relation to environmental considerations, include:

- Department of Water and Environmental Regulation (DWER) – EPA Services
- Department of Water and Environmental Regulation (DWER) – Land Use Planning (Water)
- Department of Biodiversity, Conservation and Attractions (DBCA)
- Main Roads Western Australia.

3.2 Stakeholder engagement process

Consultation with key stakeholders was undertaken throughout preparation of the DSP, as required. The purpose of stakeholder engagement throughout preparation of the DSP was to:

- Ensure key stakeholders were made aware of the DSP prior to its lodgement.
- Discuss the proposed methodologies associated with baseline environmental investigations.
- Discuss the outcomes of site specific investigations and the relative environmental significance of the identified environmental values.
- Discuss the DSP design and how this responds to identified environmental values.
- Discuss the future stages of the land use planning process and outline how the environmental values of the site are proposed to be managed through each stage of this process.

3.3 Stakeholder consultation

A summary of stakeholder consultation outcomes is provided in **Table 2**.

The key component of stakeholder consultation completed for the DSP, with regard to environmental matters, was two meetings held with DWER – EPA Services prior to lodgement. Whilst the EPA do not play a statutory role in assessing district structure plans, the DSP will inform future MRS and CoS LPS 17 amendments, which will be referred to EPA under Section 48A of the EP Act. As such, it was considered important that consultation was undertaken with DWER – EPA Services to ensure there was alignment regarding the design approach for the DSP design, such that future MRS and CoS LPS 17 amendments would be consistent with likely EPA expectations. The DSP layout was finalised to reflect the agreed outcomes of this consultation and as such, is considered to be consistent with the expectations of DWER – EPA Services.

Table 2: Summary of stakeholder consultation for the environmental considerations of the DSP

Date	Stakeholder	Issues/topics discussed	Outcomes
May to July 2019	DWER - Land Use Planning (Water)	RPS corresponded with DWER regarding the monitoring, water modelling and POS irrigation requirements to support the District Water Management Strategy (DWMS).	DWER confirmed the monitoring undertaken for the DWMS is acceptable subject to further monitoring at future LWMS and UWMP stages. In regard to modelling, DWER requested an integrated groundwater- surface water model; RPS completed both groundwater and 2D flood modelling in the DWMS to estimate flood areas, discharge rates and impacts of drainage on water dependent ecosystems. In regard to irrigation supply, the site will obtain its water supply from existing license transfers and subsoil harvesting. The groundwater modelling has shown these sources will be more than adequate to provide the site's POS irrigation supply.
September 2019	DBCA	Representatives of RPS and DBCA met onsite to discuss response to threatened flora population on Lot 29.	Identification of species confirmed by all parties. Proposed retention within future conservation area agreed.
September 2019	DWER - EPA Services	Representatives of Lendlease, Emerge Associates and CLE held an introductory meeting with representatives of DWER – EPA Services to discuss the DSP and the proposed environmental approach.	Agreement was reached that early consultation with DWER – EPA Services was of value, as the DSP will inform future MRS and LPS amendments which the EPA will consider. Consensus with regard to proposed environmental survey approach and identification of significant environmental values.
November 2019	DWER - EPA Services	Representatives of Emerge Associates and CLE held a follow up meeting to present the DSP design and predicted environmental outcomes.	The DSP and the design approach which had informed its preparation were presented, with no issued raised from attending parties. In addition, the predicted environmental outcomes for each of the key environmental values (based on implemented of the DSP design) were presented (generally consistent with the figures included in **Table 24**), with no issued raised from attending parties. Consensus was reached around the preferred approach for future stages of the land use planning process, being that establishment MRS 'Parks and Recreation' reserve over environmental values in the north-west portion of the site was a logical approach, with other environmental values to be addressed through local reserves and local scheme provisions at the CoS LPS 17 amendment stage.
December 2019	Main Roads Western Australia	Representatives of Lendlease and Emerge Associates held a meeting with representatives of Main Roads Western Australia to discuss the location of the future Perth Darwin National Highway interchange location and environmental management considerations.	Preliminary options analysis for potential interchange locations was discussed, concentrating on the applicable environmental values and the potential environmental impacts. Main Roads representatives outlined that impacts to Bush Forever Site 13, intact Yanga complex vegetation and intact watercourses supporting riparian vegetation should be avoided if possible. It was acknowledged that an interchange in proximity to the indicative location shown on the DSP would not be able to avoid all environmental impacts, and as such it would be exercise of minimising environmental impacts where possible and managing these through state and commonwealth environmental approvals process (discussed further in **Section 2.5**).

4 Environmental Principles and Factors

4.1 Principles

The five principles of environmental protection in Western Australia are set out in Section 4A of the EP Act. The manner in which these principles have been considered within the DSP and will be addressed through future planning and development stages is presented in **Table 3**.

Table 3: EP Act Principles

Principle	Consideration
1. The precautionary principle *Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In application of this precautionary principle, decisions should be guided by:* *a. careful evaluation to avoid, where practicable, serious or irreversible damage to the environment; and* b. *an assessment of the risk-weighted consequences of various options.*	The proponent has addressed the precautionary principle by undertaking a range of thorough and detailed site-specific investigations to avoid any scientific uncertainty. This has provided a comprehensive understanding of the flora, vegetation, fauna, wetlands, surface water, groundwater, acoustic and geotechnical conditions of the site. As such, a suitable understanding of the environmental values of the site is known such that decisions regarding the DSP and its design can be made without the risk of any potentially unknown environmental values being impacted. In addition, the DSP design has been informed by and responds to the outcomes of environmental investigations completed to date, through the adoption of an impact-avoidance approach to mitigate potential environmental impacts. This reduces the risk of significant environmental impacts occurring, which reduces any potential environmental risks associated with future implementation of the DSP.
2. The principle of intergenerational equity *The present generation should ensure that the health, diversity and productivity of the environment is maintained and enhanced for the benefit of future generations.*	Environmental values within the site are currently located within a number of privately owned land parcels, which are not accessible to the public, nor are these environmental values currently managed for conservation purposes. This includes Bush Forever Site 13, which is wholly situated within a private landholding and is not known to be subject to any existing or ongoing management. Whilst implementation of the DSP would result in some environmental impacts, significant impact avoidance measures have been incorporated into the DSP layout, through the proposed regional and local reserve network. As such, implementation of the DSP will allow for the proposed reserves (containing significant environmental values, including Bush Forever Site 13) to be transferred into public land tenure and ownership, and managed for conservation purposes in the long-term. This will ensure that significant environmental values within the site will be accessible to the public and their conservation values will continue to be maintained and enhanced in the long-term for future generations to benefit from.
3. The principle of the conservation of biological diversity and ecological integrity *Conservation of biological diversity and ecological integrity should be a fundamental consideration.*	As outlined above, a range of thorough and detailed site-specific investigations have been undertaken to determine the existing biological diversity and ecological integrity of the site. These investigations have informed the DSP layout, which has responded to this principle through the provision of the proposed regional and local reserve network, which will facilitate the future retention and conservation of significant environmental values within the site that support high biological diversity and ecological integrity.

Principle	Consideration
4. Principles relating to improved valuation, pricing and incentive mechanisms *a. Environmental factors should be included in the valuation of assets and services.* *b. The polluter pays principles – those who generate pollution and waste should bear the cost of containment, avoidance and abatement.* *c. The users of goods and services should pay prices based on the full life-cycle costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.* *d. Environmental goals, having been established, should be pursued in the most cost-effective way, by establishing incentive structure, including market mechanisms, which enable those best placed to maximise benefits and/or minimise costs to develop their own solution and responses to environmental problems.*	The DSP design proposes a regional and local reserve network which targets large, contiguous areas of intact native vegetation and other environmental values. These environmental values have been targeted for future retention through the proposed regional and local reserve network given they are of suitable area, shape, geometry, condition and connectivity such that they have high ecological viability and resilience, which means ongoing and long-term maintenance and mangement costs of these reserves will be minimised while preserving the original ecological viability of the environmental values. In contrast, smaller, isolated and more disturbed areas of environmental values are typically less ecologically viable and have not been targeted for retention in the DSP. The ecological viability of such areas is more difficult to maintain or restore in the long-term, and ongoing management costs become increasingly higher, which is generally not practical for land management authorities. In some situations these areas are suitable to support multiple uses, whereby some environmental characteristics can be retained (for example mature trees or vegetation) while also allowing other recreational activities or drainage functions.
5. The principle of waste minimisation *All reasonable and practicable measures should be taken to minimise the generation of waste and its discharge into the environment.*	Future implementation of urban development across the site will take all reasonable and practical measures to minimise the generation of waste and its discharge into the environment.

4.2 Key environmental factors

The EPA policy framework considers 13 environmental factors, relating to five themes; sea, land, water, air and people. For each of these factors, the EPA has identified an environmental objective aimed towards ensuring the objects and principles of the EP Act are achieved. **Table 4** outlines each of these environmental factors, the EPA's stated objective and a scoping assessment of whether each of the listed environmental factors are applicable to the DSP.

The environmental factors determined to be applicable to the DSP are discussed in detail in **Sections 4.3 - 4.7**.

Table 4: EPA factors applicable to the DSP

Theme	Factor	Objective	Applicable to DSP	EAR section
Sea	Benthic Communities and Habitats	To protect benthic communities and habitats so that biological diversity and ecological integrity are maintained.	**No**. The site is situated approximately 22 km inland from the coast and does not contain or interact with marine environments. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A
	Coastal Processes	To maintain the geophysical processes that shape coastal morphology so that the environmental values of the coast are protected.	**No**. The site is situated approximately 22 km inland from the coast and is therefore not subject to coastal processes. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A
	Marine Environmental Quality	To maintain the quality of water, sediment and biota so that environmental values are protected.	**No**. The site is situated approximately 22 km inland from the coast and does not contain or interact with marine environments. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A
	Marine Fauna	To protect marine fauna so that biological diversity and ecological integrity are maintained.	**No**. The site is situated approximately 22 km inland from the coast and does not contain or interact with marine environments. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A
Land	Flora and Vegetation	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	**Yes**. The site contains a range of flora and vegetation values, of varying local and regional significance. The DSP has been formulated such that future urban development can mitigate significant impacts to existing flora and vegetation values. Notwithstanding, this is an applicable factor for the DSP and is considered further below.	**Section 4.3**
	Landforms	To maintain the variety and integrity of significant physical landforms so that environmental values are protected.	**No**. The site is generally flat and low-lying, comprising a palusplain wetland landform across its majority. The physical landforms which occur within the site are not significant, given they are common and widespread across the local area and eastern Swan Coastal Plain region. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A
	Subterranean Fauna	To protect subterranean fauna so that biological diversity and ecological integrity are maintained.	**No**. It is unlikely that the site supports any significant habitat values for subterranean fauna, given the key known habitat types (such as calcretes, fractured rock aquifers and karst limestone) do not occur. Whilst there is some uncertainty as to the specific occurrence of subterranean fauna, the risk of any significant impacts to subterranean fauna as a result of any future urban development outlined in the DSP is low, due to the proposed groundwater management strategy, as discussed in relation to the inland waters factor. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A

Theme	Factor	Objective	Applicable to DSP	EAR section
	Terrestrial Environmental Quality	To maintain the quality of land and soils so that environmental values are protected.	**Yes**. Regional acid sulfate soil (ASS) risk mapping identifies the potential for ASS to occur within the site. In addition, potential contamination considerations associated with historical and surrounding land uses are applicable to the site. Whilst investigations to date have not identified any significant terrestrial environmental quality risks associated with the proposed future urban land uses within the site, this is an applicable factor for the DSP and is considered further below.	**Section 4.6**
	Terrestrial Fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	**Yes**. The site contains fauna habitat which has the potential to be used by native fauna, including some conservation-significant fauna species. In addition, the site is located in proximity to the Twin Swamps Nature Reserve, which supports a population of Western Swamp Tortoise. The DSP has been formulated such that significant impacts to existing fauna habitat values can be avoided. Notwithstanding, this is an applicable factor for the DSP and is considered further below.	**Section 4.4**
Water	Inland Waters	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.	**Yes**. The site contains a number of surface water features, including waterways and wetlands. The DSP has been formulated such that significant impacts to existing surface water and groundwater regimes can be avoided to the extent that environmental values are maintained. Notwithstanding, this is an applicable factor for the DSP and is considered further below.	**Section 4.5**
Air	Air Quality	To maintain air quality and minimise emissions so that environmental values are protected.	**No**. The DSP does not propose any future land uses within the site which would generate emissions that would significantly impact air quality. In addition, the DSP does not propose any sensitive land uses to be established in proximity to any existing operations whose emissions significantly impact air quality. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A
People	Social Surroundings	To protect social surroundings from significant harm.	**Yes**. A Registered Aboriginal Heritage Site pursuant to the *Aboriginal Heritage Act 1972* is mapped as occurring over the site, which is associated with the mythological values of the Ellen Brook and its tributaries. In addition, there a number of surrounding land uses whose noise or odour emissions could impact the amenity of future urban land uses within the site (as proposed in the DSP), including the Perth Darwin National Highway, Perth-Geraldton rail freight line, Ellenbrook Speedway, Pearce Airbase, poultry farms and a plant nursery. Whilst all of these considerations can be suitably managed through the land use planning process to avoid significant impacts to social surrounds, this is an applicable factor for the DSP and is considered further below.	**Section 4.7**
	Human Health	To protect human health from significant harm.	**No**. This factor relates solely to impacts to human health arising from the emission of radiation. The DSP does not propose any future land uses within the site which would produce radioactive emissions that would impact human health. In addition, the DSP does not propose any sensitive land uses to be established in proximity to any existing operations which emit radioactive emissions impacting human health. As such, this is not an applicable factor for the DSP and any associated future urban development of the site.	N/A

4.3 Flora and vegetation

4.3.1 EPA objective

To protect flora and vegetation so that biological diversity and ecological integrity are maintained.

4.3.2 Policy and guidance

Relevant policy and guidance documents for flora and vegetation, which have informed site-specific investigations and/or have been used to assess potential impacts, include:

- *Environmental Factor Guideline – Flora and Vegetation* (EPA 2016b)
- *Technical Guidance – Flora and Vegetation Surveys Environmental Impact Assessment* (EPA 2016d).

4.3.3 Receiving environment

4.3.3.1 Regional context

The site is situated in the eastern portion of the Swan Coastal Plain, within the Pinjarra Plain. The Pinjarra Plain contains vegetation representative of six different vegetation complexes, of varying composition, as described by Heddle *et al.* (1980). Historical agricultural development and associated land clearing across the Pinjarra Plain has resulted in a highly modified environment, with reduced areas of intact native vegetation remaining, as evidenced in **Table 5** which compares the pre-European extent of each vegetation complex to its 2015 mapped extent (EPA 2015a).

Table 5: Vegetation complexes on the Pinjarra Plain, ordered by pre-European extent (EPA 2015)

Vegetation complex	Pre-European extent	2015 extent	Percentage remaining 2015
Guildford complex	92,340 ha	4,936 ha	5.3%
Yanga complex	26,176 ha	4,312 ha	16.5%
Serpentine River complex	19,855 ha	2,028 ha	10.2%
Swan complex	16,501 ha	2,232 ha	13.5%
Dardanup complex	9,504 ha	630 ha	6.6%
Beermullah complex	6,707 ha	444 ha	6.6%

As shown in **Figure 4**, the site is primarily associated with the Yanga vegetation complex, which is described as a low open forest of *Casuarina obesa* with patches of *Actinostrobus pyramidalis* and *Melaleuca* species on low lying flats, with a mixture of low open forest of *Banksia* species - *Eucalyptus todtiana* and open woodland of *Corymbia calophylla - Banksia* species (Heddle *et al.* 1980). Of the six vegetation complexes mapped as occurring within the Pinjarra Plain, the Yanga complex has the highest proportion of its pre-European extent remaining (16.5%) (EPA 2015a).

The south-western portion of the site is associated with the Bassendean North complex, which is described as a low open forest and low open woodland of *Banksia* species - *Eucalyptus todtiana* to low woodland of *Melaleuca* species and sedgelands which occupy the moister sites (Heddle *et al.* 1980). The Bassendean (north) complex is situated within the Bassendean Dunes landform, which abuts the Pinjarra Plain. 71.8% of the pre-European extent of this complex remains (EPA 2015a).

The EPA (2015b) outline the following objectives for regional vegetation complexes:

- Retain at least 10% of the original extent of vegetation complexes within 'constrained areas', which the EPA (2008) define as '*an area where there is a reasonable expectation that development will be able to proceed. This may include urban, urban deferred or industrial zoned land or land with existing development approvals.*'
- Retain at 30% of the original extent of vegetation complexes within 'unconstrained areas', the Darling Plateau and rural zoned land of the Peel region.

Based on the definition provided by EPA (2008), it is likely the site is considered to be in an 'unconstrained area' and the 30% vegetation complex retention target applies.

The site is highly modified from its natural state as a result of historical land clearing and primarily comprises cleared land and pasture. Notwithstanding, the site does contain scattered remnant vegetation in addition to some larger, more intact areas of native vegetation, primarily associated with Bush Forever Site 13 (within Lot 5). Land surrounding the site also comprises a combination of cleared agricultural land and discrete areas of remnant vegetation, including Bush Forever Site 300 to the south and Bush Forever Site 400 (Twin Swamps Nature Reserve) to the north-east.

4.3.3.2 Site-specific investigations

Site-specific fauna investigations completed to date include:

- *Flora and Vegetation Assessment – Various Lots North Ellenbrook* (Emerge Associates 2019) (**Appendix B**)
- *Flora and Vegetation Survey – Lots 29 & 30 Maralla Road, North Ellenbrook* (PGV Environmental 2019b) (**Appendix E**).

Investigations completed by Emerge Associates (2019) included a 'detailed' flora and vegetation survey undertaken across the majority of the site, over three days in October and November 2018. The portions of the site not covered by Emerge (2019) survey were assessed in a separate flora and vegetation survey completed by PGV Environmental (2019b) over two days in July and September 2019. The results of these investigations are discussed below.

Varying land ownership across the site meant that not all lots within the site could be directly accessed as part of undertaking the above flora and vegetation surveys. Lots which could not be directly accessed were observed from the boundary of adjacent lots or public road reserves. Whilst it is expected that further survey may be required as part of more detailed, future stages of the land use planning process, a suitable level of survey has been undertaken to date to inform preparation and lodgement of the DSP.

4.3.3.3 Plant communities

Due to prevalence of existing rural-residential land uses across the site, the majority of the site (363 ha, 72%) comprises non-native vegetation with bare soil, pasture weeds, planted trees and scattered remnant trees and shrubs.

Remnant native vegetation within the site is generally concentrated in the western extent. A range of wetland, transitional and upland plant communities occur, collectively covering approximately 138 ha (28%) of the site, as described in **Table 6** and shown in **Figure 4**.

Table 6: Plant communities within the site (Emerge 2019; PGV 2019)

Plant community	Description	Area (ha)
Parkland cleared	Cleared or parkland cleared areas consisting of scattered *Corymbia calophylla*, *Eucalyptus rudis* and *Melaleuca* spp trees, bare ground or planted/non-native vegetation.	363.03
Dryland		
Ac	Tall open shrubland to shrubland *Adenanthos cygnorum* over pasture weeds.	3.72
BaBm	Open woodland *Banksia attenuata* and *Banksia menziesii* over shrubland *Allocasuarina humilis, Stirlingia latifolia, Hibbertia hypericoides* and *Eremaea pauciflora* over forbland *Patersonia occidentalis*, *Dampiera linearis*, **Ursinia anthemoides*, *Conostylis aculeata* and grassland *Neurachne alopecuroidea*, **Ehrharta calycina* and **Briza maxima*.	4.18
BmBa (L29)	*Banksia menziesii/B. attenuata* low open woodland over *Alexgeorgea nitens/Dasypogon bromeliifolius*	0.18
Bi	Sparse to open woodland *Banksia ilicifolia* over forbland *Dasypogon bromeliifolius* and grassland **Ehrharta calycina* and **Briza maxima*.	4.01
CcDb	Open forest of *Corymbia calophylla* over forbland of *Dasypogon bromeliifolius* and grassland of pasture weeds.	0.61
Et	Low open woodland of *Eucalyptus todtiana* over pasture weeds.	2.11
Jf	Open tall shrubland of *Jacksonia furcellata* over sparse shrubland *Xanthorrhoea preissii* and *Macrozamia riedlei* over open forbland *Dasypogon bromeliifolius*, *Haemodorum spicatum, Podotheca gnaphalioides* and **Ursinia anthemoides*.	5.77
Jf (L29)	*Jacksonia furcellata* tall shrubland over *Alexgeorgea nitens* closed sedgeland	10.19
X	Shrubland *Xanthorrhoea* spp over forbland of *Podotheca gnaphalioides, Desmocladus flexuosus, *Gladiolus caryophyllaceus*, **Wahlenbergia capensis* and Trachymene pilosa.	17.77
Transitional		
Cc	Open forest of *Corymbia calophylla* over grassland of pasture weeds.	9.47
CcDs	Open forest of *Corymbia calophylla* over open shrubland *Astartea scoparia* (or absent) over forbland of *Dielsia stenostachya, Isolepis stellata* and *Cotula coronopifolia*.	3.36
Rc	*Regelia ciliata* low shrubland	0.20
RcX	Shrubland of *Regelia ciliata* and *Xanthorrhoea* spp. over grassland of pasture weeds.	1.84
Wetland		
As	*Acacia saligna* tall shrubland to tall open scrub over weeds	2.80
Asc	Shrubland of *Astartea scoparia*.	0.81
AsMr	*Acacia saligna/Melaleuca rhaphiophylla* tall open scrub over weeds	1.77
AsRcDs	Sparse woodland of *Melaleuca preissiana* over shrubland to closed shrubland of *Astartea scoparia, Regelia ciliata* and *Hypocalymma angustifolium* over forbland of *Dielsia stenostachya*, *Isolepis stellata*, *I. prolifera* and *Aphelia cyperoides* and grassland of pasture weeds.	3.65

Plant community	Description	Area (ha)
CcMp	Open woodland of *Corymbia calophylla* and *Melaleuca preissiana* over open to closed shrubland of *Astartea scoparia*, *Pericalymma ellipticum*, *Hypocalymma angustifolium* and *Xanthorrhoea* spp. over forbland of *Dasypogon bromeliifolius*, *Dielsia stenostachya* and open to closed grassland pasture weeds.	37.57
CcTlLl	Woodland to open forest of *Corymbia calophylla* over shrubland of *Taxandria linearifolia* over open to closed sedgeland of *Lepidosperma longitudinale* over forbland *Cycnogeton lineare, *Lotus subbiflorus* and *Lobelia anceps* and grassland of pasture grasses.	5.20
Er	Open forest of *Eucalyptus rudis* over forbland of **Zantedeschia aethiopica* and closed grassland of pasture weeds.	2.19
ErCcM	Open woodland to open forest of *Eucalyptus rudis, Melaleuca preissiana* and *Corymbia calophylla* over sparse shrubland of *Astartea scoparia* over forbland of *Cycnogeton lineare, Zantedeschia aethiopica* and open sedgeland of *Lepidosperma longitudinale* over grassland of pasture weeds.	2.73
Gc	*Grevillea curviloba* subsp. *curviloba* open heath over *Xanthorrhoea preissii* low shrubland	0.93
Jp	Open rushland to rushland of *Juncus pallidus* over grassland of pasture weeds.	4.09
Mp	Low open woodland to open forest *Melaleuca preissiana* with tall shrubland of *Acacia saligna* (or layer absent) over grassland of pasture weeds.	4.47
MpAs	Sparse to open woodland of *Melaleuca preissiana* over tall closed shrubland of *Acacia saligna* over open shrubland *Regelia ciliata* and *Xanthorrhoea* spp. (or absent) over closed grassland of pasture weeds.	0.91
MpErPe	Open woodland of *Eucalyptus rudis* and *Melaleuca preissiana* over shrubland of *Pteridium esculentum* and *Acacia saligna* over open rushland of *Juncus* spp. Over grassland of pasture weeds.	0.82
Mr	Low open woodland to open forest *Melaleuca rhaphiophylla* over grassland of pasture weeds.	3.75
MrMt	*Melaleuca rhaphiophylla*/*M. teretifolia* open shrubland over weeds.	0.94

4.3.3.4 Vegetation condition

Vegetation condition mapping for the site is shown in **Figure 5**. The majority (75%) of the site was observed to be in 'completely degraded' condition. Approximately 9% of the site (45 ha) was determined to contain intact native vegetation of 'good' or better condition.

Table 7: Vegetation condition within the site (Emerge 2019, PGV Environmental 2019)

Condition category (Keighery 1994)	Area (ha)
Pristine	0.0
Excellent	0.0
Very Good	24.5
Good	20.5
Good – Degraded	18.5
Degraded	35.6
Degraded – Completely Degraded	26.3
Completely Degraded	375.4

Intact vegetation determined to be in 'good' or better condition is considered to be representative of the overarching vegetation complex. As such, the site supports approximately:

- 41.7 ha of intact vegetation representative of the Yanga vegetation complex
- 3.3 ha of intact vegetation representative of the Bassendean North vegetation complex.

4.3.3.5 Threatened and priority ecological communities

Banksia Woodlands of the SCP (TEC – Commonwealth)

Emerge Associates (2019) identified two separate patches of the 'Banksia Woodlands of the SCP' TEC within the site, as shown in **Figure 6** and described as follows:

- 8.2 ha patch (2.4 ha in 'good' condition, 5.8 ha in 'degraded' condition) within Lot 101. This patch is associated with plant communities **BaBm** and **Jf**.
- 1.1 ha patch (0.7 ha in 'good' condition, 0.4 ha in 'very good' condition) within Lot 3 and Lot 4. This patch is associated with plant communities **BaBm** and **Bi**.

The survey report concluded that, whilst both identified patches meet the minimum TEC criteria, both patches are unlikely to be considered particularly significant remnants of Banksia woodland. Both patches are either isolated, small in area, and/or highly disturbed from their natural form, which collectively reduce their overall conservation value.

In addition, the site also contains a 3.5 ha patch of vegetation **potentially** representative of the TEC, in 'good – degraded' condition, associated with plant community **Ac**, within Lot 106. Emerge Associates (2019) concluded further investigation of this vegetation is required to confirm whether it is representative of the TEC (for example, if it is in 'good' or better condition and whether it meets the minimum 2% *Banksia* species canopy cover threshold), given this land was unable to be directly accessed at the time of survey.

Overall, the site contains a total of 9.3 ha of confirmed Banksia Woodland of the SCP TEC (0.4 ha in 'very good' condition, 3.1 ha in 'good' condition and 5.8 ha in 'degraded' condition). An additional 3.5 ha of potential TEC in 'good – degraded' was identified, but requires further investigation to confirm its status.

Banksia dominated woodlands of the SCP IBRA region (PEC – State)

Patches of vegetation communities **BaBm** and **Bi** were identified by Emerge Associates (2019) as also being representative of the State listed priority ecological community (PEC) 'Banksia dominated woodlands of the SCP IBRA region'. A total of 5.7 ha of this PEC occurs within the site across three patches, as shown in **Figure 6** and described as follows:

- 3.1 ha patch (2.4 ha in 'good' condition, 0.7 ha in 'degraded' condition) within Lot 101.
- 1.5 ha patch (1.5 ha in 'good' condition) within Lot 106.
- 1.1 ha patch (0.7 ha in 'good' condition, 0.4 ha in 'very good' condition) within Lot 3 and Lot 4.

The majority (74%) of this vegetation overlaps with confirmed occurrences of the Banksia Woodlands of the SCP TEC. The TEC and PEC areas are not identical given the two communities are defined based on different criteria.

Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain (TEC – State)

PGV Environmental (2019b) identified a single patch of **MrMt** vegetation within Lot 30 to be **potentially** representative of the 'Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain' TEC. This area of vegetation comprises a single 0.6 ha patch associated an existing Resource Enhancement Wetland feature, and was assessed to be in 'degraded' condition. PGV Environmental (2019b) concluded that this vegetation has 'potential to be a degraded example of FCT 15 Forests and woodlands of deep seasonal wetlands'. The extent of the potential TEC occurrence is shown in **Figure 6**.

Other TECs or PECs

Based on the results of the Emerge Associates (2019) and PGV Environmental (2019b) flora and vegetation surveys completed across the site, no additional TECs or PECs are considered likely to occur beyond those discussed above.

4.3.3.6 Threatened and priority flora

PGV Environmental (2019b) identified two stands of *Grevillea curviloba* subsp. *curviloba* (Narrow curved-leaf Grevillea) as occurring within Lot 29. The species is listed as threatened under State and Commonwealth legislation. Both identified stands of the species were observed to comprise thousands of stems each, but may be clonal and thus may only represent two individuals of the species (PGV Environmental 2019b). The mapped extent of the occurrence aligns with plant community **Gc** and is shown in **Figure 4**. The species is known to occur to the south, within the adjacent Ellenbrook development, but was not identified at any other locations within the site.

No other priority or threatened flora species were identified within the site or considered likely to occur (Emerge Associates 2019; PGV Environmental 2019b).

4.3.4 Potential impacts of the DSP

There are a number of potential impacts to flora and vegetation values which may occur as a result of future implementation of the DSP, including:

- Direct impacts
  - Clearing of up to 65.5 ha of native vegetation, of which 14.4 ha (22%) is intact vegetation in 'good' or better condition, which includes (areas not mutually exclusive);
    - 11.2 ha of intact vegetation representative of the Yanga vegetation complex.
    - 9.3 h of confirmed Banksia Woodlands of the SCP TEC vegetation (0.4 ha in 'very good' condition, 3.1 ha in 'good' condition and 5.8 ha in 'degraded' condition).
    - 3.5 ha of potential Banksia Woodlands of the SCP TEC vegetation (in 'good – degraded' condition), however further investigation of this vegetation is required to confirm whether it is representative of the TEC.
    - 5.7 ha of confirmed Banksia dominated woodlands of the SCP IBRA region PEC vegetation.
- Indirect impacts
  - Fragmentation of flora and vegetation.
  - Introduction and/or spread of weeds and or/disease.

The potential environmental impacts of the DSP outlined above represent a worst-case scenario and do not account for any additional conservation outcomes that may be achieved at future stages of the land use planning process. Specifically, future local structure plans will identify additional areas of local POS across the site (which are not identified as part of the DSP process), which may provide further opportunities to retain flora and vegetation environmental values (such as Yanga complex vegetation and areas of Banksia Woodland TEC and/or PEC). As such, the actual extent and magnitude of environmental impacts may be less than those outlined above, when urban development of the site is implemented.

4.3.5 Assessment of potential impacts

4.3.5.1 Clearing of native vegetation

Vegetation condition

Table 8 summarises the potential impacts to native vegetation, based on vegetation condition, as a result of future implementation of the DSP.

Table 8: Summary of potential native vegetation impacts (by vegetation condition)

Vegetation condition	Area within site (ha)	Area within DSP reserves (ha)	Area within DSP development footprint (ha)	Proportion within DSP development footprint
Very Good	24.5	24.0	0.4	2%
Good	20.5	6.5	14.0	69%
Good – Degraded	18.5	6.0	12.5	68%
Degraded	35.6	8.3	27.3	77%
Degraded – Completely Degraded	26.3	15.1	11.2	43%
Completely Degraded	375.4	39.2	336.2	90%
TOTAL	**500.8**	**99.1**	**401.7**	-

Potential impacts to native vegetation within the site are primarily associated with vegetation in 'completely degraded', 'degraded – completed degraded', 'degraded' and 'good – degraded' condition. Impacts to areas of vegetation in 'very good' or 'good' condition vegetation are limited, given impacts in these areas have been avoided through the provision of regional and local reserves to facilitate future retention. As such, the potential impacts are not considered to be significant.

As outlined in **Section 4.3.4**, the potential impacts to native vegetation presented in **Table 8** represent a worst-case scenario, as they are based on the DSP design and therefore do not account for any future local POS areas which may provide additional retention opportunities.

Yanga complex vegetation

Table 9 summarises the potential impacts to intact (i.e. 'good' or better condition) native vegetation representative of the Yanga vegetation complex, as a result of future implementation of the DSP.

Table 9: Potential impacts to Yanga complex vegetation

Yanga vegetation complex	Value
Swan Coastal Plain extent	
Pre-European extent (ha)	26,176
2015 extent remaining on Swan Coastal Plain (ha)	4,312
Percentage of pre-European extent remaining on Swan Coastal Plain	16.5%
Potential impacts of the DSP	
Extent within the site (ha)	41.7
Extent within DSP reserves (extent protected) (ha)	30.5
Extent within DSP development area (extent impacted) (ha)	11.2
% of extent remaining on Swan Coastal Plain within DSP development area	0.3%

The DSP provides for the protection of the majority (30.5 ha, 73%) of intact Yanga complex vegetation occurring within the site. The proposed reserve network has been formulated to align with the areas of the site which support the largest, most contiguous and highest condition occurrences of Yanga complex vegetation, which primarily occurs in the north-west of the site. As such, the majority of potential impacts to Yanga vegetation complex have been avoided and the residual impact is not considered to be significant. Further opportunities to provide for the future retention of Yanga complex vegetation will be available at the LSP stage, through strategic location of local POS areas, which may further reduce potential impacts to this vegetation complex.

Banksia Woodlands of the Swan Coastal Plain TEC and Banksia dominated woodlands of the SCP PEC

The DSP does not propose regional or local reserves to be established over any determined areas of this TEC or PEC. As such, at a district-level, these values are identified within the development area and have not been identified for future retention. The anticipated future loss of this vegetation is unlikely to be considered a significant impact given:

- Occurrences of this TEC and PEC within the site are either isolated, small in area, and/or highly disturbed from their natural form, reducing their overall environmental significance.
- Adjacent regional reserves to the south of the site are likely to contain large, contiguous areas of intact Banksia Woodland TEC and PEC vegetation which provides a local and regional conservation outcome for the communities, independent of the outcomes within the site.
- The overall environmental significance of this vegetation is comparatively lower than other environmental values within the site, such as the large, contiguous area of intact 'Yanga' complex vegetation in the north-west of the site. As such, the areas of higher environmental significance are prioritised for protection in the DSP.

- The ongoing cost and effort required to retain and manage small, isolated and highly disturbed areas of native vegetation to maintain their ecological viability is high. As such, potential long-term management authorities may be unwilling to take on and actively manage the assets due to the high maintenance costs and the difficultly of maintaining their ecological viability.

Notwithstanding the above, and as outlined in **Section 4.3.4**, the potential impacts to the Banksia Woodlands of the Swan Coastal Plain TEC and Banksia dominated woodlands of the SCP IBRA region PEC represent a worst-case scenario, as they are based on the DSP design and therefore do not account for any future local POS areas which may provide additional retention opportunities.

Further assessment of the residual impacts on the Banksia Woodlands of the Swan Coastal Plain TEC as a result of the DSP will be considered through the EPBC Act referral and assessment process, which will be the responsibility of individual proponents of any proposed actions. The EPBC Act referral and assessment process typically occurs following the local structure planning stage, such that further retention opportunities within local POS areas can be considered and the final impacts of development on MNES are known. If the residual impacts of proposed actions associated with implementation of the DSP are determined to be significant, the EPBC Act assessment process provides a statutory mechanism to consider these impacts and any necessary responses (such as offsets), to appropriately manage residual impacts.

4.3.5.2 Fragmentation of flora and vegetation

Vegetation across the majority of the site is already highly fragmented as a result of extensive historical land clearing and disturbance associated with historical and existing land uses. The north-west of the site supports large, contiguous areas of intact native vegetation, which is much less fragmented then other areas of the site, and has been identified for future protection in the DSP through the proposed MRS 'Parks and Recreation' reserve, which would ensure any future fragmentation of flora and vegetation values in this area are avoided. Whilst some native vegetation clearing will be required to implement the DSP, this is primarily limited to isolated and disturbed patches of vegetation, the clearing of which is unlikely to increase fragmentation across the site such that it would be considered a significant impact to flora and vegetation values.

4.3.5.3 Introduction and/or spread of weeds

The site contains 62 non-native (weed) species, of which four species are listed as declared pests under the *Biosecurity and Agriculture Management Act 2007*, including:

- **Zantedeschia aethiopica* (arum lily)
- **Asparagus asparagoides* (bridal creeper)
- **Moraea flaccida* (one-leaf cape tulip)
- **Solanum linnaeanum* (apple of Sodom).

Weeds are prevalent throughout the majority of the site, due to the high level of historical land clearing and disturbance associated with historical and existing land uses. Implementation of the DSP provides an opportunity to remove the majority of weeds (and associated weed seedbank) from the site, through the clearing of weed dominated vegetation and development for residential uses. Where vegetation is proposed to be retained within future reserves, weed coverage is comparatively less, associated with the generally higher condition of vegetation. Notwithstanding, future reserves

will be subject to environmental management plans, which are proposed to be required under future local scheme provisions, which will specify any applicable weed management requirements.

4.3.6 Impact mitigation

To mitigate impacts to flora and vegetation values within the site as a result of future implementation of the DSP, a range of impact avoidance, minimisation and rehabilitation measures are proposed, as discussed below. The planning mechanism/s and the associated stage of the land use planning process at which each of the mitigation measures will be implemented is also outlined.

4.3.6.1 Avoid

Avoidance of impacts to flora and vegetation values has been achieved through the identification of regional and local reserves in the DSP, which will provide for the future retention of flora and vegetation values within these areas. The following reserves are identified in the DSP:

- A future MRS 'Parks and Recreation' reserve, which will be established and implemented through the future MRS amendment stage of the land use planning process.
- Two future local reserves and one future local drainage reserve, which will be implemented through the following stages of the land use planning process:
    - At the CoS LPS 17 amendment stage; text provisions will be included requiring these reserves to be accommodated in future local structure plan/s.
    - At the local structure planning stage; these reserves will be included in the spatial design.
    - At the subdivision and development stage; these reserves will be established.

Implementation of the regional and local reserve network shown in the DSP will result in avoidance of the following impacts to flora and vegetation values within the site:

- Retention of up to 59.8 ha of native vegetation (of which 30.5 ha (51%) is intact vegetation in 'good' or better condition), which includes;
    - The largest, consolidated and most intact area of vegetation within the site, associated with Bush Forever Site 13 and surrounding areas of contiguous vegetation.
    - By targeting consolidated, intact areas of native vegetation for reservation, fragmentation of flora and vegetation values is avoided.
    - 30.5 ha of intact vegetation representative of the Yanga vegetation complex.
    - 0.6 ha (full extent) of vegetation within the site potentially representative of the FCT 15 Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain TEC.
    - The entire population of *Grevillea curviloba* subsp. *curviloba* within Lot 29 (0.9 ha), with an appropriate conservation area buffer zone.

Further opportunities to avoid impacts to flora and vegetation values will be provided at the future local structure planning stage, where the location of local POS areas will further consider opportunities to align with flora and vegetation values (such as Yanga complex vegetation and areas of Banksia Woodland TEC and/or PEC), to enable their potential future retention.

4.3.6.2 Minimise

Minimisation of impacts to flora and vegetation values will be provided at future stages of the land use planning process, through the following mitigation measures:

- Preparation and implementation of a Reserve Management Plan for the proposed MRS 'Parks and Recreation' reserve, which will outline how the reserve will be managed to main existing flora and vegetation values. This will be prepared as part of the MRS amendment stage of the land use planning process.
- Preparation and implementation of Reserve Management Plan/s for the proposed local reserves, which will be required to outline how the reserves will be managed to maintain existing flora and vegetation values. This will be implemented through the following stages of the land use planning process:
    - At the CoS LPS 17 amendment stage; text provisions will be included requiring these management plans to be prepared and implemented as part of the subdivision process.
    - At the subdivision and development stage; these management plans will be prepared and implemented.

Implementation of the regional and local reserve network shown in the DSP, in additional to the proposed management plan framework, will minimise a range of potential impacts to flora and vegetation values within the site, including weed introduction and/or spread of weeds and or/disease, unauthorised vehicular and pedestrian access to reserves, and edge effects.

4.3.6.3 Rehabilitate

No rehabilitation mitigation measures are proposed within the site at the DSP stage. However, future stages of the land use planning process may identify rehabilitation mitigation measures to be implemented, particularly associated with foreshore, wetland and wetland buffer areas.

4.3.7 Predicted outcome

The EPA objective for flora and vegetation is 'to protect flora and vegetation so that biological diversity and ecological integrity are maintained'.

Implementation of the DSP has the potential to impact flora and vegetation values. However, potential impacts on flora and vegetation values can be suitably mitigated through a range of impact avoidance and minimisation measures such that that it is unlikely any significant residual impacts will occur and the EPA objective will be met.

Potential impacts on flora and vegetation values are primarily mitigated through avoidance measures, including the future provision of a range of regional and local reserves. The proposed mitigation measures will be implemented through various stages of the land use planning process.

Where future impacts are expected to flora and vegetation values listed as MNES under the EPBC Act (such as the Banksia Woodlands of the SCP TEC), proponents of any proposed action will consider whether referral under the EPBC Act is required.

4.4 Terrestrial fauna

4.4.1 EPA objective

To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.

4.4.2 Policy and guidance

Relevant policy and guidance documents for terrestrial fauna, which have informed site-specific investigations and/or have been used to assess potential impacts, include:

- *Environmental Factor Guideline – Terrestrial Fauna* (EPA 2016a)
- *Technical Guidance – Sampling methods for terrestrial vertebrate fauna (EPA 2016f)*
- *Technical Guidance – Terrestrial fauna surveys (EPA 2016e)*
- *EPBC Act Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo, Baudin's cockatoo and Forest red-tailed black cockatoo.* (DSEWPaC 2012)
- *Survey guidelines for Australia's threatened reptiles* (DSEWPaC 2011b)
- *Survey guidelines for Australia's threatened fish* (DSEWPaC 2011a).

4.4.3 Receiving environment

4.4.3.1 Regional context

As outlined in **Section 4.3.3.1**, the site is located in a highly modified regional and local landscape, resulting in generally reduced fauna habitat values. Notwithstanding, the site does contain some larger, more consolidated areas of fauna habitat, primarily associated with Bush Forever Site 13. In addition, land surrounding the site also includes some discrete, larger areas of fauna habitat, including Bush Forever Site 300 to the south and Bush Forever Site 400 (Twin Swamps Nature Reserve) to the north-east, which is one of two remaining reserves which support a population of the Western Swamp Tortoise across the historical range of the species. Mature native paddock trees which occur sporadically within rural and agricultural land across the locality and region also provide fauna habitat values, primarily for avifauna species, including black cockatoos.

Overall, the site is situated within a regional landscape that has been subject to significant historical disturbance. Whilst the site provides habitat of varying composition and condition for native fauna, the fauna assemblages utilising the site would be reduced compared to what would be expected if the site had not been subject to such historical disturbances.

4.4.3.2 Site-specific investigations

Site-specific fauna investigations completed to date include:

- *Fauna Assessment – Various Lots, Bullsbrook* (BCE 2019) (**Appendix C**)
- *Preliminary Assessment of Listed Aquatic Fauna within Various Lots, North Ellenbrook* (IPE 2019) (**Appendix D**).
- *Black Cockatoo Habitat Assessment – Lots 29 and 30 Maralla Road* (PGV Environmental 2019a) (**Appendix E**).

Investigations completed by BCE (2019) included a level 1 fauna assessment and a targeted black cockatoo assessment undertaken over five days in December 2018 and April 2019. Investigations completed by IPE (2019) included a level 1 aquatic fauna assessment undertaken over one day in November 2018, which focused on determining the possibility and likelihood of conservation significant aquatic fauna being present within the site, given the proximity of the site to known habitat for the conservation-significant Western Swamp Tortoise.

Fragmented land ownership across the site meant that not all lots within the site could be directly accessed as part of undertaking the above fauna surveys. Lots which could not be directly accessed were observed from the boundary of adjacent lots or public road reserves. Notwithstanding, BCE (2019) concluded that the lots which could not be directly accessed were observed to contain a similar range of habitats to those lots which were inspected (with the exception of more intact native vegetation within Bush Forever Site 13), allowing observed habitat types to be appropriately extrapolated. Whilst it is expected that further survey may be required as part of more detailed, future stages of land use planning process, a suitable level of survey has been undertaken to date to inform preparation and lodgement of the DSP.

4.4.3.3 Fauna habitat types

The site primarily comprises rural pasture dominated by weed species, with the majority of native vegetation cleared (BCE 2019). Notwithstanding, a range of more intact fauna habitat types were observed across the site, with seven broad vegetation and substrate associations (VSAs) identified across the site by BCE (2019) and are described in **Table 10** and shown in **Figure 7**.

Table 10: Vegetation and soil associations observed within the site (BCE 2019)

VSA	Description	Area
VSA 1	**Melaleuca woodland**. Vegetation along water courses, surrounding ponds and in damp soils; modong or stout paperbark (*Melaleuca preissiana*) woodland with occasional flooded gum (*Eucalyptus rudis*) and marri (*Corymbia calophylla*) on dark grey clay/peaty sands. This includes small patches of ephemeral swamp subject to shallow and temporary seasonal inundation.	21.3
VSA 2	**Marri woodland**. Small pockets of intact open marri woodland over balga (*Xanthorrhoea* spp.) and occasional slender banksia (*Banksia attenuata*) and firewood banksia (*Banksia menziesii*) and sheoak (*Allocasuarina* spp.) on pale grey sandy soil. This VSA occurs in very small, localised patches in low elevation areas including occasional swales.	46.9
VSA 3	**Banksia woodland**. Degraded mixed woodlands of *B. attenuata* and *B. menziesii*, with scattered prickly-bark (*Eucalyptus todtiana*) over woolybush (*Adenanthos cygnorum*) on pale grey deep sand.	12.0
VSA 4	**Cleared areas**. Open cleared areas of pasture grasses and occasional marri, tuart (*Eucalyptus gomphocephala*) (potentially planted), planted ornamental eucalypts and occasional extensive beds of pigface (*Carpobrotus* spp.). Some areas subject to seasonal waterlogging and even inundation. This VSA is the most extensive across the site.	360.2
VSA 5	**Melaleuca and Astartea shrubland**. Stands of *Astartea scoparia* with *Melaleuca preissiana* and occasional *C. calophylla* and planted ornamental eucalypts. Some areas subject to seasonal waterlogging and even inundation. This VSA occurs on or near the eastern and north-eastern boundaries of the site.	11.3
VSA 6	**Jacksonia over Dasypogon herbland**. Degraded habitat of scattered *Jacksonia furcellata* over *Dasypogon bromeliifolius* and extensive beds of Pigface.	38.8
VSA 7	Surface water in semi-permanent ponds and seasonal creeks with some small patches of emergent typha sp. on two ponds.	0.6

Given the small size and high level of disturbance within remaining areas of native vegetation across the site, it is unlikely that the site supports many of the fauna species found in surrounding bushland areas. In addition, many of the water courses and other surface water features within the site that may support aquatic species appeared to be eutrophic, with heavily trampled banks and highly disturbed or absent riparian vegetation. (BCE 2019)

Notwithstanding, good habitat connectivity was observed in the northern portion of the site where vegetation lies adjacent to the creek on the southern border of Bush Forever Site 13, primarily associated with areas of Melaleuca woodland (VSA 1) and Marri woodland (VSA 2) (BCE 2019). This is consistent with the results of the *Flora and Vegetation Assessment* (Emerge Associates 2019), which identified this area as comprising the most intact remnants of native riparian vegetation.

4.4.3.4 Conservation-significant species

235 vertebrate fauna species were determined to potentially occur within the site, as summarised in **Table 11**. Of these 235 species, 47 were recorded during the onsite survey.

Table 11: Vertebrate fauna species potentially occurring within the site (BCE 2019)

Taxon	No. species potentially occur	Status within site				
		Resident	Regular visitor or migrant	Irregular visitor	Vagrant	Locally extinct
Birds	*162	38	48	61	15	-
Reptiles	35	34	-	-	1	-
Mammals	*22	11	6	3	2	-
Frogs	9	9	-	-	-	-
Fish	*7	3	3	-	1	-
TOTAL	**235**	**95**	**57**	**64**	**19**	**-**

** Of the 162 bird species potentially occurring within the site, 9 are introduced species. Of the 22 mammal species, 5 are introduced. Of the 7 fish species, 3 are introduced.*

Of these 235 species potentially occurring within the site, 17 are listed under State and/or Commonwealth legislation (as a 'threatened' or 'migratory' species) and are therefore considered conservation-significant, as summarised in **Table 12**. Of these 17 conservation-significant species;

- None were identified as residents of the site.
- Only three species are considered to be regular visitors to the site, including Carnaby's black cockatoo, forest red-tailed black cockatoo and the peregrine falcon.
- The remaining 14 species are considered to be either irregular visitors, migratory visitors, or vagrants to the site, and therefore have not been considered further in this EAR (but are discussed further in the Fauna Assessment report (BCE 2019), provided in **Appendix C**). These are primarily migratory shorebirds, which may occur as occasional, non-breeding visitors to the site in small numbers, but the amount of suitable habitat within the site is limited (BCE 2019).

Table 12: Vertebrate fauna species potentially occurring within the site which are listed under State and/or Commonwealth legislation (BCE 2019)

Species	Common name	Status within site	Recorded*
BIRDS			
Actitis hypoleucos	Common Sandpiper	Irregular Visitor	No
Apus pacificus	Fork-tailed Swift	Migratory Visitor	No
Calidris acuminata	Sharp-tailed Sandpiper	Irregular Visitor	No
Calidris ruficollis	Red-necked Stint	Irregular Visitor	No
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	Regular Visitor	**Yes**
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	Irregular Visitor	No
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	Regular Visitor	**Yes**
Falco peregrinus	Peregrine Falcon	Regular Visitor	No
Rostratula australis	Australian Painted-snipe	Vagrant	No
Threskiornis falcinellus	Glossy Ibis	Vagrant	No
Tringa glareola	Wood Sandpiper	Irregular Visitor	No
Tringa nebularia	Common Greenshank	Irregular Visitor	No
Tringa stagnatilis	Marsh Sandpiper	Irregular Visitor	No
REPTILES			
Pseudemydura umbrina	Western Swamp Tortoise	Vagrant	No
MAMMALS			
Dasyurus geoffroii	Chuditch	Vagrant	No
Phascogale tapoatafa wambenger	Brush-tailed Phascogale	Vagrant	No
FISH			
Galaxiella nigrostriata	Black-striped minnow	Vagrant	No

** Recorded as occurring within the site during site inspection completed by BCE (2019) or IPE (2019).*

In addition to the species listed in **Table 12**;

- *Westralunio carteri* (Carter's freshwater mussel) is an invertebrate fauna species which is listed as 'Vulnerable' under State and Commonwealth legislation. Based on the level 1 aquatic fauna assessment (IPE 2019), portions of creeklines with wider hydrological connectivity and a higher level of vegetation intactness were determined to provide suitable habitat for the species.
- *Isoodon fusciventer* (quenda) is a vertebrate mammal species which is not listed as threatened under State or Commonwealth legislation, however is identified as a 'Priority 3' species at a State level. Evidence of quenda was observed within the site and the species is considered to be a resident of the site (BCE 2019). Further discussion regarding quenda is provided in **Section 4.4.3.7**.

4.4.3.5 Black cockatoos

Due to the local and regional conservation significance of black cockatoos, in addition to their regular visitation of the site, a targeted assessment of black cockatoo habitat within the site was completed by BCE (2019). This included an assessment of foraging, breeding and roosting habitat.

Of the three species of black cockatoo, direct observations and indirect evidence of Carnaby's black cockatoo (CBC) and forest red-tailed black cockatoo (FRTBC) were recorded within the site, with both species determined to be regular visitors. In contrast, direct observation or indirect evidence of Baudin's black cockatoo was not recorded within the site. The site is situated outside of the Baudin's black cockatoo known range and as such, the species is considered a vagrant at best within the site (BCE 2019) and has not been considered further.

Foraging habitat

The site is situated within the known foraging range for CBC. Within the site, CBC foraging habitat was determined to occur in areas supporting banksia species, in addition to areas of vegetation containing marri, jarrah and tuart (BCE 2019). As outlined in **Table 13** and shown in **Figure 8**:

- 80% of the site (400.2 ha) supports no, or 'negligible to low' value CBC foraging habitat.
- 20% of the site (100.5 ha) support CBC foraging habitat of varying value, including areas of 'low to moderate', 'moderate' and 'moderate to high' foraging value.
- No areas of the site support any 'high' value CBC foraging habitat.

CBC foraging evidence was observed in a number of locations during the site-specific investigations, as shown in **Figure 8**.

Table 13: CBC foraging habitat type, quality and extent within the site (BCE 2019)

Foraging value	CBC foraging plants present	Foraging signs	Extent (ha)
0/6 – no foraging value	N/A	N/A	0.0
1/6 – negligible to low foraging value	Isolated marri, banksia, *Jacksonia furcellata*, *Xanthorrhoea preissii*, occasional patches of *pelargonium* pp. Standing water.	None	400.2
2/6 – low foraging value	N/A	N/A	0.0
3/6 – low to moderate foraging value	Isolated and patchy marri, jarrah, tuart and banksia. Occasional patches of *Pelargonium* spp. Standing water.	None	36.9
4/6 – moderate foraging value	Common marri and occasional jarrah and tuart, with some banksia, *Acacia saligna*. Standing water.	Infrequent	59.0
5/6 – moderate to high foraging value	*Banksia attenuata, B. menziesii, B. ilicifolia* with *Eucalyptus todtiana* and *X. preissii*.	Infrequent	4.6
6/6 – high foraging value	N/A	N/A	0.0

The site is also situated within the known foraging range for FRTBC. Within the site, FRTBC foraging habitat was determined to occur in areas supporting marri and jarrah species (BCE 2019). As outlined in **Table 14** and shown in **Figure 9**:

- 88% of the site (442.1 ha) supports no, or 'negligible to low' value FRTBC foraging habitat.
- 5% of the site (22.5 ha) supports FRTBC foraging habitat of varying value, including areas of 'moderate' and 'moderate to high' foraging value.
- 7% of the site (36.1 ha) supports 'high' value FRTBC foraging habitat.

FRTBC foraging evidence was observed in a number of locations during the site-specific investigations, the locations of which are shown in **Figure 9**.

Table 14: FRTBC foraging habitat type, quality and extent within the site (BCE 2019)

Foraging value	CBC foraging plants present	Foraging signs	Extent (ha)
0/6 – no foraging value	N/A	N/A	147.5
1/6 – negligible to low foraging value	Occasional marri, jarrah.	Infrequent	294.6
2/6 – low foraging value	N/A	N/A	0.00
3/6 – low to moderate foraging value	N/A	N/A	0.00
4/6 – moderate foraging value	Marri.	Occasional	2.0
5/6 – moderate to high foraging value	Frequent marri and occasional jarrah, Standing water.	Occasional	20.5
6/6 – high foraging value	Common marri with occasional jarrah, standing water.	Occasional	36.1

Breeding habitat

The site is outside of the traditional breeding range for both CBC and FRTBC. Notwithstanding, suitable breeding habitat (as defined by DSEWPAC (2012)) for both species is found across the Swan Coastal Plain. Suitable breeding habitat is defined as '*trees of species known to support breeding within the range of the species which either have a suitable nest hollow or are of a suitable diameter at breast height (DBH) to develop a nest hollow. For most tree species, suitable DBH is 500 mm. For salmon gum and wandoo, suitable DBH is 300 mm*' (DSEWPaC 2012).

BCE (2019) identified 414 black cockatoo potential breeding habitat trees within the site, comprising a range of tree species, including marri (346 trees), tuart (26 trees), unidentified eucalypts (18 trees), paperbarks (12 trees), jarrah (7 trees), river red gum (4 trees) and prickly bark (1 tree).

The 414 black cockatoo potential breeding habitat trees identified within the site were each assigned an applicable habitat score or 'category' by BCE (2019), which is based on whether each tree contained hollow/s and if so, morphology of the hollow/s (size, height, angle and diameter) relative to black cockatoo preferences. The location and determined categories of habitat trees identified within the site (BCE 2019) are shown in **Figure 10** and outlined in **Table 15**.

Table 15: Black cockatoo habitat trees recorded within the site (BCE 2019)

Category	Description of habitat values (BCE ranking system)	Trees
1	Active nest observed; adult (or immature) bird seen entering or emerging from hollow.	0
2	Hollow opening considered large enough (approximately >100 mm) and in a position of the tree suited to black-cockatoo entrance (e.g. in a chimney type opening or on the side of a large enough vertical limb), chew marks around the opening or inside, or egg remains inside the hollow.	4
3	Hollow which met the size and position expectations for nesting Black-Cockatoos but with no obvious chew marks were visible from the ground.	9
4	Tree which either has hollows but not of an angle preferred by black cockatoos, or had hidden parts of the tree that could not be guaranteed devoid of hollows.	29
5	Trees that were large enough to be recorded but had no sign of any hollows big enough for Black-Cockatoos.	372
	TOTAL	**414**

Of the 414 black cockatoo potential breeding habitat trees identified within the site;

- 97% (401) do not contain, or are unlikely to contain, hollow/s suitable for black cockatoos.
- 3% (13) contain hollow/s of suitable morphology for use by black cockatoos.

Of the 13 black cockatoo habitat trees identified within the site which contain suitable hollow/s for use by black cockatoo species, 4 of these trees were observed to have chew marks around the opening or inside of the hollows, or egg remains inside the hollow. The observed chew marks and egg remains could not be definitively attributed to a specific fauna species (BCE 2019) and these trees were also observed to be used in varying degrees by galahs, wood ducks or ringneck parrots, suggesting that hollows within the site are used by a variety of fauna species. As such, historical use of these hollows could not be confirmed to be associated with black cockatoos.

As outlined in **Section 4.4.3.2**, fragmented land ownership across the site meant that not all lots within the site could be directly accessed during the fauna assessment and as such, the black cockatoo potential breeding habitat trees recorded by BCE (2019) do not represent a complete account of all such habitat trees. Notwithstanding, the majority of land parcels within the site were able to accessed, providing a suitable level of survey being completed to support the DSP.

Roosting habitat

The site is within the traditional roosting range for CBC and is within the more recently established roosting range for FRTBC (Peck *et al.* 2018). However, no black cockatoo roosting sites have been historically recorded within the site, based on the Great Cocky Count database (Peck *et al.* 2018), with the nearest FRTBC roost located in Ellenbrook approximately 3 km south of the south, and the nearest CBC roost located east of the Darling Escarpment, approximately 7 km east of the site.

Black cockatoo roosting habitat typically comprises large stands of native trees, close to water and foraging resources. BCE (2019) determined that patches of marri and other stands of tuart, jarrah or other large eucalypts provide potential roosting habitat for CBC and FRTBC. A roost survey completed at sunset on 23 April 2019 did not record (visually or aurally) any black cockatoos within the site. No other evidence of black cockatoo roosting was observed within the site.

Overall, the site contains black cockatoo roosting habitat which has the potential to be used by CBC or FRTBC, however no evidence of roosting activity was observed during the site inspection.

4.4.3.6 Western Swamp Tortoise

The Western Swamp Tortoise (WST) (*Pseudemydura umbrina*) historically occupied the portion of the eastern Swan Coastal Plain between Guildford and Bullsbrook (Burbidge *et al.* 2010), an area within which the site is located. The majority of this land was historically cleared to support agricultural land uses, resulting in significant habitat loss for the species. There are currently only two known wild populations of the species, occurring within Twin Swamps Nature Reserve (approximately 0.9 km north-east of the site) and Ellen Brook Nature Reserve (approximately 1.4 km south-east of the site). These two reserves are located within the policy area of the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* (WST EPP). The site is situated adjacent to the WST EPP area, as shown in **Figure 11**.

The species has specific habitat requirements, including (IPE 2019):

- The presence of water-holding soils (such as clay, sandy duplex soils or peat soils).
- Shallow, ephemeral wetlands that contain water for around seven months (the species is not known to live in permanent waters) with flat to low-sloping banks.
- Intact remnant native vegetation with medium density understorey for aestivation and protection, avoiding areas of very dense vegetation.

Based on the level 1 aquatic fauna assessment and associated site investigations, IPE (2019) concluded that the 99% (494.5 ha) of the site does not contain suitable habitat for WST. Notwithstanding, a small number of surface water features within the site are considered to provide marginal (1.5 ha) or suitable (4.7 ha) habitat for WST, as shown in **Figure 11**. Areas of suitable habitat are generally associated with more intact waterways and wetlands which occur within the site.

IPE (2019) concluded whilst it is possible that WST are present within areas of suitable or marginal habitat within the site, it is not likely that WST are present. This conclusion is based on the reliance of the WST species on human intervention to maintain the two remaining populations within the two reserves, through processes such as a captive breeding program at Perth Zoo, installation of predator-proof fencing and highly active management of the reserves (including abstraction of groundwater to maintain required surface water conditions).

Whilst the site is located within the known historical range of the WST; contains some small areas of suitable habitat for the species; is within proximity to known populations of the species; and the species has the ability to traverse up to 1 km over land (Burbidge *et al.* 2010), areas of suitable habitat within the site are not protected from predators and are not activity managed for conservation purposes. In addition, a road and railway separate the site from the known WST populations, which provide significant physical barriers to any movement of WST outside of the two reserves. These factors reduce the likelihood of the species being present within the site.

Overall, the site contains small areas of suitable habitat for WST. It is considered possible that WST are present within the site, but it is not considered likely due to a range of factors which would diminish their chance of reaching or surviving within the site.

4.4.3.7 Quenda

The site's location in the northern Swan Coastal Plain is within the known distribution of the species. Habitat for the species within the site is associated with areas of low vegetation characterised by a dense scrub and understorey, which provides refuge from predators. Indirect evidence of the species occurring within the site was observed in the form of numerous foraging holes, the locations of which are shown on **Figure 7**. BCE (2019) concluded that quenda are a resident of the site, with the species also considered likely to occur within Bush Forever Site 300 to the south of Maralla Road.

4.4.4 Potential impacts of the DSP

There are a number of potential impacts to terrestrial fauna values which may occur as a result of future implementation of the DSP, including:

- Direct impacts
  - Potential fauna interactions during future development works resulting in fauna injury or mortality.
- Indirect impacts
  - Clearing of suitable fauna habitat within the site, including:
    - General fauna habitat types (VSAs)
    - Suitable foraging, roosting and breeding habitat for black cockatoos
    - Suitable habitat for Western Swamp Tortoise
    - Suitable habitat for Quenda
  - Offsite impacts to existing Western Swamp Tortoise habitat through altered hydrology.

As outlined in **Section 4.3.4**, the potential impacts of the DSP on terrestrial fauna values presented in this EAR represent a worst-case scenario and do not account for any future conservation outcomes that may be achieved at future stages of the land use planning process. Specifically, future local structure planning will also consider opportunities to align local POS areas with existing environmental values (including terrestrial fauna habitat, such as habitat for black cockatoos) to enable their potential future retention, which may increase the overall conservation outcome for terrestrial fauna values, beyond that shown in the DSP.

4.4.4.1 Potential fauna interactions during future development works resulting in fauna injury or mortality

Implementation of the DSP and associated future urban development of the site has the potential to result in fauna interactions during construction works, which could lead to fauna injury or mortality.

In order to mitigate this impact, a Fauna Management Plan will be required to be prepared and implemented as part of subdivisional and development works which involve impacts to fauna habitat. This requirement will be included as a local scheme provision when the CoS LPS 17 is amended and will suitably mitigate the potential impacts.

4.4.4.2 Clearing of suitable fauna habitat

General fauna habitat types (VSAs)

Table 16 summarises the potential impacts to fauna habitat types, based on identified VSAs, as a result of future implementation of the DSP.

Table 16: Summary of proposed native vegetation impacts (by vegetation condition)

Vegetation and soil association (fauna habitat type)	Area within site (ha)	Area within DSP reserves (ha)	Area within DSP development footprint (ha)	Proportion within DSP development footprint
VSA 1 Melaleuca woodland	21.3	14.6	6.7	31%
VSA 2 Marri woodland	46.9	24.3	22.6	48%
VSA 3 Banksia woodland	12.0	0.0	12.0	100%
VSA 4 Cleared Parkland	360.2	37.6	322.6	90%
VSA 5 Melaleuca and Astartea shrubland	11.3	4.3	7.0	62%
VSA 6 Jacksonia over Dasypogon herbland	38.8	17.0	21.8	56%
VSA 7 Standing water	0.6	0.2	0.4	73%
Unclassified habitat	10.2	1.2	9.0	88%
TOTAL	**501.4**	**99.2**	**402.1**	**-**

The DSP has been formulated to avoid impacts to portions of the site which support the largest, most contiguous and intact areas of fauna habitat, which primarily occur in the north-west. This provides for the retention of significant proportions of VSA 1 Melaleuca woodland and VSA 2 Marri woodland, which are generally the most intact and dominant fauna habitat types within the site. Whilst potential impacts to VSAs 3, 5 and 6 may appear relatively high, these habitat types generally occur in smaller, more isolated areas which are typically subject to higher levels of disturbance and as such, provided comparatively lower fauna habitat values to the larger, more contiguous and less disturbed habitat within VSA 1 and 2. In this context, the potential impacts are not considered to be significant.

As outlined in **Section 4.4.4**, the potential impacts to fauna habitat types presented in **Table 16** represent a worst-case scenario, as they are based on the DSP design and therefore do not account for any future local POS areas which may provide additional fauna habitat retention opportunities.

Black cockatoo habitat

Table 17 summarises the potential impacts to black cockatoo foraging habitat as a result of future implementation of the DSP. With regard to CBC foraging habitat, potential impacts are not considered to be significant given:

- The site does not contain any 'high' value CBC foraging habitat, thus none will be impacted.
- Where CBC foraging habitat of variable quality does occur, 40 ha (40%) is proposed for future retention within the proposed regional and local reserves shown in the DSP.

With regard to FRTBC foraging habitat, potential impacts are also not considered to be significant, given only a small proportion (18%) of 'high' quality foraging habitat will be potentially impacted, as the majority (82%) is proposed for future retention within the proposed regional and local reserves.

In addition, further opportunities to provide for the future retention of black cockatoo foraging through the strategic location of local POS areas will be available at the local structure planning stage, which may provide for further reduction to the potential impacts.

Table 17: Potential impacts to black cockatoo foraging habitat

Fauna habitat type	Area within site (ha)	Area within DSP reserves (ha)	Area within DSP development footprint (ha)	Proportion within DSP development footprint
CBC foraging habitat				
'no' or 'negligible to low' value	400.2	58.7	341.5	85%
'low to moderate', 'moderate' or 'moderate to high' value	100.6	40.4	60.2	60%
'high' value	0.0	0.0	0.0	0%
TOTAL	**500.8**	**99.1**	**401.7**	**-**
FRTBC foraging habitat				
'no' or 'negligible to low' value	442.1	64.0	378.1	85%
'moderate' or 'moderate to high' value	22.6	5.6	17.0	75%
'high' value	36.1	29.5	6.6	18%
TOTAL	**500.8**	**99.1**	**401.7**	-

Table 18 summarises the potential impacts to identified black cockatoo potential breeding habitat trees as a result of future implementation of the DSP.

Table 18: Potential impacts to black cockatoo potential breeding habitat trees

Black cockatoo potential breeding habitat trees	No. trees within site (ha)	No. trees within DSP reserves (ha)	No. trees within DSP development footprint (ha)	Proportion trees within DSP development footprint
Trees containing hollow/s suitable for use by black cockatoos	13	6	7	54%
Trees not containing (or unlikely to contain) suitable hollow/s	401	179	222	55%
TOTAL	**414**	**185**	**229**	**-**

As discussed in **Section 4.4.3.5**, the black cockatoo potential breeding habitat trees recorded by BCE (2019) do not represent a complete account of all habitat trees across the site. In this respect, based on the known fauna habitat types, additional habitat trees are expected to occur within other (currently un-surveyed) areas of the site, most likely within Bush Forever Site 13 and contiguous vegetation across Lot 5, which are areas identified for future protection in the DSP.

In this context, it is likely that the proportion of black cockatoo breeding habitat trees to be potentially impacted would decrease below that indicated in **Table 18,** once a full account of all habitat trees across the site is known. Notwithstanding, the currently known potential impacts to black cockatoos as a result of potential loss of potential breeding habitat trees are not considered to be significant, given approximately half of black cockatoo potential breeding habitat trees are identified for future retention within the local and regional reserves shown in the DSP.

In addition, further opportunities to provide for the future retention of black cockatoo potential breeding habitat trees through the strategic location of local POS areas will be available at the local structure planning stage, which may provide for further reduction to the potential impacts.

Western Swamp Tortoise habitat

Table 19 summarises the potential impacts to WST habitat within the site, as a result of future implementation of the DSP.

Table 19: Potential impacts to WST habitat within the site

Western Swamp Tortoise habitat type	Area within site (ha)	Area within DSP reserves (ha)	Area within DSP development footprint (ha)	Proportion within DSP development footprint
Marginal habitat	1.4	1.4	0.0	0%
Suitable habitat	4.6	4.1	0.5	11%
Unsuitable or no habitat	495.1	94.0	401.1	81%
TOTAL	**501.1**	**99.5**	**401.6**	**-**

As discussed in **Section 4.4.3.6**, the majority of the site contains unsuitable or no habitat for WST, with only a limited area of suitable or marginal habitat determined to occur (IPE 2019). Whilst potential use of these limited areas of marginal or suitable habitat by WST was determined to be possible, IPE (2019) concluded that it was not likely that WST would utilise habitat within the site.

Notwithstanding the above, the DSP has been formulated to prioritise avoidance of potential impacts to marginal or suitable WST habitat areas within the site, through provision of local and regional reserves to allow for future retention of these values. As such, approximately 92% (5.5 ha) of identified suitable or marginal habitat for WST within the site has been identified within local or regional reserves for future retention.

Further mitigation of potential impacts will be implemented as part of future stages of the land use planning process. Specifically, local structure planning will provide opportunities to align local POS area with suitable WST habitat, to enable potential future retention. This may result in an outcome whereby no areas of marginal or suitable WST habitat are impacted by urban development.

In this context, the potential impacts to WST are unlikely to be considered significant, given; the largest, most contiguous areas of marginal or suitable WST habitat within the site (which would be the most likely areas of the site, if any, to be used by WST) have been identified for future retention, there will be additional habitat retention opportunities at the local structure planning stage, and, if residual impacts still remain, impacted areas of habitat would be small and isolated, outside of the larger, more contiguous habitat areas protected within regional or local reserves shown on the DSP.

4.4.4.3 Offsite impacts to existing Western Swamp Tortoise habitat through altered hydrology

Specific portions of the site experience some hydrological (surface or groundwater) connectivity with Twin Swamps Nature Reserve (850 m east of the site) and Ellen Brook Nature Reserve (1.4 km south-east of the site), which support the only two known wild populations of the WST species.

Potential offsite impacts to WST habitat are related to hydrological considerations and as such, have been considered in the context of the Inland Waters factor, discussed in **Section 4.5.5.4**. In summary, potential offsite impacts to WST habitat as a result of implementing the proposed DSP can be suitably mitigated such that no significant impact to WST will occur.

4.4.5 Impact mitigation

To mitigate impacts to terrestrial fauna values within the site as a result of future implementation of the DSP, a range of avoidance, minimisation and rehabilitation measures are proposed, as discussed below. The planning mechanism/s and the associated stage of the land use planning process at which each of the mitigation measures will be implemented is also provided below.

4.4.5.1 Avoid

Avoidance of impacts to terrestrial fauna values has been achieved through the identification of regional and local reserves across the site, which will provide for the future retention of environmental values within these areas. The proposed regional and local reserves shown on the DSP and the associated timing of their implementation (with respect to the land use planning process) is detailed in **Section 4.3.6.1**.

Implementation of the regional and local reserve network shown in the DSP will result in avoidance of the following impacts to flora and vegetation values within the site:

- Retention of the following fauna habitat values:
  - The largest, most consolidated and most intact area of fauna habitat within the site, associated with Bush Forever Site 13 and surrounding areas of contiguous vegetation, generally associated with VSAs 1 and 2.
  - 40.4 ha (40%) of CBC foraging habitat of variable value ('low to moderate', 'moderate' or 'moderate to high' value), noting that no 'high' value CBC foraging habitat occurs.
  - 29.5 ha (82%) of FRTBC foraging habitat of 'high' value.
  - 185 (45%) black cockatoo breeding trees (based on currently known tree locations, but likely to increase as further survey is completed).
  - 5.5 ha (92%) of marginal or suitable Western Swamp Tortoise habitat.

Further opportunities to avoid impacts to terrestrial fauna values will be provided at the future local structure planning stage, where the location of local POS areas will consider opportunities to align with existing environmental values (including habitat for black cockatoos or WST), to enable their potential future retention.

4.4.5.2 Minimise

Minimisation of impacts to terrestrial fauna values will be provided at future stages of the land use planning process, through the following mitigation measures:

- Preparation and implementation of a Reserve Management Plan for the proposed MRS 'Parks and Recreation' reserve, which will outline how the reserve will be managed to main existing terrestrial fauna values. This will be prepared as part of the future MRS amendment stage.
- Preparation and implementation of Reserve Management Plan/s for the proposed local reserves, which will be required to outline how the reserves will be managed to maintain existing terrestrial fauna habitat values. This will be implemented through the following stages of the land use planning process:
    - At the CoS LPS 17 amendment stage; text provisions will be included requiring these management plans to be prepared and implemented as part of the subdivision process.
    - At the subdivision and development stage; these management plans will be prepared and implemented.
- Preparation and implementation of Fauna Management Plan/s to outline measures to mitigation risks of fauna interactions and potential injury or mortality during the construction process, which will be implemented through the following stages of the land use planning process:
    - At the CoS LPS 17 amendment stage; text provisions will be included requiring the Fauna Management Plan to be prepared and implemented as part of the subdivision and development stage.
    - At the subdivision and development stage; the Fauna Management Plan will be prepared and implemented.

4.4.5.3 Rehabilitate

No rehabilitation mitigation measures are proposed within the site at the DSP stage. However, future stages of the land use planning process may identify rehabilitation mitigation measures to be implemented, particularly associated with foreshore, wetland and wetland buffer areas.

4.4.6 Predicted outcome

The EPA objective for flora and vegetation is 'to protect terrestrial fauna so that biological diversity and ecological integrity are maintained'.

Implementation of the DSP has the potential to impact terrestrial fauna values. However, potential impacts on terrestrial fauna habitat can be suitably mitigated through a range of impact avoidance and minimisation measures such that that it is unlikely any significant residual impacts will occur and the EPA objective will be met.

Potential impacts on terrestrial fauna values are primarily mitigated through avoidance measures, including the future provision of a range of regional and local reserves to provide for the retention of various fauna habitat types. The proposed mitigation measures will be implemented through various stages of the land use planning process.

Where future impacts are expected to terrestrial fauna values listed as MNES under the EPBC Act, proponents of any proposed actions will consider whether referral under the EPBC Act is required.

4.5 Inland waters

4.5.1 EPA objective

To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected.

4.5.2 Policy and guidance

Relevant policy and guidance documents for inland waters, which have informed site-specific investigations and/or have been used to assess potential impacts, include:

- *Environmental Factor Guideline – Inland Waters* (EPA 2018)
- *State Planning Policy 2.9: Water Resources* (WAPC 2006)
- *Better Urban Water Management* (WAPC 2008)
- *Decision Process for Stormwater Management in Western Australia* (DWER 2017)
- *Australian Runoff Quality: A guide to Water Sensitive Urban Design* (Engineers Australia 2006)
- *Stormwater Management Manual for Western Australia* (DoW 2007).

4.5.3 Receiving environment

4.5.3.1 Regional context

In a hydrological context, the location of the site within the Yanga association of the Pinjarra Plain (between the Darling Escarpment and the Bassendean Dunes) is characterised by a relatively flat landscape comprising poorly drained alluvial soils. This landscape contains expressions of perched groundwater and is interspersed with a large number of poorly defined and low-incised waterway and wetland features.

4.5.3.2 Groundwater

A *District Water Management Strategy* (DWMS) (RPS 2019) has been prepared for the site to support the DSP. The DWMS details the existing hydrological conditions of the site, which have been summarised below.

The existing average annual maximum groundwater level (AAMGL) for the site has been calculated based a groundwater monitoring program undertaken between June to December 2019, capturing the annual winter peak (RPS 2019).

The AAMGL across the site has been determined to range from approximately 24 to 44 mAHD and groundwater migrates to the southeast (RPS 2019). The majority of the site is inundated or experiences low separation between natural surface levels and groundwater. Specifically:

- 25% of the site experiences seasonal groundwater levels at or above natural surface level.
- 52% of the site experiences seasonal groundwater levels between 0 and 1 m below natural surface level.
- 23% of the site experiences seasonal groundwater levels greater than 1 m below natural surface level.

Based on groundwater monitoring completed across the site in August 2019, groundwater quality across the site is characterised as being acidic (pH 5.5), generally fresh and having heightened total nitrogen and total phosphorus levels. Higher concentrations of salinity and nutrient levels were observed in proximity and downstream of the plant nursey situated directly north of the site.

4.5.3.3 Groundwater dependent ecosystems

Due to the high groundwater levels across the site associated with the unconfined groundwater aquifer, many of the environmental assets within the site are likely to be groundwater-dependent. This is likely to be primarily associated with existing wetland features and associated wetland-type vegetation. Some surface water features within the site, whilst primarily associated with surface-water flows, may also be groundwater-dependent due to the minimal separation to groundwater.

4.5.3.4 Surface water features

Surface water flows enter the site from the west and are conveyed across the site through two primary natural waterways, being Sawpit Gully and an unnamed northern creekline, as shown in **Figure 12**. These are discussed below. Further detail regarding the surface water characteristics of the site is provided in the *District Water Management Strategy* (RPS 2019).

Sawpit Gully

Sawpit Gully is the primary natural waterway within the site, which enters the site at the western boundary of Lot 110 and exits the site at the southern boundary of Lot 32. Sawpit Gully ultimately discharges into Ellen Brook approximately 2.5 km downstream (south-east) of the site. Within the site, Sawpit Gully can be characterised by:

- West of Sawpit Road, where it represents a vegetated watercourse with a well-defined, largely natural and undisturbed channel and banks, supporting intact riparian vegetation (typically in 'very good' condition) and generally representing an intact and relatively undisturbed natural creekline. The portion of Sawpit Gully within Lots 5 and 110 represent these characteristics.
- East of Sawpit Road, where it represents a watercourse with a well-defined channel, with incised and disturbed banks as a result of agricultural land uses, with varying levels of vegetation cover;
    - Portions with mature native trees, but with a highly disturbed understorey generally lacking native species and dominated by weeds and pasture grasses (i.e. vegetation typically in 'degraded' or condition). This primarily occurs within Lots 13, 15 and 32.
    - Portions without any native vegetation or mature trees, due to complete historical clearing of vegetation to establish pasture grasses and grazing land. This primarily occurs within Lots 13, 32 and 33.

A number of surface water flow paths and modified agricultural drains in the central and south-western portions of the site also convey surface water flows into Sawpit Gully.

Unnamed northern creekline

The unnamed northern creekline provides surface water drainage for the northern portion of the site, entering the site at the western boundary of Lot 5 (Bush Forever Site 13) and exiting the site at the eastern boundary of Lot 15. The unnamed northern creekline ultimately discharges into Ellen Brook approximately 3 km downstream (east) of the site.

Within the site, the unnamed northern creekline can be characterised by:

- West of Sawpit Road, where it represents a vegetated flow-path with no defined or distinctive channel, with very low sloping banks supporting intact riparian vegetation (typically in 'very good' or 'good' condition). This form primarily occurs within Lots 2, 4, 5 and 116.
- East of Sawpit Road (within Lot 15), where it represents a highly disturbed watercourse with a well-defined channel, with incised and disturbed banks as a result of agricultural land uses. This portion of the unnamed northern creekline supports minimal native vegetation, and where vegetation does occur, it is generally limited to mature native trees with a highly disturbed understorey comprising weeds and pasture grasses (vegetation typically in 'degraded' or 'completely degraded' condition).

4.5.3.5 Wetlands

Geomorphic wetland mapping for the Swan Coastal Plain (DBCA 2019) identifies the majority of the site as comprising a wetland landform. DBCA mapped wetlands within the site are listed in **Table 20** and shown in **Figure 12**.

Table 20: Geomorphic wetlands mapped within the site (DBCA 2019)

UFI	Wetland management category	Wetland type	Total area (ha)	Area within site (ha)
8926	Conservation	Sumpland (seasonally inundated basin)	14.0	14.0
9185	Resource enhancement	Sumpland (seasonally inundated basin)	2.5	2.5
12283	Resource enhancement	Sumpland (seasonally inundated basin)	10.4	4.1
12444	Resource enhancement	Palusplain (seasonally waterlogged flat)	1.1	1.1
8935	Multiple use	Dampland (seasonally waterlogged basin)	5.9	5.9
8936	Multiple use	Sumpland (seasonally inundated basin)	14.7	11.1
15732	Multiple use (Ellen Brook Floodplain)	Palusplain (seasonally waterlogged flat)	13,734.5	333.7

NOTE: Whilst a small portion of CCW UFI #15389 is mapped as intersecting the southern portion of the site, the actual extent of this CCW is bound by the southern side of Maralla Road, which provides an existing hard edge and clearly established interface. As such, this wetland does not occur within the site and has not been listed above.

Where the DBCA-mapped boundary of wetlands within the site do not align with on-ground conditions, more accurate wetland boundaries have been determined based on an assessment of landform, topography, surface water features and extent of riparian vegetation. For example, the northern boundary of CCW UFI #8926 is mapped by DBCA as extending into an adjacent rural-residential paddock, which contains only pasture grasses. A refined northern boundary for this wetland has been determined (UFIs 8926, 9185 and 12283), which is clearly delineated by the extent of riparian vegetation. Where more accurate wetland boundaries have been determined within the site, these are shown in **Figure 12**.

Based on the extent of DBCA mapped geomorphic wetlands (incorporating refined wetland boundaries, where applicable) approximately 375 ha (75%) of the site comprises a wetland landform, with the remaining 126 ha (25%) comprising an upland landform.

In total, the site contains:

- 14.9 ha of conservation category wetlands (CCW) (3.0% of total site area), comprising one CCW feature, which is wholly contained within the site.
- 8.8 ha of resource enhancement wetlands (REW) (1.8% of total site area), comprising three REW features, two of which are wholly contained within the site.
- 351.2 ha of multiple use wetlands (MUW) (70.1% of total site area), the majority of which are associated with the Ellen Brook floodplain.

4.5.3.6 Hydrological connectivity with Western Swamp Tortoise habitat

As discussed in **Section 4.4.3.6**, known Western Swamp Tortoise habitat occurs within Ellen Brook Nature Reserve and Twin Swamps Nature Reserve (which are situated within the wider WST EPP policy area), both of which are situated to the east or south-east of the site. The hydrological connectivity between the site and these two reserves is discussed below and shown in **Figure 11**.

Twin Swamps Nature Reserve

With regard to groundwater, the northern-most portions of the site (Lots 2, 3, 4, 101 and 116) are located hydrologically up-gradient of the Twin Swamps Nature Reserve and as such, have some groundwater connectivity with the Twin Swamps Nature Reserve (RPS 2019). The balance of the site is not located hydrologically up-gradient of the Twin Swamp Nature Reserve and as such does not have groundwater connectivity (RPS 2019).

With regard to surface water, none of the surface water features which traverse the site drain into the Twin Swamps Nature Reserve. Whilst the unnamed northern creekline passes through the WST EPP policy area, it does not intersect or drain into Twin Swamps Nature Reserve (RPS 2019).

Ellen Brook Nature Reserve

With regard to groundwater, the site and Ellen Brook Nature Reserve are not hydrogeologically connected as they are separated by the Ellen Brook waterway (RPS 2019).

With regard to surface water, drainage from the following two areas of the site traverse the EPP area and discharge into Ellen Brook upstream of the Ellen Brook Nature Reserve:

- The northern portion of the site (including Lots 2, 4, 5, 15 & 116) discharges to the unnamed northern creekline, which ultimately drains into Ellen Brook waterway upstream of the Ellen Brook Nature Reserve.
- The eastern portion of the site (including the northern parts of Lots 29, 30, 31 & 32) discharges across Railway Parade to the east of the site, ultimately draining into Ellen Brook waterway upstream of the Ellen Brook Nature Reserve.

Given the Ellen Brook waterway passes through the Ellen Brook Nature Reserve, the above areas within the site have some surface water connectivity with the Ellen Brook Nature Reserve (RPS 2019).

4.5.4 Potential impacts of the DSP

There are a number of potential impacts to inland water values which may occur as a result of future implementation of the DSP, including:

- Direct impacts
  - Loss of wetland features and landform.
  - Modification of existing surface water hydrology within the site, resulting in potential impacts to wetlands, waterways, flora and vegetation and terrestrial fauna habitat values.
  - Modification of existing groundwater hydrology within the site, resulting in potential impacts to groundwater dependent impacts.
- Indirect impacts
  - Offsite impacts to Western Swamp Tortoise habitat through altered hydrology.

4.5.5 Assessment of potential impacts

4.5.5.1 Loss of wetland features and landform

Table 21 summarises the potential impacts to wetland features as a result of future implementation of the DSP. In summary:

- No impacts to CCWs are anticipated, as the only CCW within the site is situated within the proposed MRS 'Parks and Recreation' reserve boundary.
- No impacts to the majority of REW features within the site are anticipated, given their proposed future retention proposed within local reserves. However, one of the three mapped REWs (UFI #9185) has not been identified within a proposed reserve on the DSP. This REW (totaling 3.2 ha) was not identified within the proposed reserves, given it was observed to be highly disturbed from its natural form as a result of rural land uses, with limited vegetation values remaining in 'degraded' condition. Notwithstanding, given this portion of the site provides a natural low-point, this wetland area may still be partly or wholly accommodated within future local open space to provide a drainage and/or vegetation retention function. This will be determined as part of the local structure planning process.

Given all CCWs and the majority of REWs are proposed future retention within the proposed regional and local reserves shown in the DSP, the proposed impacts are not considered to be significant.

Table 21: Summary of potential wetland impacts

Wetland category	Area within site (ha)	Area within DSP reserves (ha)	Area within DSP development footprint (ha)	Proportion within DSP development footprint
Conservation category wetlands	14.9	14.9	0.0	0%
Resource enhancement wetlands	8.8	5.6	3.2	36%
TOTAL	**23.7**	**20.5**	**3.2**	**-**

4.5.5.2 Modification of existing surface water hydrology within the site

This section discusses the potential impacts to waterways, flora and vegetation and terrestrial fauna habitat values as a result of the modifications to the existing surface water hydrology of the site. Discussion with respect to the proposed surface water management strategy of future urban development is provided in the *District Water Management Strategy* (RPS 2019).

Future urban development of the site, as outlined in the DSP, will involve some modification of the existing surface water features within the site. In this regard:

- The DSP provides regional or local reserves along the full, existing alignment of Sawpit Gully and as such, no modification to this surface water feature is proposed. This will include the associated riparian vegetation and terrestrial fauna habitat values which this creekline supports.
- The DSP provides regional or local reserves for the unnamed northern creekline. The highly disturbed portion of this watercourse (east of Sawpit Road, within Lot 15) is proposed to be realigned along the north-eastern boundary of the site, however the existing entry and exit points will be maintained. This is not expected to result in a significant impact given this portion of the watercourse is highly modified and supports reduced environmental values.
- Where existing surface water features currently occur outside of the proposed regional and local reserves shown on the DSP, these are likely to be impacted by future urban development, due to the need to fill the land to achieve suitable separation to groundwater for urban land uses. Notwithstanding, the vast majority of these surface water features are highly modified agricultural drains or flow-paths, with little to no native riparian vegetation, thus their potential loss is unlikely to be considered significant.

4.5.5.3 Modification of existing groundwater hydrology within the site

This section discusses the potential impacts to existing groundwater-dependent ecosystems within the site. Discussion with respect to the proposed groundwater management strategy of future urban development is provided in the *District Water Management Strategy* (RPS 2019).

Future urban development of the site, as outlined in the DSP, will involve some modification of the existing groundwater regime within the site, which has the potential to impact groundwater-dependent ecosystems. As outlined in the *District Water Management Strategy* (RPS 2019), groundwater levels are proposed to be managed across the proposed development area through the installation of sub-soil drainage systems, in order to enable a controlled groundwater level to be maintained in development areas and therefore reduce the quantity of imported fill that will be required to achieve suitable groundwater separation for residential land uses.

As part of future implementation of the DSP, sub-soil drainage systems will be installed such that they do not lower groundwater levels to the extent that they impact upon groundwater dependent ecosystems retained within the proposed regional and local reserves shown on the DSP. This has been considered as part of preparation of the DWMS and is reflected in the proposed groundwater management principles outline in the DWMS, which will be implemented as part of subsequent stages of development, ensuring significant impacts to groundwater dependent ecosystems are avoided.

4.5.5.4 Offsite impacts to existing Western Swamp Tortoise habitat through altered hydrology

The site is physically separated from Twin Swamps Nature Reserve (850 m east of the site) and Ellen Brook Nature Reserve (1.4 km south-east of the site), which support the only two known wild populations of the WST species. As such, connectivity between the site and the two reserves is therefore limited to indirect hydrological considerations, including:

- Some groundwater connectivity with Twin Swamps Nature Reserve, given the northern-most portions of the site (Lots 2, 3, 4, 101 and 116) are located hydrologically up-gradient of the reserve. However, groundwater modelling has been completed to support the DSP which demonstrates that implementation of the DSP and associated future urban development within the site will not impact the existing hydrology of the Twin Swamps Nature Reserve. This is reflected in the groundwater management principles outlined in the DWMS (RPS 2019).
- Some surface-water connectivity with Ellen Brook Nature Reserve, given the two primary creeklines which pass through the site ultimately discharge into Ellen Brook, which then flows through Ellen Brook Nature Reserve. To ensure implementation of the DSP and associated future urban development within the site will not impact the existing surface water regime within the Ellen Brook Nature Reserve, pre-development flow rates for the two creeklines exiting the site will be maintained, whilst stormwater treatment infrastructure (such as bio retention areas and living streams) will be installed to suitably manage the water quality of surface flows exiting the site. This is reflected in the surface water management principles outlined in the DWMS (RPS 2019).

Overall, the existing spatial separation and the proposed management of groundwater and surface water within the site will ensure that future implementation of the DSP and associated future urban development of the site will not impact existing populations of WST within Twin Swamps Nature Reserve and Ellen Brook Nature Reserve. This is reflected in the DWMS principles and will be implemented as part of subsequent stages of development, ensuring any significant offsite impacts to WST habitat are avoided (RPS 2019).

4.5.6 Impact mitigation

To mitigate impacts to inland waters within the site as a result of future implementation of the DSP, a range of avoidance, minimisation and rehabilitation measures are proposed, as discussed below. The planning mechanism/s and the associated stage of the land use planning process at which each of the mitigation measures will be implemented is also outlined.

4.5.6.1 Avoid

Avoidance of impacts to inland waters has been achieved through the identification of regional and local reserves across the site, which will provide for the future retention of environmental values within these areas. The proposed regional and local reserves shown on the DSP and the associated timing of their implementation (with respect to the land use planning process) is detailed in **Section 4.3.6.1**.

Implementation of the regional and local reserve network shown in the DSP will result in avoidance of the following impacts to inland water values within the site:

- Retention of 14.9 ha (100%) of mapped conservation category wetlands, comprising one wetland feature.
- Retention of 5.6 ha (64%) of mapped resource enhancement wetlands, comprising two wetland features.
- Retention of both primary waterways traversing the site (Sawpit Gully and the unnamed northern creekline). Whilst a highly disturbed portion of the unnamed northern creekline (within Lot 15) will be realigned, the existing flows of both waterways are proposed to be maintained as part of future urban development, as outlined in the DWMS (RPS 2019).

4.5.6.2 Minimise

Minimisation of impacts to inland water values will be provided at future stages of the land use planning process, through the following mitigation measures:

- Implementation of the District Water Management Strategy (RPS 2019), which has been prepared to support the DSP, and the associated water management principles it proposes.
- Future preparation and implementation of a Local Water Management Strategy and Urban Water Management Plan/s, which will outline:
    - How groundwater will be managed as part of urban development, in accordance with the principles established in the DWMS, to ensure that that no significant impacts to groundwater dependent ecosystems (within the site) and Twin Swamps Nature Reserve (outside of the site) occur.
    - How surface water is will be managed as part of urban development, in accordance with the principles established in the DWMS, to ensure that no significant impacts to retained waterways and associated riparian vegetation and fauna habitat values (within the site) and the Ellen Brook Nature Reserve (outside of the site) occur.

  This will be implemented through the following stages of the land use planning process:
    - At the CoS LPS 17 amendment stage; text provisions will be included requiring the preparation of a Local Water Management Strategy at the local structure planning stage and an Urban Water Management Plan/s at the subdivision stage, including specification of their required content as outlined above.
    - At the local structure planning stage, the Local Water Management Strategy will be prepared and implemented.
    - At the subdivision and development stage, the Urban Water Management Plan/s will be prepared and implemented.
- Preparation and implementation of Reserve Management Plan/s for proposed local reserves, which will be required to outline how any retained waterways and wetlands will be managed to maintain existing environmental values, and will be implemented through the following stages of the land use planning process:
    - At the CoS LPS 17 amendment stage; text provisions will be included requiring the Reserve Management Plans are to be prepared and implemented as part of the subdivision and development stage.
    - At the subdivision and development stage; the Reserve Management Plan/s will be prepared and implemented.

4.5.6.3 Rehabilitate

No rehabilitation mitigation measures are proposed within the site at the DSP stage. However, future stages of the land use planning process may identify rehabilitation mitigation measures to be implemented, particularly associated with foreshore, wetland and wetland buffer areas, such as those associated with Sawpit Gully and the unnamed northern creekline, both of which are highly modified as a result of historical land clearing and agricultural land uses.

4.5.7 Predicted outcome

The EPA objective for inland waters is 'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'.

Implementation of the DSP has the potential to impact inland water values. However, potential impacts on inland waters can be suitably mitigated through a range of impact avoidance and minimisation measures such that that it is unlikely any significant residual impacts will occur and the EPA objective will be met.

Potential impacts on inland water are primarily mitigated through avoidance measures, including the future provision of a range of regional and local reserves to provide for the future retention on the primary natural waterways within the site. In addition, a range of impact minimisation measures are proposed, including future preparation of the LWMS and UWMP/s to implement the groundwater and surface water management principles established in the DWMS, in addition to the preparation of Reserve Management Plan/s. The proposed mitigation measures will be implemented through various stages of the land use planning process.

4.6 Terrestrial environmental quality

4.6.1 EPA objective

To maintain the quality of land and soils so that environmental values are protected.

4.6.2 Policy and guidance

Relevant policy and guidance documents for terrestrial environmental quality, which have informed site-specific investigations and/or have been used to assess potential impacts, include:

- *Environmental Factor Guideline – Terrestrial Environmental Quality* (EPA 2016)
- *Planning Bulletin No. 64: Acid Sulfate Soils* (WAPC 2009)
- *Managing urban development in acid sulfate soil areas* (DWER 2015a)
- *Identification and investigation of acid sulfate soils and acidic landscapes* (DER 2015)
- *Treatment and management of soil and water in acid sulfate soil landscapes* (DWER 2015b)
- *Assessment and management of contaminated sites: Contaminated sites guidelines* (DER 2014).

4.6.3 Receiving environment

4.6.3.1 Regional context

The site supports two distinct landforms, including upland formations of the Bassendean Dunes in the south-west of the site, which supports sandy soils, and a low-lying wetland landform across the remainder of the site, which supports a combination of pebbly silt, sand over pebbly silt and peaty clay soils, typical of the Pinjarra Plain. The site currently supports a combination of rural and rural-land uses, including small-scale hobby farms for horse agistment and pasture for cattle grazing.

4.6.3.2 Acid sulfate soils

Regional acid sulfate soils (ASS) risk mapping published by DWER (2019) indicates the majority of the site has a '*moderate to low risk of ASS occurring within three metres of the natural soil surface, but a high to moderate risk of ASS occurring beyond three metres*'. Select portions of the site are mapped by DWER as having a '*higher to moderate risk of ASS occurring within three metres of the natural soil surface*'. ASS risk mapping over the site, as published by DWER, is shown in **Figure 13**.

The risk maps do not describe the actual severity of ASS in a particular area but provide an indication of whether ASS could be present based on surface elevations and landforms.

4.6.3.3 Potential contamination

DWER Contaminated Sites Database

DWER are the responsible authority for administering the *Contaminated Sites Act 2003* and its associated procedures. DWER maintain the *Contaminated Sites Database* which holds information on known contaminated sites that have been classified by DWER as 'contaminated – remediation required', 'contaminated – restricted use' or 'remediated for restricted use'.

A search of the *Contaminated Sites Database* indicated no registered contaminated sites (as listed above) occur within the site, nor are there any registered sites within 3 km of the site (DWER 2019).

Historical and existing land uses

Based on a review of historical aerial imagery published by Landgate (2019), the majority of the site appears to have been cleared of remnant vegetation prior to 1965 (the earliest available aerial imagery published by Landgate), to enable rural land uses to be established.

In addition to existing rural and rural-residential land uses across the site, Lot 10 Maralla Road in the south-west of the site has historically supported turf farming activities (since approximately the early 1990s), however it is unclear if this land use is still currently in operation.

Based on a review of the guideline titled *Assessment and management of contaminated sites: Contaminated sites guidelines* (DER 2014), the existing rural-residential land uses present across the majority site are not identified as potentially contaminating land uses, and therefore are not considered to represent any significant risk of potential contamination.

The guideline (DER 2014) identifies '*market gardens, orchards, poly-tunnels, plant nurseries*' (which may incorporate turf farms, such as that within Lot 10) as potentially contaminating land uses, with common contaminant types associated with these land uses listed as including heavy metals, pesticides, insecticides and hydrocarbons (DER 2014). Preliminary investigations indicate that the risk of any significant contamination is generally low, however site-specific investigations would be required to determine the extent to which any contamination may occur within Lot 10, with such investigations typically undertaken in response a condition of subdivision approval. As such, this can be addressed as part of future stages of the typical land use planning process associated with urban development and would not preclude progression of the DSP.

Per- and poly-fluoroalkyl substances (PFAS)

The site is situated approximately 3.7 km south-west of RAAF Pearce airbase, which is known to be subject to PFAS contamination. The Department of Defence have undertaken a range of associated PFAS investigations at RAAF Pearce airbase, including a Preliminary Site Investigation, a Detailed Site Investigation, a Human Health Risk Assessment and an Ecological Risk Assessment.

The outcomes of these investigations have informed preparation of the *RAAF Base Pearce PFAS Management Area Plan* (PMAP) (DoD 2019), which was published in July 2019. The purpose of the PMAP is to '*provide a roadmap for response management by Defence of potential risks arising from PFAS contamination associated with RAAF Base Pearce and surrounding areas, consistent with the PFAS National Environmental Management Plan*' (DoD 2019).

The PMAP 'management area' includes; the RAAF Pearce airbase, selected private properties to the south and west of the airbase, land to the north of the airbase and portions of the Ellen Brook and Ki-it Monger Brook adjacent to the airbase. The PMAP 'management area' does not extend into the site, and at its closest point is approximately 2.7 km from the site. In this regard, the PMAP states: '*The Management Area excludes portions of the Investigation Area that were not found to be impacted by PFAS or were not found to present an elevated risk of PFAS exposure to receptors (e.g. land to the south of the Site* [RAAF Pearce airbase] *and Twin Swamps Nature Reserve)*' (DoD 2019).

As such, PFAS considerations related to RAAF Pearce airbase are not a relevant consideration for the site and the DSP. Furthermore, preliminary groundwater investigations completed within the site indicate that there is no immediate source of PFAS impacting the site.

4.6.4 Potential impacts of the DSP

There are a number of potential impacts to terrestrial environmental quality which may occur as a result of future implementation of the DSP, including:

- Disturbance of ASS, resulting in acidification and release of heavy metals from ASS.
- Disturbance, spread and environmental exposure to potential contamination from historical turf farm land uses on Lot 10.

4.6.5 Assessment of impacts

4.6.5.1 Disturbance of ASS, resulting in acidification and release of heavy metals from ASS

Based on regional ASS risk mapping, there is potential for the site to contain ASS. Disturbance of potential ASS soils could occur as a result of future urban development works, including excavation of soils (particularly for deep works such as gravity sewer installation), dewatering, temporary or permanent lowering of groundwater table. As such, the extent of ASS which is encountered and potentially disturbed (if any), and any management requirements, will be largely dependent upon the extent to which these activities occur.

The potential impacts of ASS on terrestrial environmental quality can be suitably managed through the typical urban development land use planning process such that significant impacts to terrestrial environmental quality can be avoided. Mitigation measures include completion of an ASS self-assessment form as part of subdivision and, if determined to be required, preparation and implementation of an ASS management plan to support civil works.

4.6.5.2 Potential contamination from historical turf farm land uses on Lot 10

Given the existing market garden land use within Lot 10 is identified as potentially contaminating (DER 2014), there is potential for soil and/or groundwater contamination within Lot 10 as a result of this land use. As such, if contamination is determined to occur, then there is potential for contaminated soil or groundwater to be disturbed or spread as part of future urban development, potentially resulting in impacts to the environment through resultant exposure to any contaminants.

Whilst preliminary investigations have indicated that the risk of any significant contamination is generally low, detailed investigations to confirm whether potential contamination occurs and if so, implementation of any required remediation, can be suitably undertaken and implemented through the typical urban development land use planning process, such that there is a low risk of any significant impacts to the environment as a result of exposure to contamination.

4.6.6 Impact mitigation

4.6.6.1 Avoid

Opportunities to avoid areas of potential ASS and potential contamination within Lot 10 would be dependent on the type and depth of works proposed as part of future urban development of the site. Based on typical urban development construction requirements (e.g. the installation of deep sewer), it is unlikely that these areas can be avoided. Notwithstanding, potential impacts to terrestrial environmental quality can be suitably minimised, as discussed below.

4.6.6.2 Minimise

Minimisation of impacts to terrestrial environmental quality will be provided at future stages of the land use planning process, through the following mitigation measures:

- Completion of an ASS self-assessment form, to determine whether an ASS management plan is required. If determined to be required, an ASS management plan will then be prepared and implemented as part of subdivisional and development works. This requirement is expected to be included as a condition of future subdivision approval.
- Completion of soil and groundwater investigations across Lot 10 to determine if any potential contamination occurs. If determined to be required, remediation, including validation of remediation, will then be completed. This requirement is expected to be included as a condition of future subdivision approval.

4.6.6.3 Rehabilitate

Should soil and/or groundwater contamination occur and require remediation, this will be implemented in accordance with remediation requirements and any associated management plan, as discussed above. No further rehabilitation is proposed or expected to be required.

4.6.7 Predicted outcome

The EPA objective for inland waters is ‘to maintain the quality of land and soils so that environmental values are protected.’

The proposed minimisation measures which will be implemented through the typical land use planning process for urban development, will suitably mitigate the risk of any potential impacts to terrestrial environmental quality, such that it is unlikely any significant residual impacts will occur and the EPA objective can be achieved.

4.7 Social surroundings

4.7.1 EPA objective

To protect social surroundings from significant harm.

4.7.2 Policy and guidance

Relevant policy and guidance documents for terrestrial environmental quality, which have informed site-specific investigations and/or have been used to assess potential impacts, include:

- *Environmental Factor Guideline – Social Surroundings* (EPA 2016c)
- *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013)
- *EPA Guidance Statement No. 3 Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005)
- *State Planning Policy 2.4 Basic Raw Materials* (WAPC 2000)
- *Draft State Planning Policy 2.4 Basic Raw Materials* (DPLH 2018a)
- *State Planning Policy 5.4 Road and Rail Noise* (DPLH 2019).

4.7.3 Receiving environment

4.7.3.1 Aboriginal heritage

Consistent with the *Aboriginal Heritage Due Diligence Guidelines* (DAA 2013), a search of the *Aboriginal Heritage Inquiry System* (DPLH 2019) has been completed for the site as part of preparing the DSP. A single Registered Aboriginal Heritage Site listed under the *Aboriginal Heritage Act 1972* is mapped as occurring across the majority of the site, as shown in **Figure 15** and detailed in **Table 22**. DPLH (2019) does not identify any other Aboriginal Heritage Places as occurring within the site.

Table 22: Aboriginal heritage sites mapped within the site (DPLH 2019)

Site ID	Site name	Site status	Site type
DPLH 3525	Ellen Brook: Upper Swan	Registered Site	Mythological

DPLH 3525 is a registered mythological site associated with the Ellen Brook waterway and its tributaries. The publically available boundary of DPLH 32535 extends over a large area (20,819 ha), of which 499 ha (2.4%) is mapped as occurring within the site.

Areas within the site which may support mythological values associated with DPLH 3525 are likely to include the two primary arterial drainage features which convey surface water, being Sawpit Gully and the unnamed northern creekline. However, no targeted site-specific ethnographic or archaeological investigations within the site have been undertaken to date to confirm whether the site contains Aboriginal heritage values, including those associated with Ellen Brook.

4.7.3.2 Non-indigenous heritage

In order to determine the actual or potential presence of sites or features of non-indigenous heritage significance within the site, a review of readily available information at a federal, state and local government level was undertaken to determine if any of the following occur within the site:

- World Heritage Sites
- National Heritage Places
- Commonwealth Heritage Places
- Sites listed in the State Register of Heritage Places
- Sites listed in the City of Swan Heritage List.

One non-indigenous heritage site included on the City of Swan Heritage List (CoS 2017a) was determined to occur within the site. CoS heritage place 283 (The Barnard Springs Trough & Wetland) occurs within Lot 8247 Sawpit Road, as shown in **Figure 15**, and is defined as a Category 2 heritage place in the CoS Heritage List (CoS 2017a), the definition of which is provided in **Table 23**.

Table 23: CoS Heritage List Management Categories (CoS 2017a)

Management category	Category description	Desirable outcome
Category 1: Exceptional significance to the locality	Essential to the heritage of the locality. Rare or outstanding example.	Inclusion on Heritage List. These places are often included in the State Register of Heritage Places and will be afforded the highest level of protection both through the provisions of the Heritage Act and the Scheme.
Category 2: Considerable significance to the locality	Very important to the heritage of the locality. High degree of integrity/authenticity.	Inclusion on Heritage List. These places are of local significance in their own right and will be afforded a high level of protection through the provisions of Scheme.

The CoS Heritage List Place Record Forms (CoS 2017b) describes heritage place 283 consisting of:

> *'An historic dam and stock watering trough carved from two sections of trees and includes a feeder pipe between the dam and the trough. A permanent natural spring feeds the dam which feeds the natural wetland after passing through the pipe and trough. There are also other small springs in the wetland. The flooded gum forest is also a significant vegetation complex which is rare.*
>
> *According to local sources, the spring in Bullsbrook was a watering place before the trough was built for stock travelling to the metropolitan markets. The year the dam and trough was built is unknown.*
>
> *Barnard Springs Trough and wetland are of scientific and educational importance. The place represents a diversity of species, plant communities and presence of endangered species. The wetland and remnant vegetation support an array of aquatic life including long-necked tortoises. The place is of aesthetic and recreational significance. The trough and dam are of historical significance and are rare and fragile. The place is associated with Barnard Drummond Clarkson, a pastoralist, farmer and explorer who was the property owner in 1896.'* (CoS 2017b)

No targeted site-specific ethnographic or archaeological investigations within the site have been undertaken to date to confirm non-indigenous values within the site, including those associated with The Barnard Springs Trough & Wetland.

4.7.3.3 Amenity

Proposed future urban development of the site, as set out in the DSP, would result in the introduction of sensitive receptors within the site. As such, existing land uses in proximity to the site have been assessed to determine whether any such land uses produce noise, odour or dust emissions which may impact the amenity of the proposed future urban land uses within the site. Applicable surrounding land uses are discussed below and shown in **Figure 14**.

Perth Darwin National Highway

A MRS 'Primary Regional Roads' reserve is situated directly west of the site, within which the Perth Darwin National Highway carriageway is currently being constructed, which is expected to be opened for public use in 2020.

A site-specific acoustic assessment (HSA 2019) has modelled the future noise emissions of Perth Darwin National Highway and their impact on potential future residential land uses within the site, in accordance with the requirements of *State Planning Policy 5.4 Road and Rail Noise* (DPLH 2019).

The assessment determined that road traffic noise modelled to be received at future residences within areas of residential development (as shown in the DSP) would exceed the 'noise targets' outlined in SPP 5.4, if no noise amelioration measures were implemented. As such the following acoustic impact mitigation measures were identified as being suitable to enable future residential land uses to be established within the site:

- A 45 m setback for residential land uses from the Perth Darwin National Highway road reserve, in addition to application of 'quite house design' architectural packages (as per SPP 5.4) to any future residences constructed between 45-430 m from the Perth Darwin National Highway road reserve. This is not considered to be a practical solution and is unlikely to be implemented.
- Installation of a 2.4 m noise-barrier wall at the boundary to the Perth Darwin National Highway road reserve (where it occurs adjacent to proposed future residential land uses within the site), which would remove the need for any residential area setbacks. Future residences adjacent to the noise wall would also require application of 'quite house design' architectural packages (as per SPP 5.4).

Overall, the acoustic assessment demonstrates the future urban development of the site, as shown in the DSP, is achievable if suitable mitigation measures to ameliorate acoustic impacts for Perth Darwin National Highway are implemented. It is expected that acoustic impact mitigation measures will include construction of a noise-barrier wall and application of 'quiet house design' to adjacent residences.

Perth-Geraldton rail freight line

A MRS 'Railways' reserve is situated approximately 50 m east of the site (on the eastern side of Railway Road), within which the existing Perth-Geraldton rail freight line is located. The freight line is currently operational.

A site-specific acoustic assessment (HSA 2019) has modelled the future noise emissions of the rail line and its impact on potential future residential land uses within the site, in accordance with the requirements of *State Planning Policy 5.4 Road and Rail Noise* (DPLH 2019).

The assessment determined that freight rail noise modelled to be received at future residences within areas of residential development (as shown in the DSP) would exceed the 'noise targets' outlined in SPP 5.4, if no noise amelioration measure were implemented. As such the following acoustic impact mitigation measures were identified as being suitable to enable future residential land uses to be established within the site:

- Application of 'quite house design' architectural packages (as per SPP 5.4) to any future residences constructed adjacent to the eastern boundary of the site.
- Installation of a 2.4 m noise-barrier wall at the eastern boundary of the site (where it occurs adjacent to proposed future residential land uses within the site), and application of 'quite house design' architectural packages (as per SPP 5.4), but to a comparatively lower specification compared to if no noise-barrier wall was constructed.

Overall, the acoustic assessment demonstrates the future urban development of the site, as shown in the DSP, is achievable if suitable mitigation measures to ameliorate acoustic impacts from the Perth-Geraldton rail freight line are implemented. It is expected that acoustic impact mitigation measures will include application of 'quiet house design' to adjacent residences and potentially construction of a noise-barrier wall.

Ellenbrook Speedway

The Ellenbrook Speedway is situated approximately 380 m east of the site (at its closest point) within Lot 40 Ellenbrook Road, Bullsbrook. The facility is owned and operated by the Racing Drivers' Association of WA Inc. Based on a review of historical aerial imagery, it appears the facility was constructed at some point between 1965 and 1974.

EPA Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005) outlines that 'raceways for motor vehicles' have the potential to produce noise and dust emissions, and recommend separation distances to sensitive land uses to be determined on a 'case by case' basis.

A site-specific acoustic assessment (HSA 2019) has modelled the future noise emissions of the Ellenbrook Speedway and its impact on potential future residential land uses within the site. The assessment determined that acoustic impacts from the adjacent Perth-Geraldton rail freight line would be higher than those associated with the Ellenbrook Speedway and as such, acoustic impact mitigation measures implemented in response to the rail freight line would also be sufficient to suitably mitigate acoustic impacts from the Ellenbrook Speedway.

RAAF Base Pearce

RAAF Base Pearce is situated approximately 3.7 km north-east of the site and is an operational military airport managed by the Department of Defence.

The Australian Noise Exposure Forecast (ANEF) determines the future impacts from aircraft noise upon the amenity of adjacent land uses. Areas within determined 'ANEF 20' contour are generally considered unsuitable for sensitive land uses, as outlined in Australian Standard 2021:2015 *Acoustics – Aircraft Noise Intrusion Building Siting and Construction*. The Department of Defence most recently released ANEF contour mapping for RAAF Base Pearce in 2003, which forecast noise exposure in 2012.

The site is situated approximately 2.8 km outside of the modelled limit of the 2012 'ANEF 20' contour, and as such, the site is not subject to an unacceptable level of acoustics emissions from RAAF Base Pearce which would preclude residential land uses. This was confirmed by the site-specific acoustic assessment (HSA 2019).

Tree farm

A tree farm is currently operated by Ellenby Tree Farm Pty Ltd on Lots 16 and 17 Sawpit Road, adjacent to the north-eastern boundary of the site. Based on the company's website, the tree farm on Sawpit Road is not the company's primary display nursery (which is located in Gnangara and is open to the public six days a week) and is only accessible to the public by prior appointment.

Tree farms may fall within the definition of 'nurseries', which the EPA (2005) outline have the potential to produce noise emissions that may affect nearby sensitive land uses. No site-specific investigations have been completed to date to determine to what extent the tree farm produces noise emissions, and whether any such noise emissions exceed allowable limits outlined in the *Environmental Protection (Noise) Regulations 1987* such that they may impacts upon future residential land uses within the site. However, available information suggests the tree farm is a relatively typical example of such an operation and is therefore considered likely to meet the requirements of the Regulations.

Poultry farms

Two poultry farms are located to the north of the site, including:

- AAA Egg Company, operating on Lots 20 and 21 Warbook Road
- Oakland Farm, operating on Lot 22 Railway Road.

Based on a review of high resolution aerial imagery, up to 15 poultry sheds currently operate across these land parcels, the locations of which are shown in **Figure 14**. The closest poultry shed is approximately 350 m north of the site.

EPA Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005) outlines that 'poultry industry' have the potential to produce odour, dust and noise emissions, and recommend a separation distance of between 300-1000 m (depending on the size of the poultry operation) to sensitive land uses.

The *Environmental Guidelines for the Australian Egg Industry* (AECL 2008) recommends a minimum separation distance of 500 m between the impact source and any land use zone that is not compatible with the development of poultry facilities, such as residential, in lieu of any specified separation distances from state/federal governments.

The *Environmental Code of Practice for Poultry Farms in Western Australia* (Poultry Farmers Association of WA 2004) recommends minimum 500 m separation distance between new poultry sheds and any existing or future residential zone.

Given the location of the existing poultry operations to the north of the site, prevailing easterly and south-easterly winds, which are typically associated with occurrences of significant odour issues for poultry farms, are unlikely to impact upon the site.

It is likely that a land use buffer from the existing poultry sheds would be required to be accommodated as part of any future residential development within the site, in order to provide suitable separation between these land uses, whilst the poultry farms remain in operation.

Basic raw materials extraction sites

Two basic raw materials 'extraction sites' mapped in *State Planning Policy 2.4 Basic Raw Materials* (WAPC 2000) and the updated *Draft State Planning Policy 2.4 Basic Raw Materials* (DPLH 2018a) are located to the west of the site, as shown in **Figure 14**. At its closest point, the site is 900 m from the mapped 'extraction sites'. Based on a review of high resolution aerial imagery, both extraction areas appear to be currently active to varying degrees. Based on the underlying geology and publically available information, both extraction sites are understood to be used as sand mines.

EPA Guidance Statement No. 3 *Separation Distances between Industrial and Sensitive Land Uses* (EPA 2005) outlines that 'extractive industries – sand and limestone extraction' have the potential to produce noise and dust emissions, and recommend a generic separation distance of between 300-500 m (depending on the size of the extraction operation) to sensitive land uses. At its closest point, the site is situated approximately 900 m from the extraction site.

Given the 900 m of separation between the site and the mapped sand extraction sites, which exceeds the maximum generic separation distance of 500 m recommended by the EPA (2005), it is considered unlikely that any noise or dust emissions from the sand extraction sites would impact any future residential land uses within the site.

4.7.4 Potential impacts of the DSP

There are a number of potential impacts to social surroundings which may occur as a result of future implementation of the DSP, including:

- Aboriginal heritage:
  - Potential impacts to DPLH 3525 *Ellen Brook: Upper Swan* Registered Aboriginal heritage site as a result of proposed future urban development works.
- Non-indigenous heritage:
  - Potential impacts to CoS heritage place 283 (The Barnard Springs Trough & Wetland) as a result of proposed future urban development works.
- Amenity:
  - Potential acoustic impacts to proposed future residential land uses as a result of road traffic using Perth Darwin National Highway.
  - Potential acoustic impacts to proposed future residential land uses as a result of rail traffic using the Perth to Geraldton rail freight line.
  - Potential acoustic impacts to proposed future residential land uses as a result of operations of the Ellenbrook Speedway.
  - Potential acoustic impacts to proposed future residential land uses as a result of adjacent tree farm operations.
  - Potential odour impacts to proposed future residential land uses as a result of adjacent poultry farm operations.

4.7.5 Assessment of impacts

Potential impacts to Aboriginal heritage (DPLH 3525 Ellen Brook: Upper Swan)

As outlined above, areas within the site which may support mythological values associated with DPLH 3525 are likely to be limited to the two primary arterial drainage features which convey surface water, being Sawpit Gully and the unnamed northern creekline. Site-specific Aboriginal heritage investigations will be required to determine whether the site contains Aboriginal heritages values associated with Ellen Brook.

Should Aboriginal heritage values associated with Ellen Brook be confirmed to occur within the site, the proposed future urban development of the site (as shown in the DSP) has the potential to impact these values through further disturbance of the two primary arterial drainage features within the site as part of their incorporation into future urban land uses. However, such impacts could be suitably mitigated to ensure significant residual impacts do not occur, including through the proposed future retention of both surface water features within local drainage reserves, implementation of construction management controls and potential rehabilitation of the proposed drainage reserves to restore their historical environmental and heritage values.

In addition, Section 18 of the *Aboriginal Heritage Act 1972* provides a statutory mechanism to resolve potential impacts to Aboriginal heritage sites associated with development proposals. As such, Aboriginal heritage considerations can be suitably addressed and resolved through this statutory process at future stages of the land use planning process and would not preclude implementation of the DSP.

Potential impacts to non-indigenous heritage sites

Further investigation of the heritage site will be required to confirm the location, extent and heritage values of the mapped CoS heritage place 283 (The Barnard Springs Trough & Wetland). If the heritage site is confirmed to occur and support heritage values, then the proposed future urban development of the site would have the potential to impact these values through disturbance or removal. However, potential impacts could be suitably mitigated as part of the future land use planning process, most likely through accommodation of heritage values within future local public open space areas, which would be spatially located through the future local structure planning process.

Potential impacts to future residential amenity as a result of noise emissions

Land uses in proximity to the site have the potential to produce noise emissions which will potentially impact the amenity of future residential land uses within the site. Based on the outcomes of site-specific assessments and relevant policy and guidance, noise emissions can be suitably mitigated as part of the proposed urban development of the site such that no significant residual impacts to the social surroundings of the proposed future residential land uses will occur. It is expected that this will be achieved through installation of noise impact amelioration measures, such as noise-barrier walls and/or quiet house design architectural treatments, with any such requirements to be confirmed through future stages of the land use planning process.

Potential impacts to future residential amenity as a result of odour emissions

Whilst the existing poultry farms to the north-east of the site remain in operation, they have the potential to produce odour emissions which will potentially impact the amenity of future residential land uses within the site. Site-specific investigations will be required to determine whether odour emission from the poultry farm operations impact the site and if so, which areas of the site are impacted.

If investigations confirm portions of the site are subject to odour impacts, then any such impacts can be suitably mitigated as part of the proposed urban development such that no significant residual impacts to the proposed future residential land uses will occur. This could be achieved through the staging of urban development to temporarily avoid areas of the site which may currently be subject to nuisance odours from adjacent land uses, through application of a temporary land use buffer, if determined to be required.

4.7.6 Impact mitigation

4.7.6.1 Avoid

Aboriginal heritage

Avoidance of impacts to potential Aboriginal heritage values has primarily been provided through the identification of the future MRS 'Parks and Recreation' reserve and local drainage reserves, which will provide for the future retention of Sawpit Gully and the unnamed northern creekline and their associated potential Aboriginal heritage values.

Non-indigenous heritage

The DSP does not provide a district-level response to the mapped CoS heritage place 283 (The Barnard Springs Trough & Wetland), given its extent and heritage values are yet to be confirmed. If the mapped heritage values are confirmed to occur, then the potential impacts of urban development on the heritage site could be avoided through the provision of a local public open space reserve over its extent, allowing for its retention. This can be suitably addressed, as determined to be required, at the local structure planning stage.

Amenity – odour

Potential impacts of odour emissions from adjacent poultry farms can be avoided through the staging of urban development to temporarily avoid affected areas of the site. This is likely to take the form of a temporary land use buffer, which will prohibit development of residential land uses within affected areas of the site until the source of the odour emissions (i.e. the poultry farms) no longer exist or are suitably reduced, such that odour impacts no longer affect the amenity values of the proposed residential land uses. Site-specific investigations would be required to determine whether a land use buffer is required and if so, which portions of the site are affected, which is likely to be limited to the north-eastern extent of Lot 15.

4.7.6.2 Minimise

Aboriginal heritage

If Aboriginal heritage values are determined to occur within the site (associated with the two primary surface water features) and they are retained within the proposed regional and local reserves, potential impacts from development works (for example, during construction and/or landscaping) could be further minimised through specification of construction management protocols and proposed landscape treatments.

This would likely be administered through the Section 18 consent process pursuant to the *Aboriginal Heritage Act 1972*. The Section 18 consent process is not fixed to a specific stage of the land use planning process, however is most commonly initiated once local structure planning has been undertaken and a more detailed development design has been determined.

Non-indigenous heritage

If the mapped CoS heritage place 283 (The Barnard Springs Trough & Wetland) is determined to be retained within a local public open space area as part of the future local structure planning process, further minimisation measures to mitigate potential impacts to the heritage values could be applied. This could involve specification of construction management protocols and proposed landscape treatments of the local public open space area such that potential construction impacts to heritage values are minimised. This would likely be included in a heritage or construction management plan which, if determined to be required, would be prepared at the subdivision and development stage of the land use planning process.

Amenity - acoustics

As outlined in **Section 4.7.3.3**, the acoustic assessment has determined that following mitigation measures could be implemented to suitably minimise acoustic impacts to future urban land uses:

- Installation of noise-barrier walls along the western and eastern boundaries of the site, to minimise acoustic impacts from Perth Darwin National Highway and the Perth-Geraldton freight rail line, respectively.
- Application of 'quite house design' architectural packages (as per SPP 5.4) to any future residences constructed adjacent to the western and eastern boundaries of the site, to minimise acoustic impacts from Perth Darwin National Highway and the Perth-Geraldton freight rail line.

It is expected that these requirements will be implemented as a condition of subdivision approval.

It is likely that site-specific investigations would be required to determine whether the existing tree farm north-east of the site produces noise emissions that exceed the requirements of limits specified in the *Environmental Protection (Noise) Regulations 1987*. If noise impacts from the tree farm impact the site, then noise amelioration measures (such as noise walls or quiet house design) may also be required along this interface. This would be determined at future stages of the land use planning process.

4.7.6.3 Rehabilitate

Aboriginal heritage

As outlined above, if Aboriginal heritage values are determined to occur within the site (associated with the two primary surface water features) and they are retained within the proposed regional and local reserves, then there may be opportunities to rehabilitate and restore portions of these reserves which have been historically disturbed.

Such rehabilitation would likely involve restoration toward a natural waterway system, which would aim enhance and restore environmental and Aboriginal heritage values. Any such rehabilitation opportunities would be determined following completion of site-specific Aboriginal heritage surveys and consultation, would be required by an associated Aboriginal Heritage Management Plan, and would likely be administered through the Section 18 consent process.

Non-indigenous heritage

If the mapped CoS heritage place 283 (The Barnard Springs Trough & Wetland) is determined to be retained within a local public open space area as part of the future local structure planning process, then there may be opportunities to rehabilitate and restore heritage values, if they have been determined to be disturbed or degraded historically. If determined to be required, any such works would likely be undertaken as part of landscaping works, and would likely be outlined in an associated heritage or construction management plan.

4.7.7 Predicted outcome

The EPA objective for social surroundings is ‘to protect social surroundings from significant harm.’

A range of site-specific investigations will be undertaken as part of future stages of the land use planning process, which will enable any Aboriginal and non-indigenous heritage values within the site to be confirmed, in addition to any potential acoustic and odour impacts affecting the site. Notwithstanding, there are appropriate mitigation measures available for each of these considerations, which could be implemented as part of future urban development site such that it is unlikely any significant residual impacts will occur and the EPA objective can be achieved.

5 Other Environmental Matters

5.1 Bushfire

The site is currently identified as a 'bushfire prone area' under the state-wide *Map of Bush Fire Prone Areas* prepared by the Office of Bushfire Risk Management (OBRM 2019). The identification of a site within a declared bushfire prone area necessitates further assessment of the bushfire risk and suitability of the proposed development to be undertaken in accordance with *State Planning Policy 3.7 Planning in Bushfire Prone Areas* (SPP 3.7) and the *Guidelines for Planning in Bushfire Prone Areas Version 1.3* (the Guidelines).

As such, a Bushfire Management Plan (Emerge Associates 2019) has been prepared to support the DSP, which has included an assessment of vegetation within and surrounding the site to determine applicable bushfire hazards, in accordance with *Australian Standard 3959:2018 Construction of buildings in bushfire-prone areas* (AS 3959), in addition to an assessment of the bushfire protection criteria outlined in the Guidelines.

The BMP has determined that the DSP can satisfy the requirements of SPP 3.7 and the Guidelines. Furthermore, the BMP has considered the proposed environmental responses of the DSP (such as the proposed future retention of existing environmental values within the proposed regional and local reserves) and has determined that these can be implemented whilst still satisfying the requirements of SPP 3.7 and the Guidelines.

The anticipated environmental impacts of the DSP, as outlined in **Section 4**, have specifically considered any bushfire management requirements. No further environmental impacts (such as clearing of vegetation) beyond those outlined in **Section 4** will be required in order to implement urban development across the site, consistent with the DSP.

This is discussed further in the *Bushfire Management Plan* (Emerge Associates 2019).

6 Holistic Impact Assessment

Overall, the DSP provides a district-level framework across the site to achieve conservation outcomes for a range of environmental values, which will be implemented through future stages of the urban development process. This is primarily achieved through the proposed regional and local reserve network shown in the DSP, which will provide for the future retention of environmental values across the site, as summarised in **Section 6.1**.

6.1 Summary of predicted environmental outcomes

Table 24 summarises the predicted environmental outcomes for the key environmental values within the site, which will be achieved through implementation of the DSP design as part of future stages of the land use planning process and the associated future urban development of the site.

Table 24: Summary of predicted DSP outcomes for key environmental values

Environmental value	Area within site (ha)	Area within DSP reserves (ha)	Proportion within DSP reserves	Area within DSP development footprint (ha)	Proportion within DSP development footprint
Intact native vegetation in 'good' or better condition	44.9	30.5	68%	14.4	32%
Intact native vegetation in 'good' or better condition (Yanga complex)	41.7	30.5	73%	11.2	27%
Bush Forever Site 13	15.7	15.7	100%	0.0	0%
TEC - Banksia woodlands of the SCP	9.3	0.0	0%	9.3	100%
TEC (Potential) - Banksia woodlands of the SCP	3.5	0.0	0%	3.5	100%
TEC (Potential) - Forests and woodlands of deep seasonal wetlands of the SCP	0.6	0.6	100%	0.0	0%
PEC - Banksia dominated woodlands of the SCP IBRA region	5.7	0.0	0%	5.7	100%
TF - *Grevillea curviloba* subsp. *curviloba* population	0.9	0.9	100%	0.0	0%
'High' value CBC foraging habitat	0.0	N/A	N/A	N/A	N/A
'High' value FRTBC foraging habitat	36.1	29.5	82%	6.6	18%
Black cockatoo potential breeding habitat trees	414 trees	185 trees	45%	229 trees	55%
Suitable WST habitat which may possibly be used by species, but not likely	4.6	4.0	87%	0.6	13%
Marginal WST habitat which may possibly be used by species, but not likely	1.4	1.4	100%	0.0	0%
Conservation category wetlands	14.9	14.9	100%	0.0	0%
Resource enhancement wetlands	8.8	5.6	64%	3.2	36%

6.2 Future local structure planning conservation outcomes

Areas of future urban development within the site will be required to accommodate additional areas of local public open space, beyond the reserve shown in the DSP, consistent with state planning policy requirements. *Development control policy 2.3 - Public open space in residential areas* (WAPC 2003) outlines that where urban development is proposed, 10% of the gross sub-divisible area is to be provided as POS. As such, additional conservation outcomes for environmental values not identified within the proposed reserve network shown on the DSP may still be achieved.

Based on the DSP design, the site contains approximately 416 ha of land identified for urban development (areas identified for 'residential', 'neighbourhood centre', 'potential local centre', 'local reserve – drainage' and 'local reserve' land uses). Based on a generic application of state planning policy measures, 10% of this area represents approximately 42 ha of potential local POS.

These figures represent a high-level indication of the potential extent of future local POS which could be implemented across the site and provide additional retention opportunities for environmental values. However, the actual extent and location of local POS areas and any associated environmental retention opportunities will be determined through the future local structure planning process.

6.3 Proposed local scheme provisions

The future CoS LPS 17 amendment will include insertion of a number of provisions within the scheme text. These local scheme provisions will form the basis for implementation of a range of environmental impact mitigation measures outlined in **Section 4**.

The proposed general form and content of the future local scheme provisions are outlined below. These proposed local scheme provisions will be refined and be confirmed in consultation with relevant stakeholders prior to lodgement of the CoS LPS 17 amendment.

The following requirements are to be addressed as part of any local structure plan prepared within the North Ellenbrook (East) District Structure Plan area:

- *The local structure plan map is to provide local reserves generally consistent with those identified in the North Ellenbrook (East) District Structure Plan to accommodate any retain their flora, vegetation, waterway and wetland values.*
- *A site-specific Aboriginal heritage survey is to be completed to identify any Aboriginal heritage values within the local structure plan area, to be prepared in consultation with the Department of Planning, Lands and Heritage.*
- *A Local Water Management Strategy is to be prepared, which is required to outline how groundwater and surface water will be managed as part of urban development in accordance with the principles established in the District Water Management Strategy, to ensure that:*
  - *Retained groundwater dependent ecosystems are maintained*
  - *Retained natural waterways area maintained*
  - *Offsite impacts to western swamp tortoise habitat is avoided.*

  The Local Water Management Strategy is subject to approval by the Department of Water and Environmental Regulation.

The following requirements are to be addressed as part of implementing any future subdivision approval for urban development within the North Ellenbrook (East) District Structure Plan area:

- *A Reserve Management Plan is to be prepared and implemented for any local reserves which contain conservation values (including intact Yanga complex vegetation, conservation category wetlands, resource enhancement wetlands, natural waterways, threatened flora or threatened ecological communities), which will outline the proposed environmental management framework to be implemented during establishment and ongoing management of the reserve. This will include specification of:*
  - *The agreed long-term management authority*
  - *Any weed management requirements*
  - *Any rehabilitation or revegetation requirements*
  - *Reserve access arrangements*
  - *Any threatened flora or ecological communities*
  - *Terrestrial fauna habitat management requirements*
  - *Flora and vegetation management requirements*

  The Reserve Management Plan is subject to approval by the City of Swan.
- *An Urban Water Management Plan is to be prepared, which is required to outline how groundwater and surface water will be managed as part of urban development and subdivision works in accordance with the principles established in the Local Water Management Strategy. The Urban Water Management Plan is subject to approval by the Department of Water and Environmental Regulation.*
- *A Fauna Management Plan is to be prepared and implemented, which will outline the environmental management framework which will be implemented to mitigate potential risks of fauna interaction during the urban development process. The Fauna Management Plan is to be prepared in consultation with the Department of Biodiversity, Conservation and Attractions and is subject to approval by the City of Swan.*
- *A Construction Environmental Management Plan is to be prepared and implemented, for all construction occurring within 100 m of retained conservation values (such as intact Yanga complex vegetation, conservation category wetlands, resource enhancement wetlands, natural waterways, threatened flora or threatened ecological communities) to outline the proposed environmental management requirements to be implemented during construction to ensure retained conservation values are protected. The CEMP is to incorporate environmental elements pre-construction and during construction, including management of potential threats and risks associated with construction activities adjacent to the retained conservation values such as dieback, disease, weeds, fauna and access management.*

6.4 DSP response to WAPC 'key considerations'

As discussed in **Section 2.2**, the DSP has been prepared to be consistent with the 'key considerations' identified by the WAPC for the North Ellenbrook 'Urban Investigation' area, as outlined in the *North-East Sub-regional Planning Framework*. A summary of how the key considerations (related to environmental matters) have been addressed as part of the DSP is provided in **Table 25**.

Table 25: North Ellenbrook Urban Investigation Area key considerations (WAPC 2018)

Key considerations	Response for potential urban development of the site
Protection of Bush Forever areas and conservation category wetlands	• The site contains one Bush Forever Site (no. 13), which the DSP includes within a future MRS 'Parks and Recreation' reserve to enable its future protection. • The site contains one conservation category wetland (UFI #8926), which the DSP includes within a future MRS 'Parks and Recreation' reserve to enable its future protection.
Protection of high value Carnaby's Black Cockatoo habitat and vegetation with 10-30% remaining in Perth and Peel regions	• With respect to Carnaby's black cockatoo habitat within the site: ○ No high value foraging habitat for Carnaby's black cockatoo occurs within the site. Notwithstanding, Carnaby's black cockatoo foraging habitat in 'low to moderate', 'moderate' and 'moderate to high' value occurs within the site, of which the proposed regional and local reserve network in the DSP provides for the retention of 40.4 ha, which represents 40% of the total extent of this habitat type across the site. ○ The proposed regional and local reserve network in the DSP provides for the retention of 185 black cockatoo potential breeding habitat trees, which represents 45% of the total number of such trees currently known to occur within the site. The amount and proportion of retained habitat trees will likely be much higher once full survey coverage of the site (including Bush Forever Site 13) can be achieved, given some lots were not able to be accessed during baseline surveys. Overall, the portions of the site which are likely to contain the largest number and most consolidated areas of black cockatoo potential breeding habitat trees is identified within the future MRS 'Parks and Recreation' reserve. ○ No high value roosting habitat for Carnaby's black cockatoo occurs within the site. Notwithstanding, the majority of suitable roosting habitat within the site is proposed for future retention within regional or local reserves. • The Yanga vegetation complex has 16.5% of the pre-European extent remaining across the Swan Coastal Plain. Within the site, 41.7 ha of intact native vegetation was determined to be representative of the Yanga complex. The DSP has been design to prioritise future retention of the most intact, largest and most contiguous areas of Yanga complex vegetation. This has primarily been provided through the identified future MRS 'Parks and Recreation' reserve, in addition to the proposed local reserves. The DSP allows for the future retention of 30.5 ha of intact Yanga vegetation, which represents 73% of the total extent of this value across the site.
Protection of threatened ecological communities and flora populations	• A population of state and commonwealth listed threatened flora species *Grevillea curviloba* subsp. *curviloba* occurs within the site. The whole population is proposed for future protection and retention within a local reserve. • A single patch of vegetation potentially representative of the state-listed TEC 'Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain' occurs within the site and is associated with an REW. This area of potential TEC and the associated REW is proposed for future protection and retention within a local reserve. • Two patches of vegetation representative of the commonwealth-listed TEC 'Banksia Woodlands of the Swan Coastal Plain' (in addition to another patch of vegetation potentially representative of this TEC) occur within the site. In this regard: ○ All patches of this vegetation within the site are either isolated, small in area, and/or highly disturbed from their natural form, reducing their overall environmental significance. ○ Adjacent regional reserves to the south of the site are likely to contain large, contiguous areas of this TEC, providing a local and regional conservation outcome for this community.

Key considerations	Response for potential urban development of the site
	○ Given the above, the overall environmental significance of this vegetation is comparatively lower than other environmental values within the site (such as the large, contiguous area of intact 'Yanga' complex vegetation in the north-west of the site). ○ In this context, the proposed DSP has prioritised the future retention of environmental values with the highest relative significance across the site, which does not include patches of this TEC. As such, the DSP does not provide for the future retention of patches of this TEC. Notwithstanding, future local structure planning stages may provide additional future retention opportunities for areas of this TEC, through the provision of local POS. Any residual impacts to the TEC will be required to be managed through the EPBC Act process.
Offsite impacts on Western Swamp Tortoise habitat (EPP)	Any offsite, indirect impacts to WST habitat can be avoided through the future urban development process, through the application of the proposed groundwater and surface water management principles provided in the District Water Management Strategy (RPS 2019). These water management principles will be implemented as part of future stages of the land use planning process, through the future Local Water Management Strategy and Urban Water Management Plan/s.
Best practice drainage and nutrient management	This is addressed in the District Water Management Strategy (RPS 2019).
Impacts, risks and management of Gnangara groundwater resources (existing Priority 3 Source Protection Area)	This is addressed in the District Water Management Strategy (RPS 2019).
Pearce Airbase operations (Department of Defence)	The site is situated outside of the ANEF contours for Pearce Airbase, and as such, the site is not subject to an unacceptable level of noise emissions which would preclude residential land uses. This was confirmed by the site-specific acoustic assessment (HSA 2019).
Transition/interface with regional open space areas	The DSP proposes a future MRS 'Parks and Recreation' reserve in the north-west of the site, which will provide for the future retention of existing environmental values which occur within this area. The urban interface with this future reserve can be appropriately designed as part of future local structure planning such that it responds to the environmental values and appropriately manages any bushfire risk.
Bushfire risk	This is addressed in the Bushfire Management Plan (Emerge Associates 2019).
Access to the regional road network	This is addressed in the DSP planning report (CLE 2019).
Basic raw materials – sequential land use allowing for extraction of sand resources	Basic raw materials mapping provided in SPP 2.4 and the updated Draft SPP 2.4 does not identify any basic raw materials occurring within the site. The site is separated from nearby basic raw materials extraction areas by a distance of approximately 900 m, which exceeds the generic separate distance recommended by EPA (2005) and as such, appropriate separation exists to enable future urban development of the site in accordance with the DSP.

6.5 DSP response to EPA strategic advice

As discussed in **Section 2.2**, the DSP has been prepared to be consistent with the overarching strategic planning framework, including EPA policy, guidance and advice. A summary of how the DSP addresses and responds to the strategic applicable recommendations of the EPA, as outlined in their *Interim Strategic Advice* (EPA 2015a) on the *Draft Perth and Peel @ 3.5 Million* documents, is provided in **Table 26**. Overall, the DSP is consistent with the EPA's strategic recommendations which are applicable to the site.

Table 26: DSP responses to applicable EPA recommendations on Perth and Peel @ 3.5 Million (EPA 2015a)

Applicable EPA recommendations	DSP response
1. That the State Government protect regionally significant natural areas. a. Continue to acquire the balance of Bush Forever sites, as opportunities arise.	The DSP includes a future MRS 'Parks and Recreation' reserve which incorporates the entirety of Bush Forever Site 13, in addition to surrounding areas of contiguous, intact native vegetation. If implemented, the MRS reservation would provide a mechanism for Bush Forever Site 13 to be acquired by the State Government and enable protection of a regionally significant natural area. This is consistent with the EPA's recommendation, as it applies to the DSP and the site.
2. That the WAPC, in relevant planning instruments, clearly distinguishes between areas set aside primarily for conservation and those for other purposes (e.g. active recreation).	The DSP has sought to clearly define the primary land use intent of each of the proposed reserves within the site. In summary: • The future MRS 'Parks and Recreation' reserve will primarily provide a conservation land use. • The 'local reserves' will provide a combination of drainage, conservation and active open space functions. This will be confirmed through the future local structure planning process to clearly establish which areas of local reserves will provide a pure conservation purpose. This is consistent with the EPA's recommendation, as it applies to the DSP and the site.
4. That the State Government enhance the viability of consolidated regionally significant natural areas by improving degraded areas and re-establishing linkages.	The proposed future MRS 'Parks and Recreation' reserve extends across the entirety of Bush Forever Sites 13, in addition to surrounding areas of contiguous, intact native vegetation. The proposed inclusion of this large, consolidated area of remnant vegetation within a single regional reserve will enhance its ongoing viability as a regionally-significant natural area. In addition, the reserve connects with the proposed 'local reserve – drainage' associated with Sawpit Gully, which will formalise and provide opportunities to restore this linkage across the site as part of future urban development. This is consistent with the EPA's recommendation, as it applies to the DSP and the site.
5. That the WAPC protects Conservation Category Wetlands and minimises the potential impacts on Resource Enhancement wetlands, including their buffers, at structure planning and subdivision design stages.	The DSP provides for the future protection of the single CCW mapped within the site, through provision of the future MRS 'Parks and Recreation' reserve across its determined extent. An appropriate buffer will also be provided as part of future urban development. The DSP design provides for minimising impacts to REWs, through the identification of proposed local reserves over two of the three REWs mapped within the site, in addition to associated buffer zones. The third REW mapped within the site (UFI #9185) was not identified within the proposed local reserve, given it was observed to be highly disturbed from its natural form as a result of rural land uses, with limited vegetation values remaining in 'degraded' condition. Notwithstanding, given this portion of the site provides a natural low-point, this wetland area may still be partly or wholly accommodated within future local open space to provide a drainage and/or vegetation retention function. This will be determined as part of the local structure planning process. Overall, the DSP provides for the protection of all mapped CCWs within the site, and minimises impacts to mapped REWs. This is consistent with the EPA's recommendation, as it applies to the DSP and the site.

Applicable EPA recommendations	DSP response
23. That local environmental outcomes on urban, industrial and rural residential land are implemented through structure plan and subdivision design, supported by contemporary policies and guidelines.	The DSP has been designed to enable local environmental outcomes to be achieved through the proposed future urban development process. This is primarily achieved through the identification of regional and local reserves across the site, which have been designed and located to respond to the determined environmental values within the site. This is consistent with the EPA's recommendation, as it applies to the DSP and the site.
24. That the WAPC should consider policy and regulatory options to address the delivery of environmental and development outcomes on land parcels with fragmented ownership.	The DSP area (i.e. the site) comprises 21 freehold land parcels, of varying ownership across a total area of approximately 501 ha. Lendlease have worked with and coordinated a process with a number of landowners across the site, in order to facilitate preparation of the DSP. This provides a consolidated direction for the land use planning process across the site and minimises the challenges commonly experienced as a result of fragmented ownership. In particular, this has enabled a strategic land use design process, free of any prejudice, to be undertaken across the site. This is consistent with the EPA's recommendation, as it applies to the DSP and the site.
30. That, at the detailed planning and design stages of individual infrastructure proposals, infrastructure agencies demonstrate further avoidance and mitigation before offsets are applied.	The DSP includes an indicative interchange location for Perth Darwin National Highway, which is proposed to provide an arterial road connection to the site and potential future urban areas west of Perth Darwin National Highway. Whilst the location of this intersection will be confirmed as part of future stages of detailed planning, its indicative location has been informed by the following principles with regard to environmental impacts: • Positioned far enough south to avoid impacts to significant environmental values on the eastern side of Perth Darwin National Highway, including Bush Forever Site 13, Yanga complex vegetation in 'Very Good' condition and the Sawpit Gully creekline. • Positioned far enough north to avoid impacts to CCWs on the western side of Perth Darwin National Highway. • Positioned far enough north to minimise impacts to the Banksia Woodlands of the SCP TEC on the western side of Perth Darwin National Highway. Whilst this indicative location would result in some impacts to this TEC, it is likely that such impacts could be suitably mitigated and, if required, offset. The EPBC Act assessment process provides a statutory mechanism to facilitate any required mitigation and offset requirements. As such, the indicative location of the interchange has been considered to avoid and minimise impacts to environmental values as far as possible, consistent with the EPA's recommendation, as it is applicable to the DSP. Notwithstanding, the exact location of the intersection will be confirmed as part of future detailed planning, which will include further consideration of potential environmental impacts. It's likely that this detailed planning and design process would also incorporate a future Section 38 referral to the EPA for the proposal, as discussed in **Section 2.5.2**, which will further consider the environmental impacts of the interchange proposal once further detail around the interchange location and design is known.

7 References

7.1 General references

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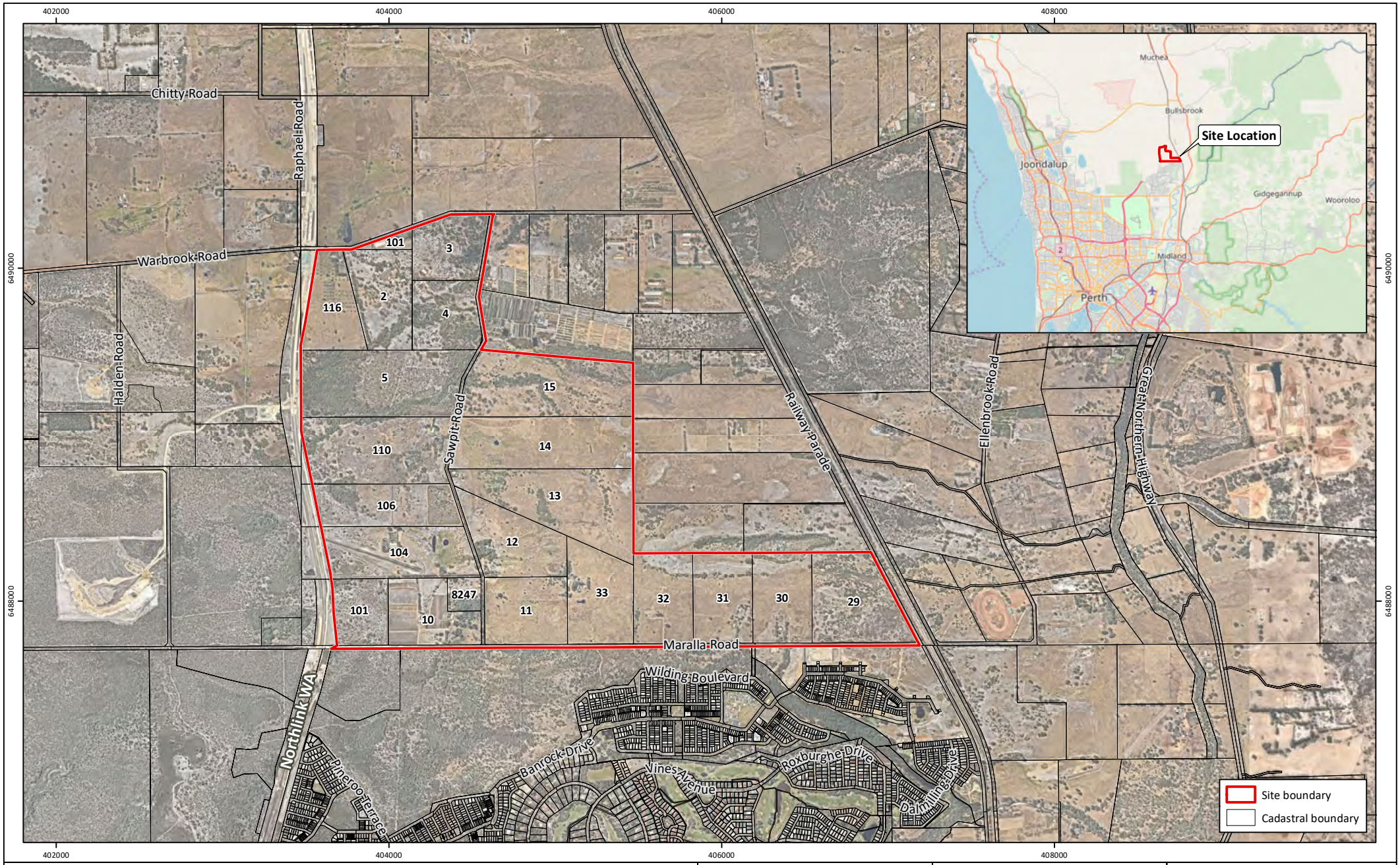

Figure 1: Site Location

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F83

Drawn:	KNM
Date:	09/12/2019
Checked:	ADB
Approved:	JDH
Date:	18/12/2019

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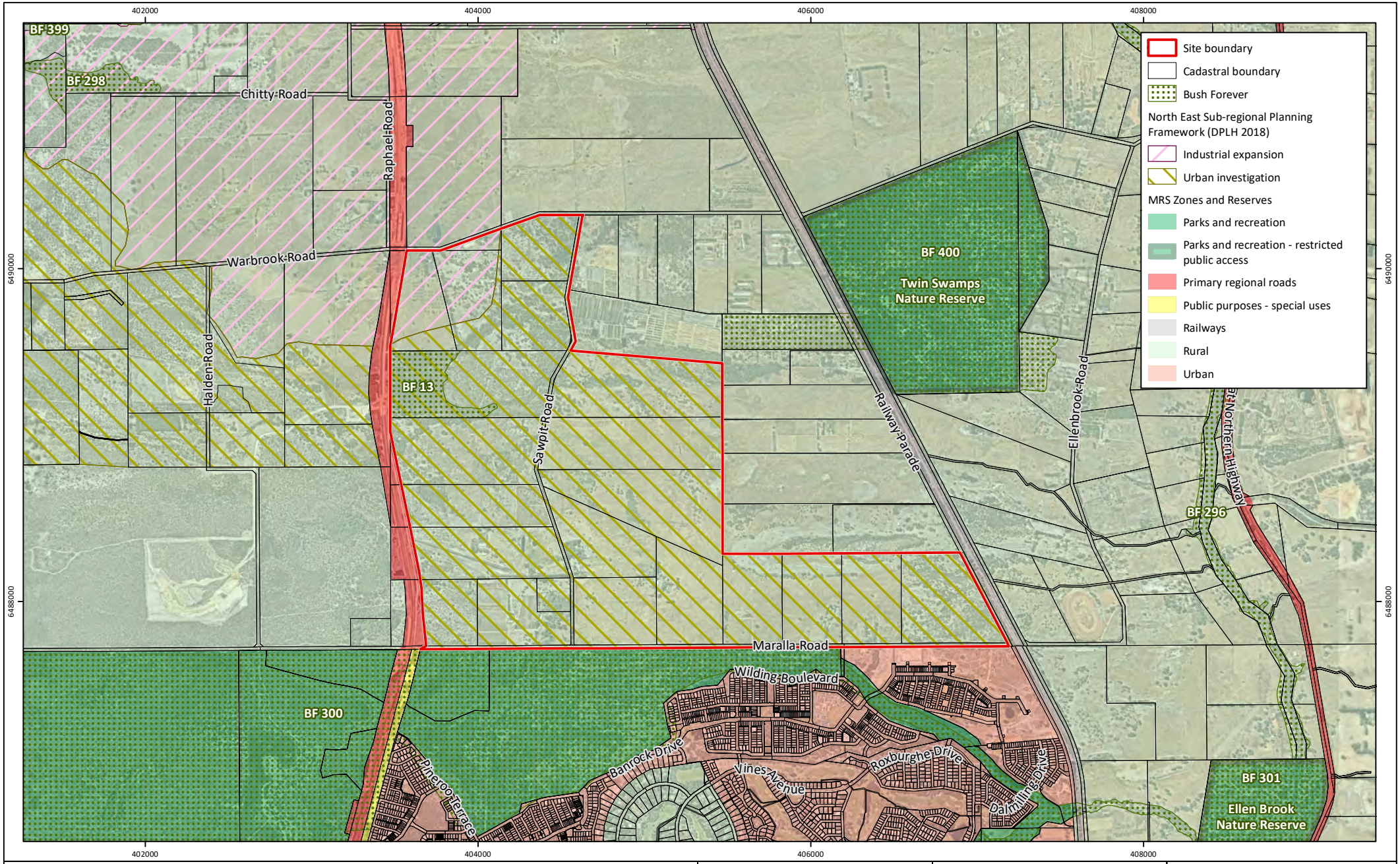

Figure 2: MRS Zones and Reserves

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F84
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Date: 18/12/2019

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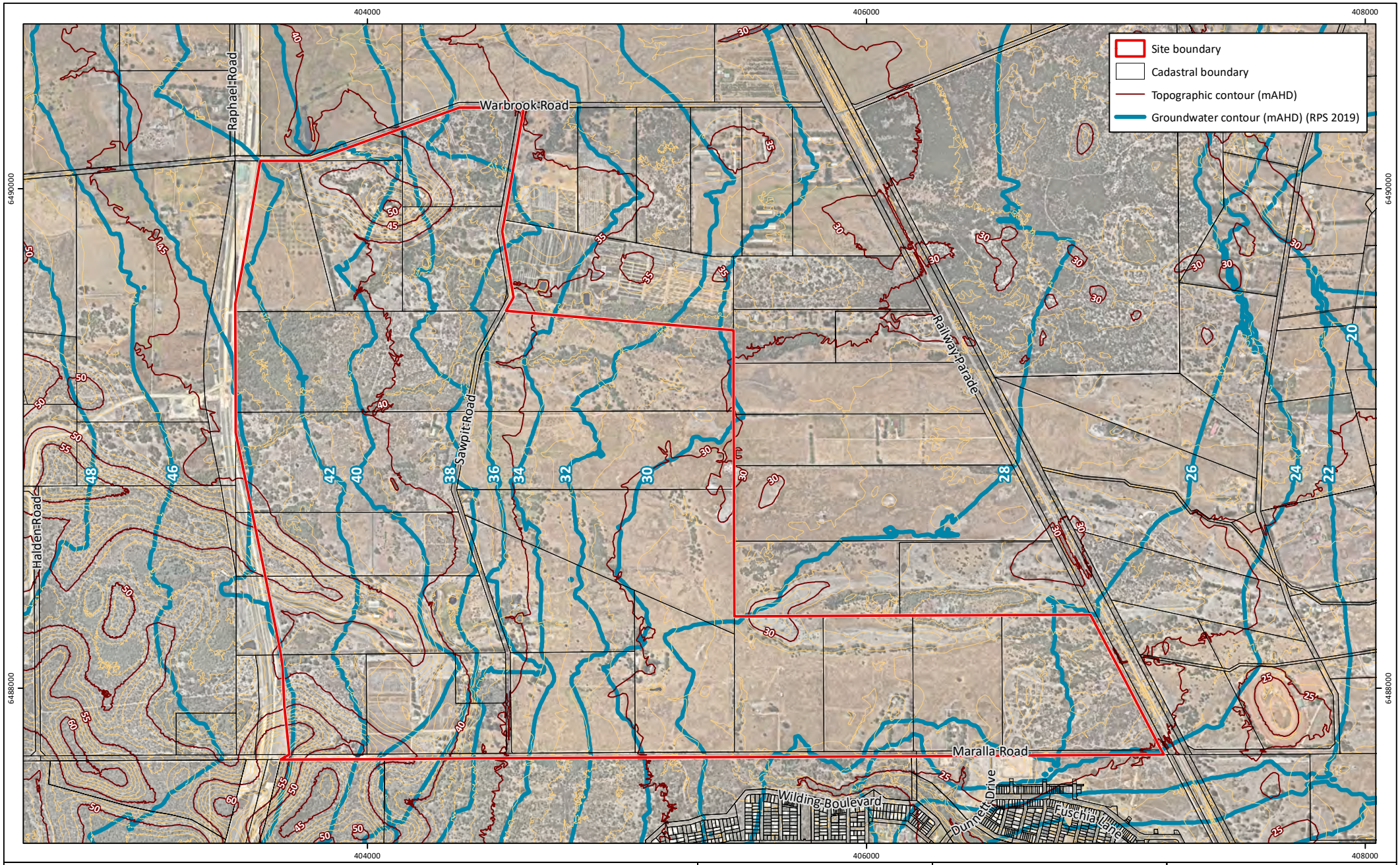

Figure 3: Topography and Landforms

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F85

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Date:	18/12/2019

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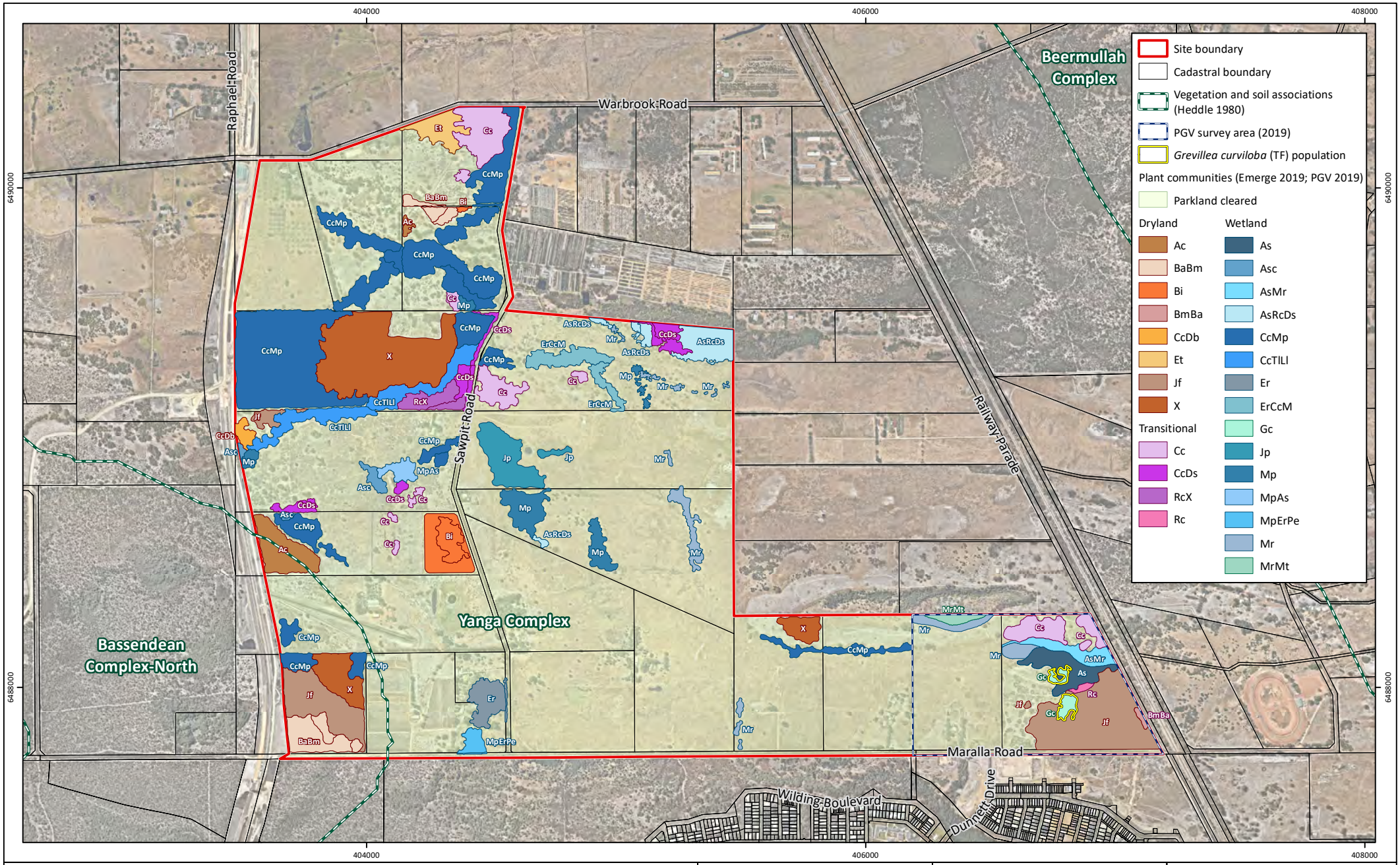

Figure 4: Plant Communities

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F86

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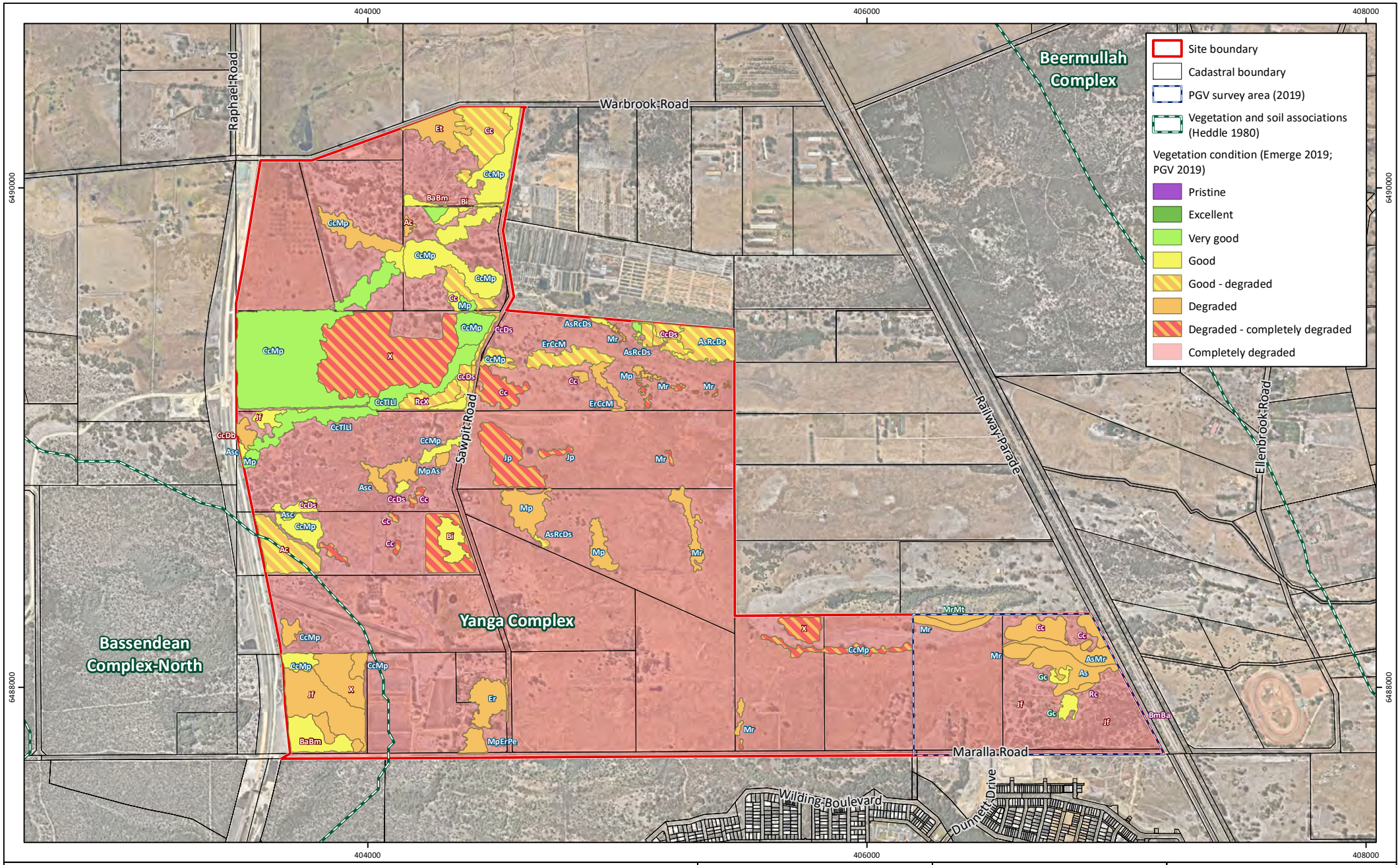

Figure 5: Vegetation Condition

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F87a

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Date:	31/01/2020

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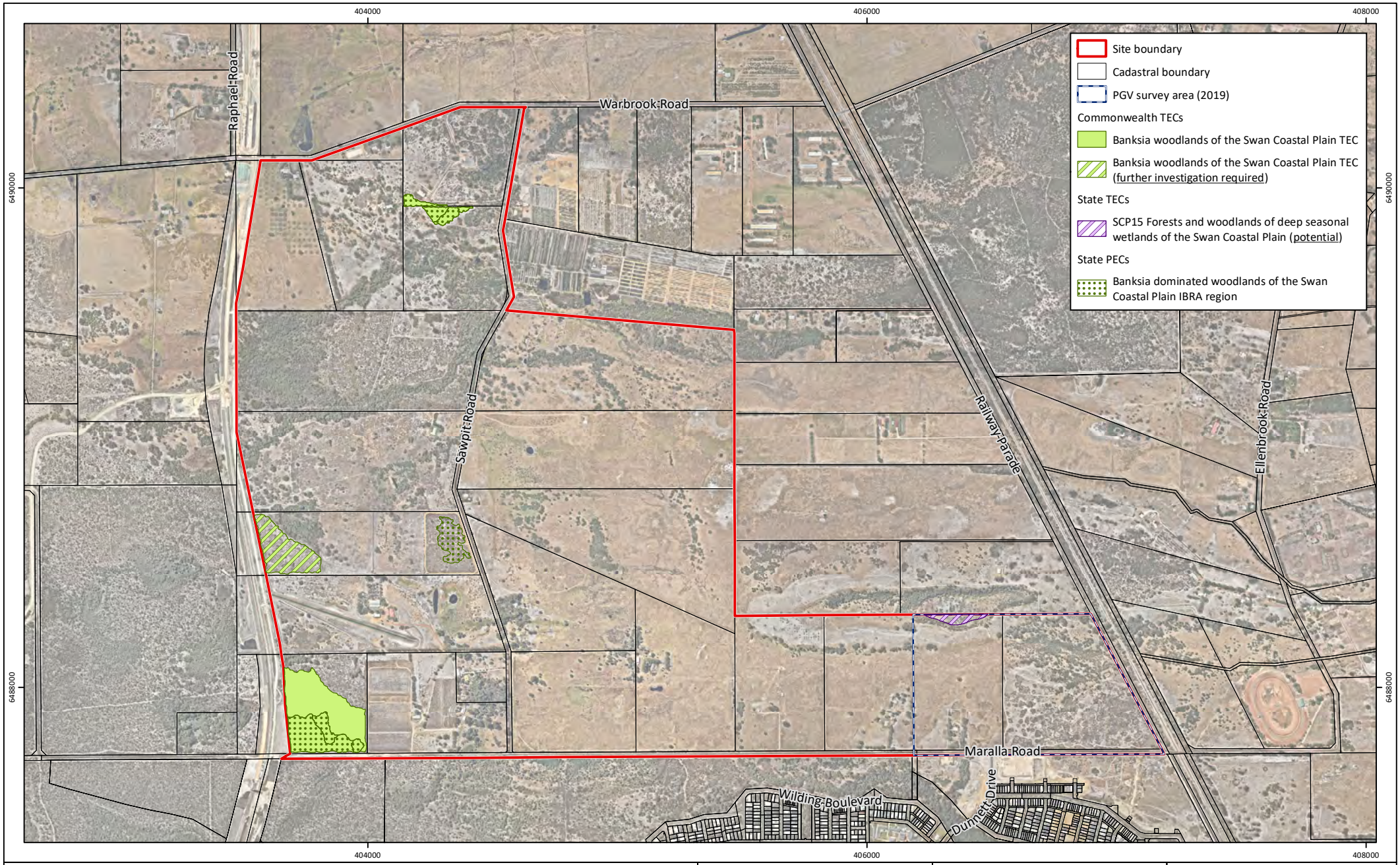

Figure 6: Threatened and Priority Ecological Communities

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F88
Drawn: KNM
Date: 09/12/2019
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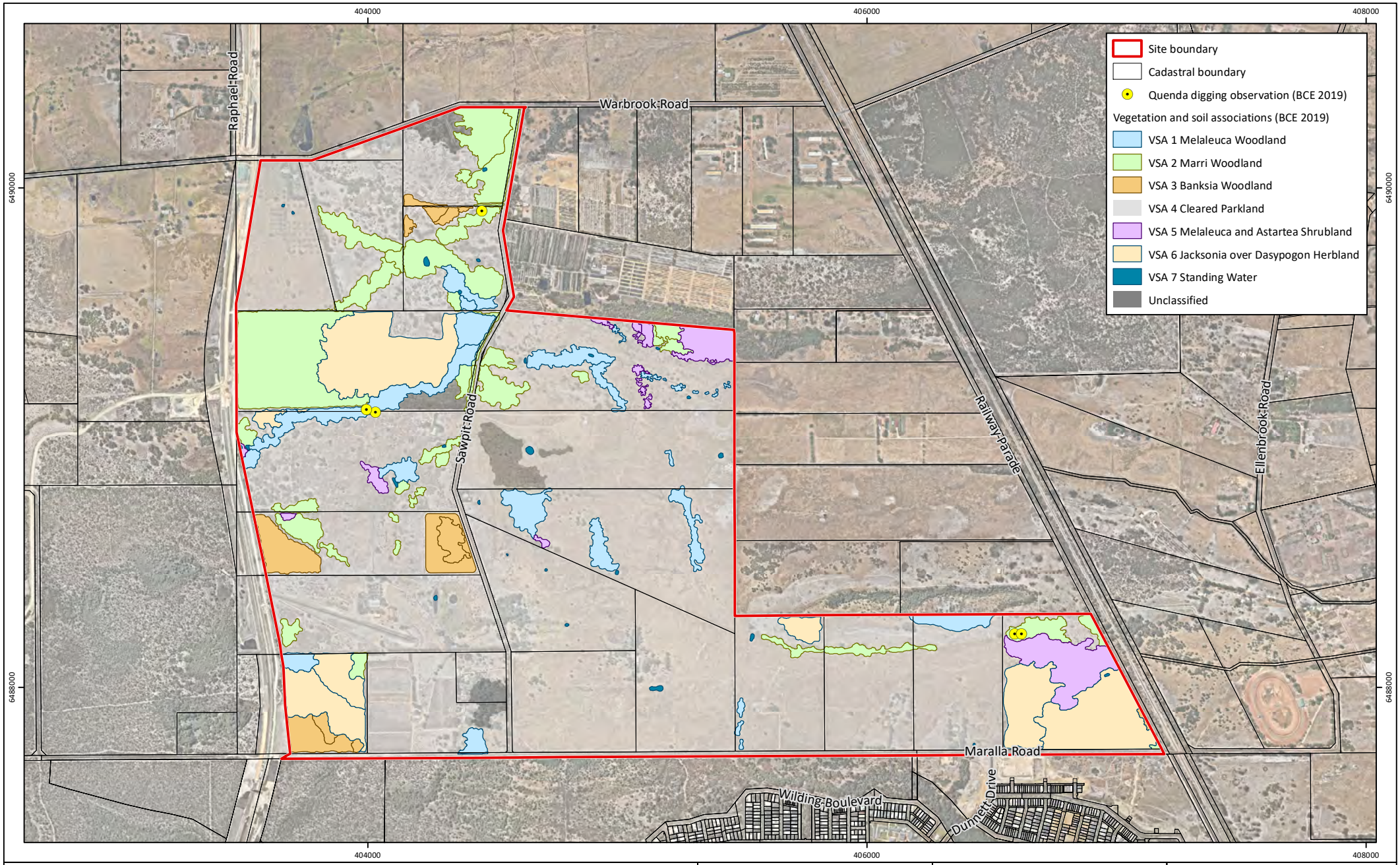

Figure 7: Fauna Habitat Types

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F89
Drawn: KNM
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Approved: JDH
Date: 18/12/2019

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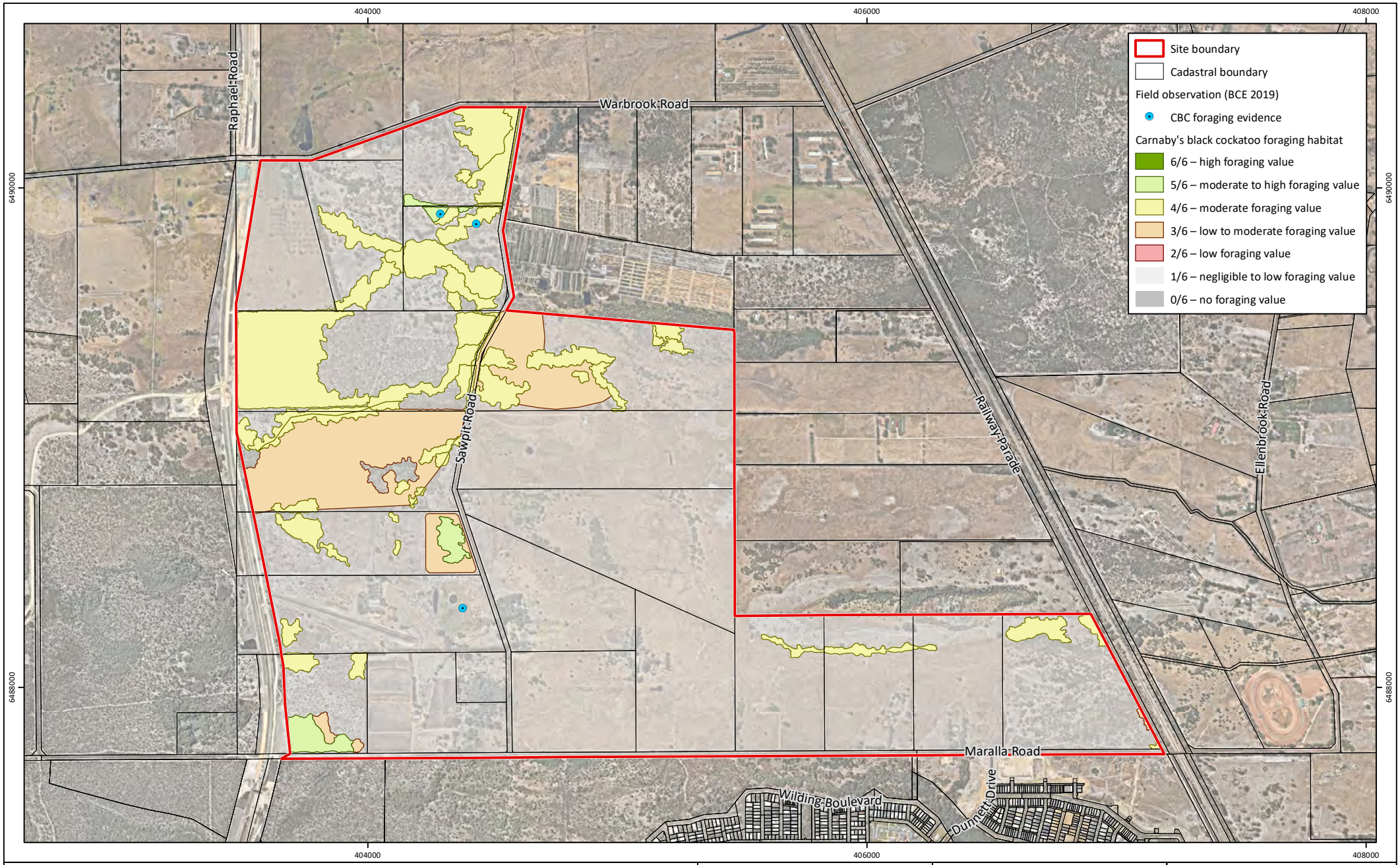

Figure 8: Carnaby's Black Cockatoo Foraging Habitat

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F90
Drawn: KNM
Date: 09/12/2019
Checked: ADB
Approved: JDH
Date: 18/12/2019

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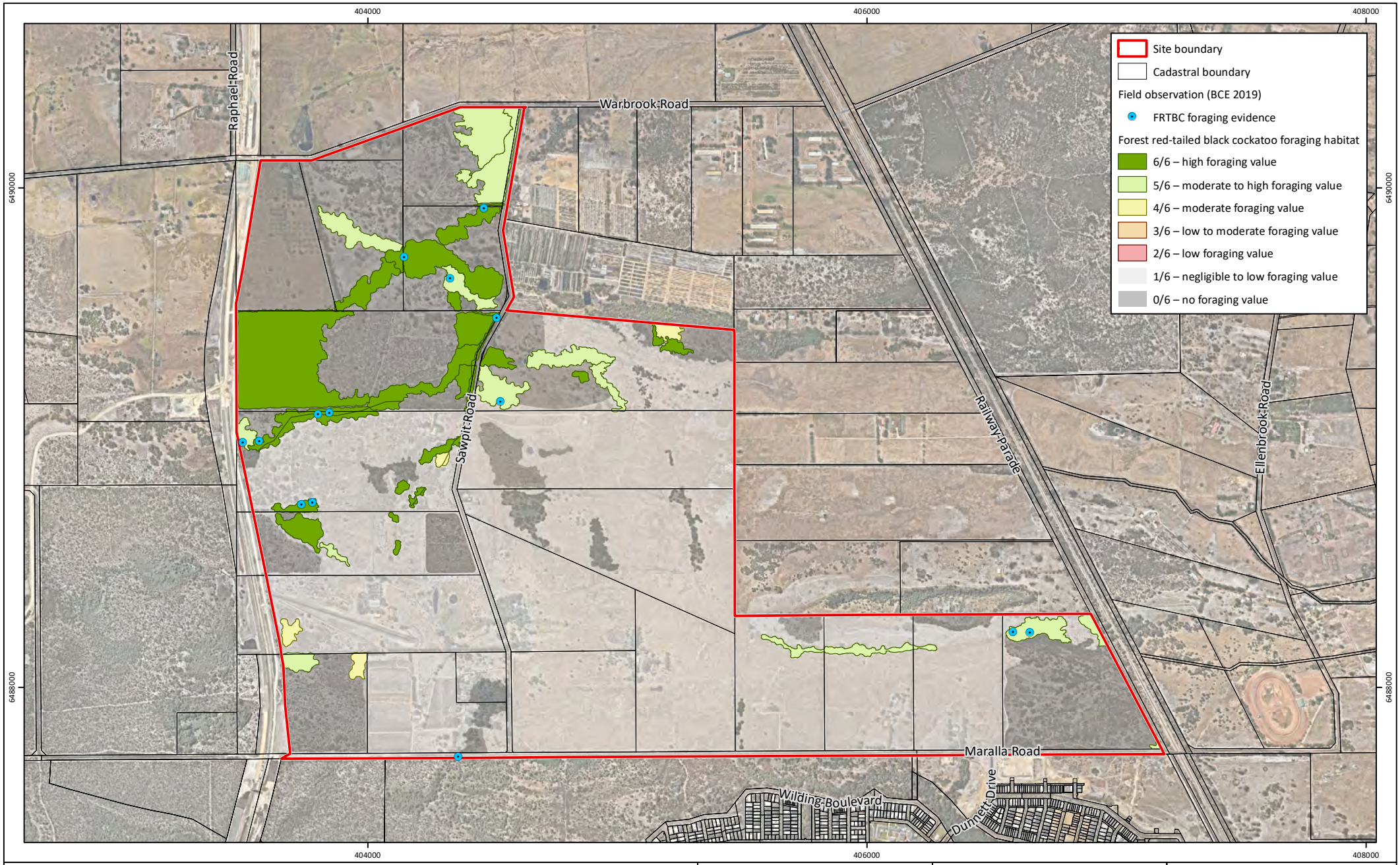

Figure 9: **Forest Red-tailed Black Cockatoo Foraging Habitat**

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F91
Drawn: KNM
Date: 09/12/2019
Checked: ADB
Approved: JDH
Date: 18/12/2019

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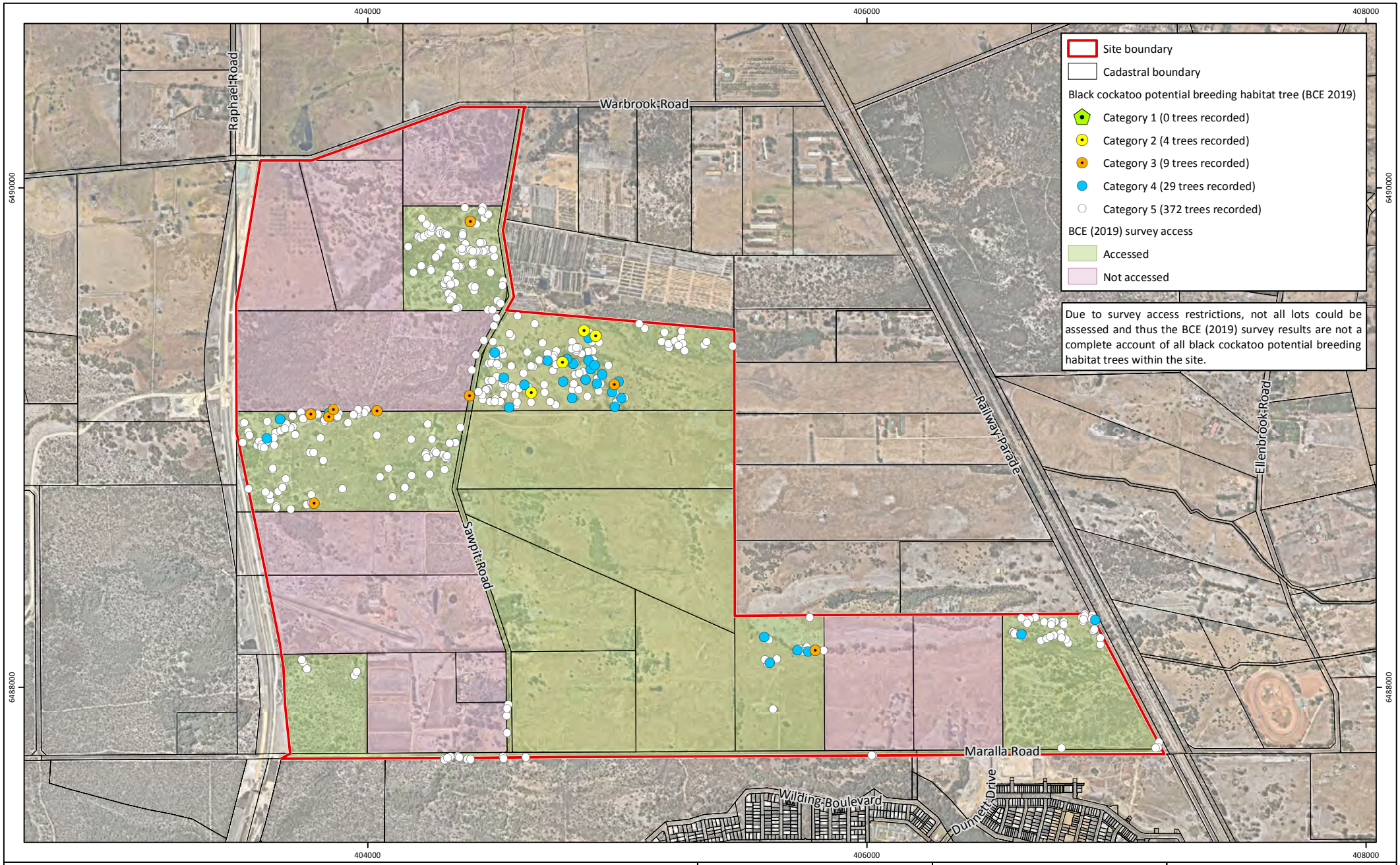

Figure 10: Black Cockatoo Potential Breeding Habitat Trees

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F92a
Drawn: ADB
Date: 10/02/2020
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Date: 10/02/2020

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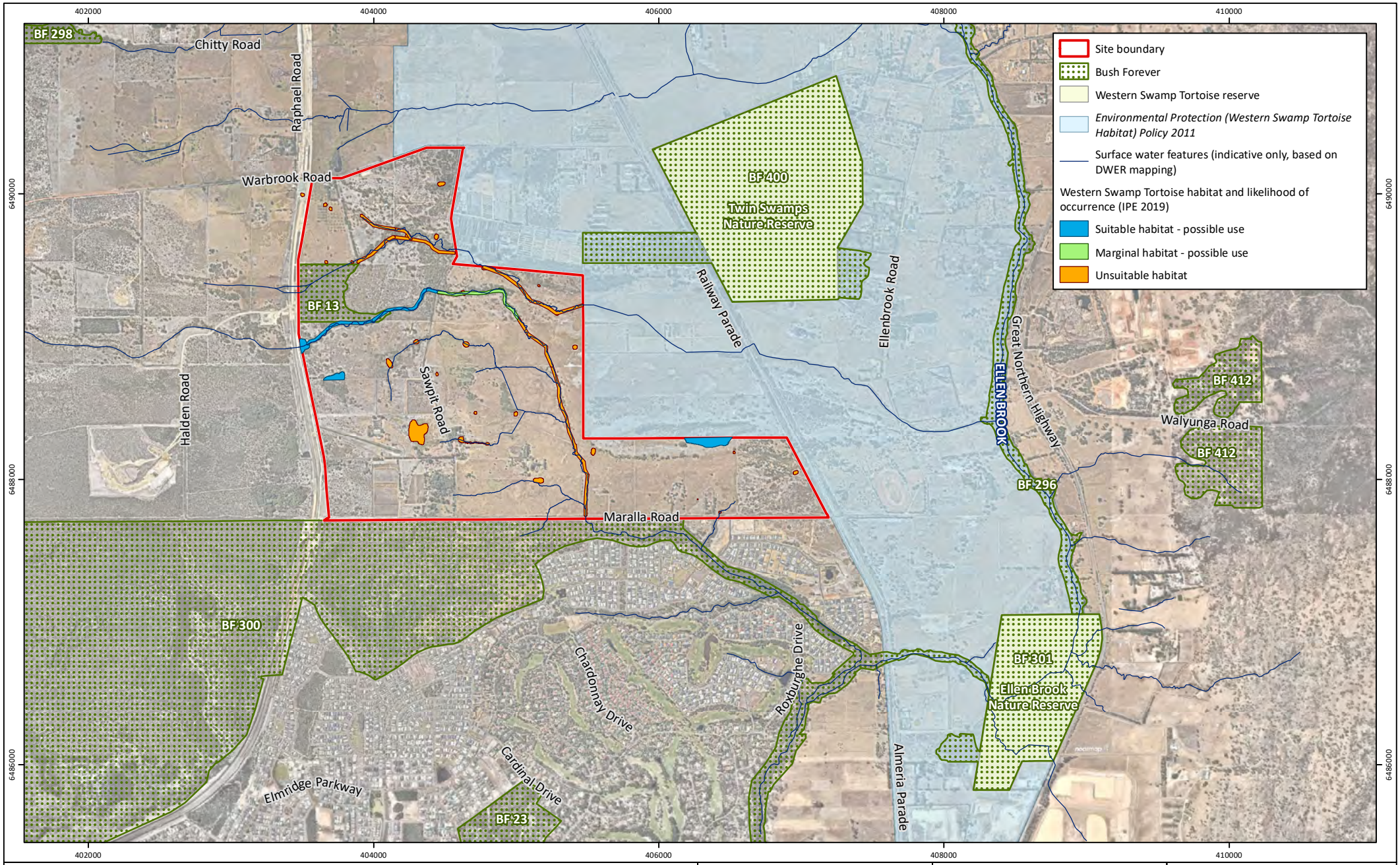

Figure 11: Western Swamp Tortoise Habitat

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F93

Drawn:	KNM
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Approved:	JDH
Date:	18/12/2019

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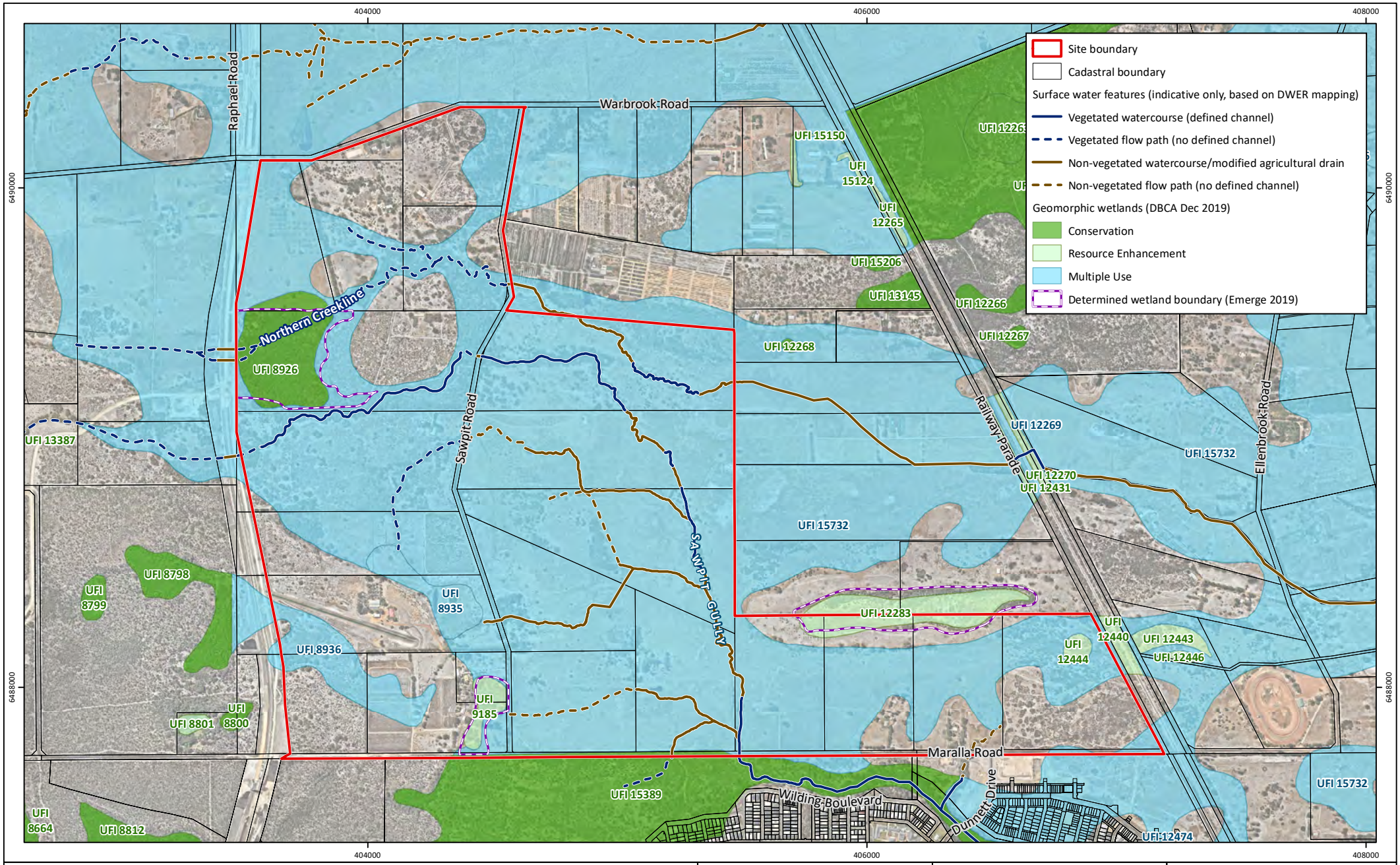

Figure 12: Surface Water Features

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F94a

Drawn:	GAR
Date:	06/02/2020
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Date:	06/02/2020

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GDA 1994 MGA Zone 50

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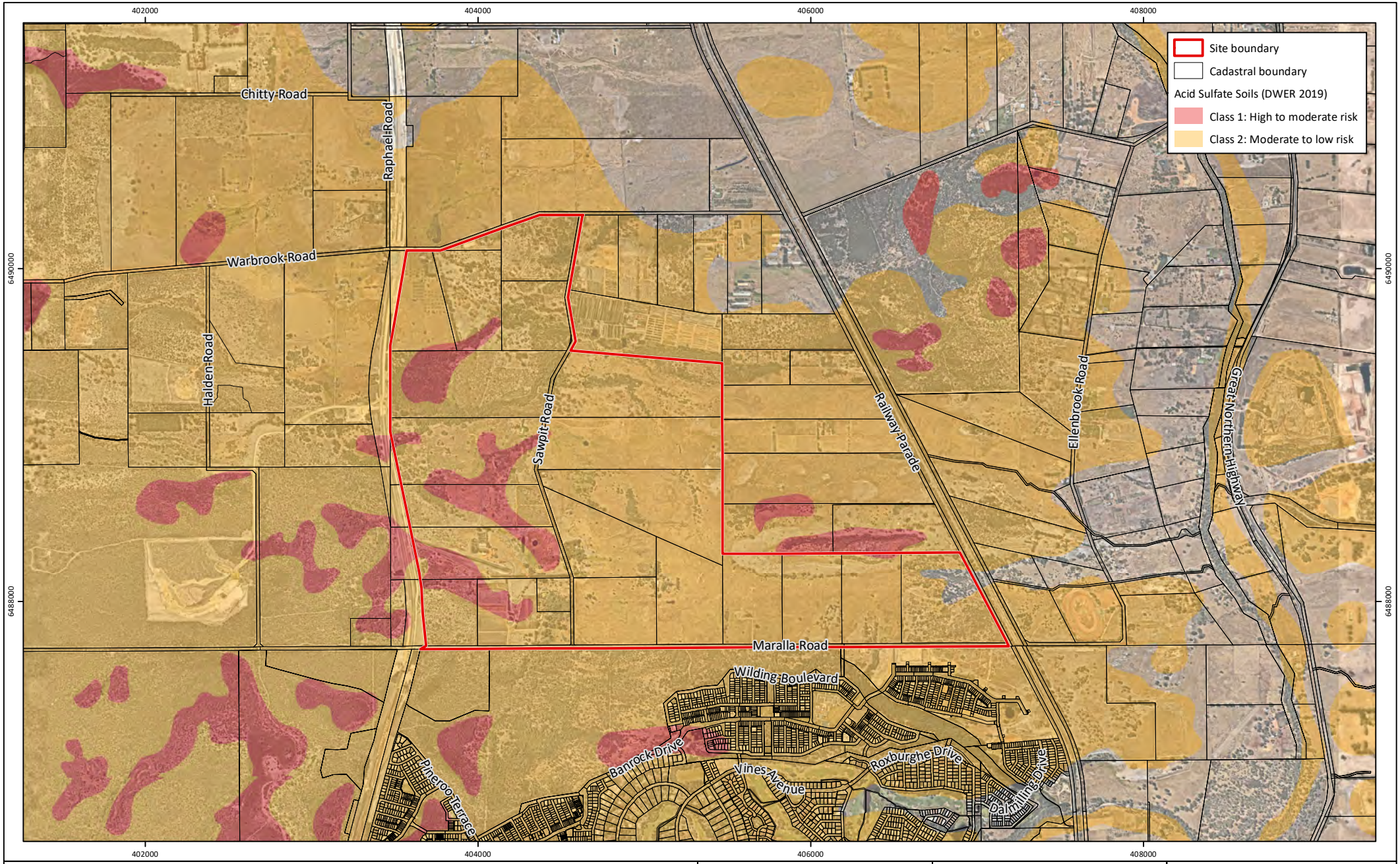

Figure 13: Acid Sulfate Soil Risk

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F95a

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Date:	06/02/2020

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GDA 1994 MGA Zone 50

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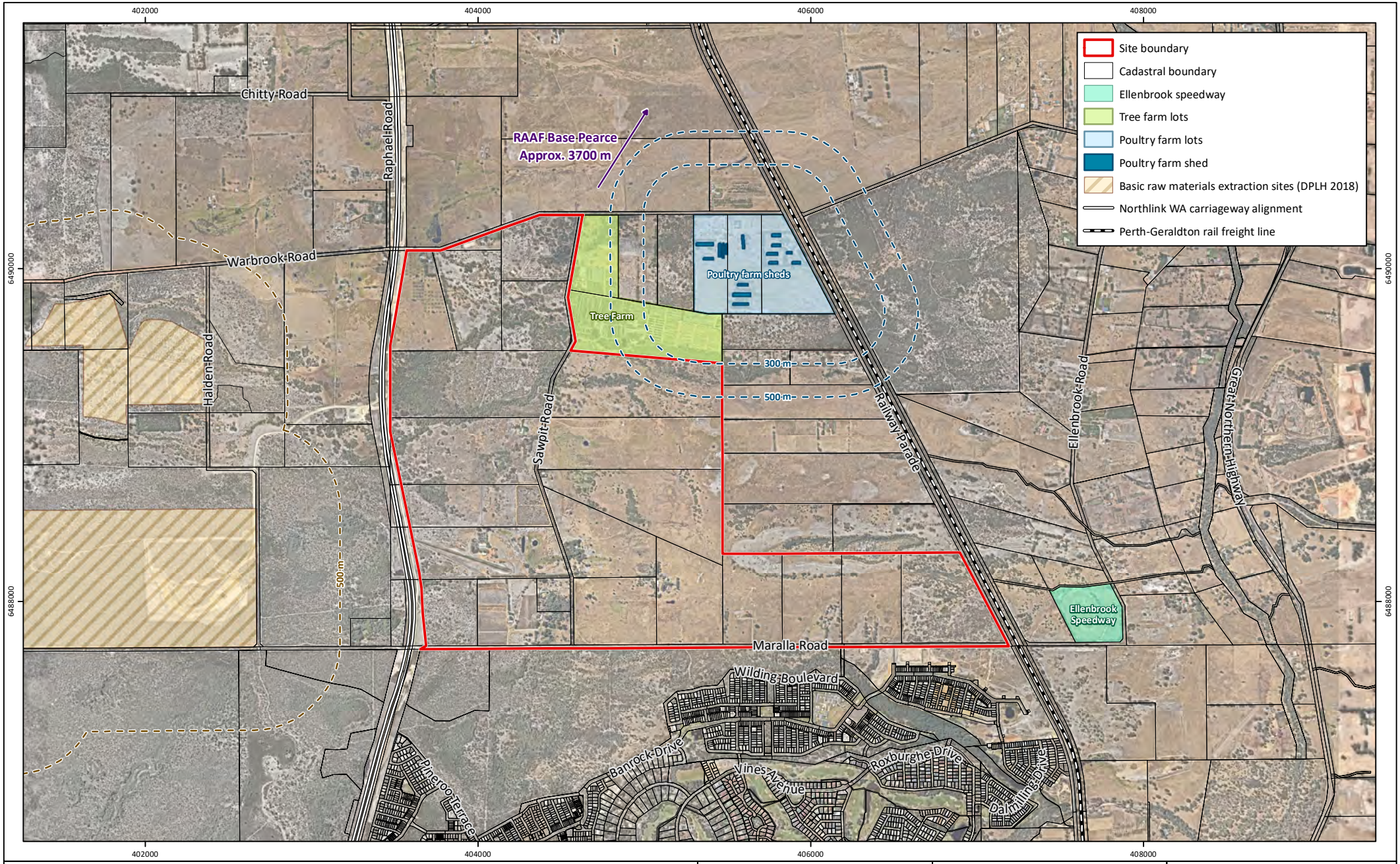

Figure 14: Surrounding Land Uses

Project:	Environmental Assessment Report North Ellenbrook (East) District Structure Plan
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F96a

Drawn:	GAR
Date:	06/02/2020
Checked:	ADB
Approved:	JDH
Date:	06/02/2020

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0 500 1,000
Metres

Scale: 1:30,000@A4

GDA 1994 MGA Zone 50

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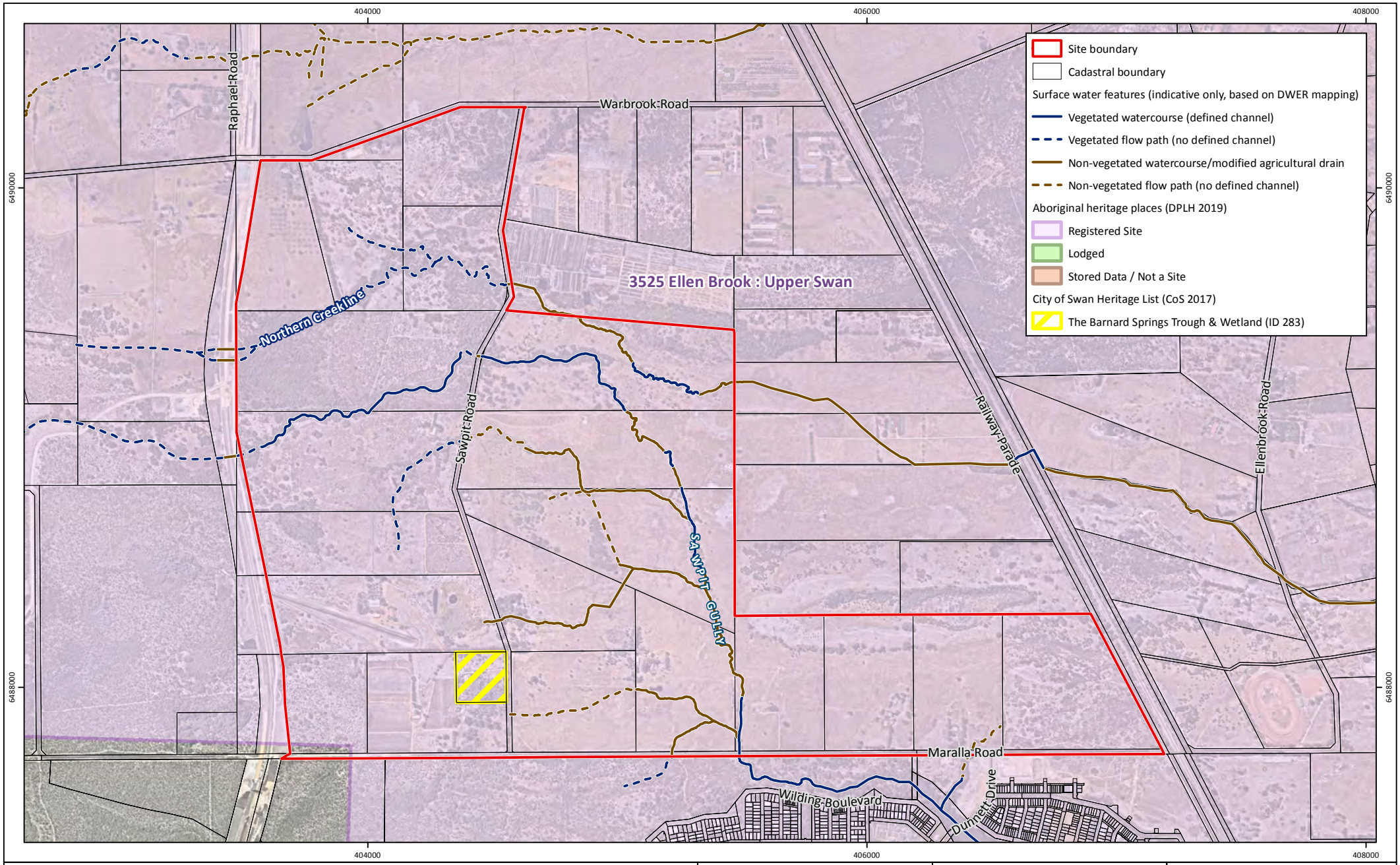

Figure 15: Heritage Sites

Project: Environmental Assessment Report
North Ellenbrook (East) District Structure Plan
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(10)--F97a
Drawn: GAR
Date: 06/02/2020
Checked: ADB
Approved: JDH
Date: 06/02/2020

N

0 200 400 600
Metres
Scale: 1:20,000@A4
GDA 1994 MGA Zone 50

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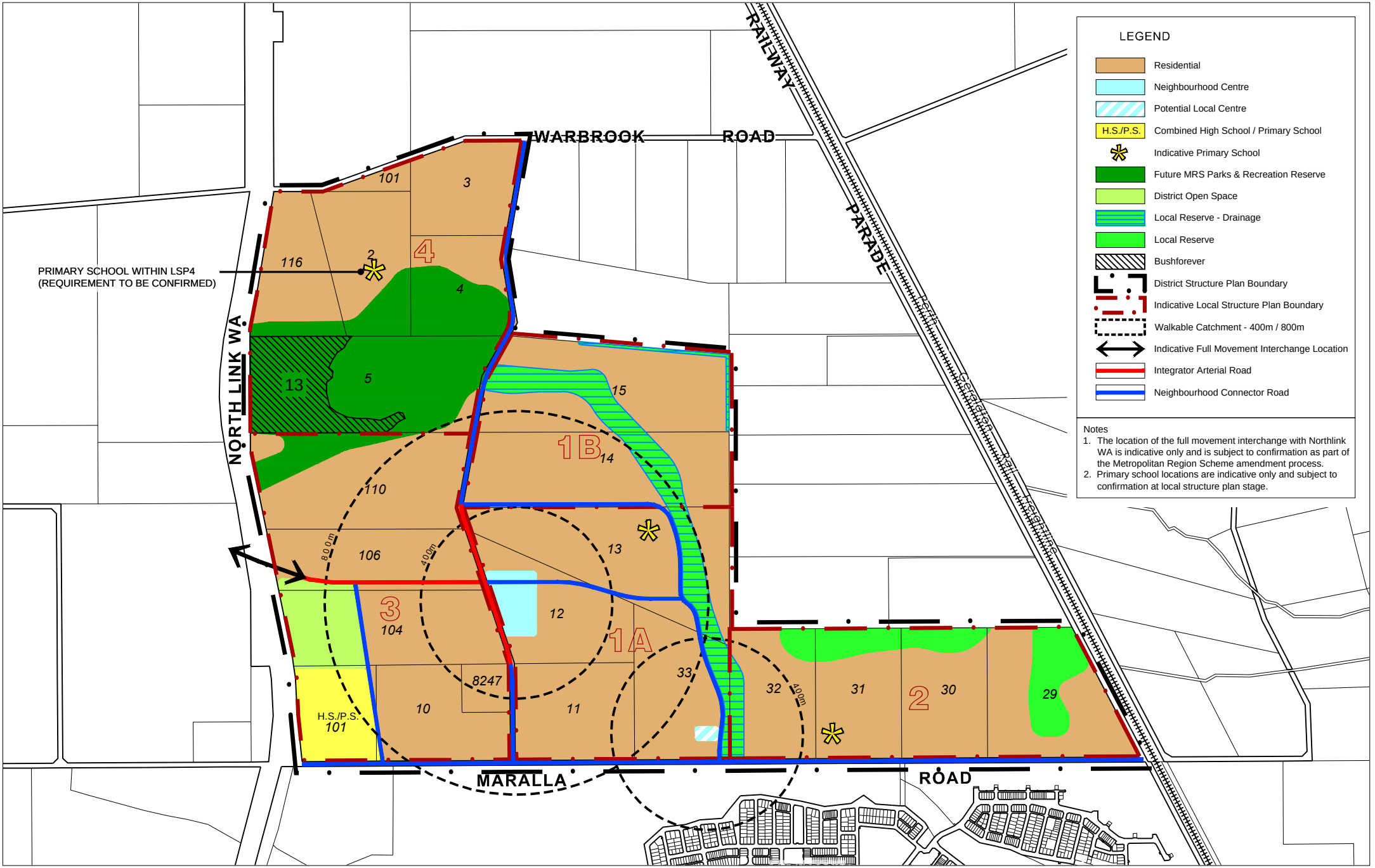
Appendix A

North Ellenbrook (East) District Structure Plan (CLE 2019)

Prepared by CLE (2019)



CLE Town Planning + Design
www.cleplan.com.au

DISTRICT STRUCTURE PLAN MAP

North Ellenbrook (east)

plan no: **3138-57B-01**
date: 19 December 2019
scale: 1:20,000 @ A4

Appendix B

Flora and Vegetation Assessment (Emerge Associates 2019)

Prepared by Emerge Associates (2019)

Flora and Vegetation Assessment

Various Lots North Ellenbrook

Project No: EP18-018

Prepared for Lendlease Communities (Ellenbrook) Pty Ltd
December 2019

Document Control

Doc name:	Flora and Vegetation Assessment Various Lots North Ellenbrook				
Doc no.:	**EP18-018(04)--014**				
Version	**Date**	**Author**		**Reviewer**	
1	May 2019	Sarah Paul	SKP	Tom Atkinson	TAA
	Issued for client comment				
A	December 2019	Rachel Weber	RAW	Tom Atkinson	TAA
	Minor updates and change to site boundary				

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Executive Summary

Lendlease Communities (Ellenbrook) Pty Ltd (Lendlease) engaged Emerge Associates (Emerge) to undertake a detailed flora and vegetation survey within 20 lots on Sawpit Road, Maralla Road and Warbrook Road in Bullsbrook. These lots are zoned 'rural' under the Metropolitan Region Scheme (MRS). Under the City of Swan *Town Planning Scheme* (TPS) no. 17 the entire site is zoned 'general rural'. Historic disturbance has occurred across the site including grazing and vegetation clearing.

A botanist and an environmental consultant from Emerge Associates visited the site on 12 and 26 October and 9 November 2018 and undertook detailed flora and vegetation surveys. During the survey an assessment was made on the type, condition and values of vegetation across the site.

Outcomes of the survey include the following:

- Non-native vegetation in 'completely degraded' condition is present across 337.73 ha of the site.
- Remnant native vegetation is present across 114.70 ha of the site in varying levels of condition.
- A total of 105 native and 60 non-native (weed) species were recorded in the site.
- No threatened or priority flora species were recorded or are considered likely to occur within the site.
- The native vegetation within the site was classified into 20 plant communities that are present in 'very good', 'good', 'good – degraded', 'degraded' and 'degraded – completely degraded' condition:
    - The majority of plant communities (**CcDs, CcTlLl, CcMp, Mp, Mr, ErCcM, AsRcDs, CcDb** and **RxC**) were considered to represent FCT 11 – wet forests and woodlands.
    - Plant communities **BaBm** and **Bi** were considered to represent FCT 21c – low lying *Banksia attenuata* woodlands and shrublands. Plant communities **Ac** and **Jf** were considered most likely to represent degraded forms of plant community **BaBm**.
    - Plant community **MpErPe** was considered to most likely represent FCT 13 – deeper wetlands on heavy soils.
- The site contains a 1.13 ha patch of the Commonwealth listed threatened ecological community (TEC) 'banksia woodlands of the Swan Coastal Plain' in Lots 3 and 4. This TEC is listed as 'endangered' under the *Environment Protection and Biodiversity Conservation Act 1999*. In addition, the **BaBm** and **Jf** vegetation in Lot 101 contributes 8.22 ha to a larger patch of the same TEC, which extends beyond the site.
- The site also supports three patches of the State listed PEC 'banksia dominated woodlands of the Swan Coastal Plain IBRA region'), which comprises 5.72 ha in total.
- Numerous large remnant native trees across the site may be locally or regionally significant due to their potential to provide black cockatoo habitat (Bamford Consulting Ecologists 2019).
- The waterways and intact vegetation associated with these features may also be locally and regionally significant due to their potential habitat values for western swamp tortoise and black striped minnow (Bamford Consulting Ecologists 2019).

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Abbreviation Tables

Table A1: Abbreviations – Organisations

Organisations	
EPA	Environmental Protection Authority
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water (now DWER)
DWER	Department of Water and Environmental Regulation
DPaW	Department of Parks and Wildlife (now DBCA)
WALGA	Western Australia Local Government Association

Table A2: Abbreviations – General terms

General terms	
CCW	Conservation category wetland
ESA	Environmentally sensitive area
FCT	Floristic community type
IBRA	Interim Biogeographic Regionalisation of Australia
MUW	Multiple use wetland
NVIS	National Vegetation Inventory System (ESCAVI 2003)
P1	Priority 1
P2	Priority 2
P3	Priority 3
P4	Priority 4
P5	Priority 5
PEC	Priority ecological community
REW	Resource enhancement wetland
T	Threatened
TEC	Threatened ecological community
UFI	Unique feature identifier

Table A3: Abbreviations –Legislation

Legislation	
BAM Act	*Biosecurity and Agriculture Management Act 2007*
BC Act	*Biodiversity Conservation Act 2016*
EP Act	*Environmental Protection Act 1986*
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*

Table A4: Abbreviations – planning

Planning terms	
MRS	Metropolitan region scheme
TPS	Town planning scheme

Table A5: Abbreviations – units of measurement

Units of measurement	
cm	Centimetre
ha	Hectare
m	Metre
m^2	Square metre
m AHD	m in relation to the Australian height datum
mm	Millimetre

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1 Introduction

1.1 Project background

Lendlease Communities (Ellenbrook) Pty Ltd (Lendlease) is exploring the potential future urban land uses of 20 lots on Sawpit Road, Maralla Road and Warbrook Road in Bullsbrook for residential purposes (see **Table 1** for all lot details). These lots (referred to herein as 'the site') are located approximately 26 kilometres (km) north-east of the Perth Central Business District within the City of Swan and are zoned 'rural' under the Metropolitan Region Scheme (MRS). Under the City of Swan *Town Planning Scheme (TPS) No. 17* the entire site is zoned 'general rural'.

The site is approximately 452.43 hectares (ha) in size and is bound by Sawpit Road and Great-Northern Highway to the west, residential development and rural residential lots to the north, rural lots to the east and Maralla Road to the south. The location and extent of the site is shown in **Figure 1.**

Table 1: Lots included within the site boundary.

Lot number	Street address	Road Name and Suburb	Size (ha)
101	-	Maralla Road, Bullsbrook	18.18
31	182	Maralla Road, Bullsbrook	19.45
32	224	Maralla Road, Bullsbrook	19.44
33	282	Maralla Road, Bullsbrook	22.39
10	5	Sawpit Road, Bullsbrook	18.39
8247	35	Sawpit Road, Bullsbrook	4.05
11	-	Sawpit Road, Bullsbrook	20.13
104	43	Sawpit Road, Bullsbrook	27.42
106	87	Sawpit Road, Bullsbrook	21.55
110	145	Sawpit Road, Bullsbrook	34.76
5	189	Sawpit Road, Bullsbrook	39.16
4	215	Sawpit Road, Bullsbrook	16.69
12	60	Sawpit Road, Bullsbrook	22.11
13	104	Sawpit Road, Bullsbrook	36.91
14	140	Sawpit Road, Bullsbrook	33.91
15	174	Sawpit Road, Bullsbrook	36.39
116	547	Warbrook Road, Bullsbrook	16.82
2	539	Warbrook Road, Bullsbrook	20.69
3	481	Warbrook Road, Bullsbrook	16.19
101	515	Warbrook Road, Bullsbrook	2.37

1.2 Purpose and scope of work

Emerge Associates (Emerge) were engaged by Lendlease to provide environmental consultancy services to support the planning process for the site. The purpose of the assessment is to document the baseline flora and vegetation values of the site, which will inform considerations around the potential for the site to support future urban land uses, which is currently being explored by Lendlease.

The scope of work was specifically to undertake a spring flora and vegetation assessment to the standard required of a detailed survey (but not undertaken over multiple seasons) in accordance with the Environmental Protection Authority's (EPA's) *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

As part of this scope of work, the following tasks were undertaken:

- Desktop review of relevant background information pertaining to the site and surrounds, including database searches for threatened flora species and ecological communities.
- Compilation of a comprehensive list of flora species recorded as part of the field survey.
- Mapping of plant communities and vegetation condition.
- Identification of conservation significant flora and vegetation.
- Documentation of the desktop assessment, survey methodology and results into a report.

2 Background

2.1 Environmental context

2.1.1 Climate

Climate has a strong influence on the types of vegetation that grow in a region and the life cycles of the flora present. It is therefore critical for a flora and vegetation survey to respond appropriately to climatic conditions to ensure that surveys are conducted during times when flora species are easiest to detect and identify.

The south west of Western Australia experiences a Mediterranean climate of hot dry summers and cool wet winters. In Mediterranean type climates some flora species will typically spend part of their life-cycle as either underground storage organs or as seed. This is an adaptation to unfavourable environmental conditions such as excessive heat and drought that occur over the summer period. These species, known as 'geophytes' or 'annuals', tend to re-emerge during winter when favourable conditions return and are most visible during spring, which is the flowering period for a majority of plant species. Therefore, spring is the optimal time to complete flora and vegetation surveys in the south west of WA.

An average of 655.1 millimetres (mm) of rainfall is recorded annually from the Pearce RAAF weather station, which is the closest weather station, located approximately 11 km from Ellenbrook. The majority of this rainfall is received between the months of May and September. Mean maximum temperatures range from 17.9^{o}C in July to 33.5^{o}C in January, while mean minimum temperatures range from 8.2^{o}C in August to 17.6^{o}C in February (BoM 2018).

A total of 544.4 mm of rain was recorded from May to September 2018 (BOM 2019) indicating sufficient seasonal rainfall occurred at the site to promote the growth of flora species prior to this survey.

2.1.2 Geomorphology and soils

Landform and soils influence vegetation types at regional and local scales. The site occurs on the Swan Coastal Plain, which is the geomorphic unit that characterises much of the Perth metropolitan area.

The Swan Coastal Plain is approximately 500 km long and 20 to 30 km wide and is roughly bound by the Indian Ocean to the west and the Darling Scarp to the east. Broadly the Swan Coastal Plain consists of two sedimentary belts of different origin. Its eastern side has formed from the deposition of alluvial material washed down from the Darling Scarp, while it's western side is comprised of three dune systems that run roughly parallel to the Indian Ocean coastline (Seddon 2004). These dune systems, referred to as Quindalup, Spearwood and Bassendean associations, represent a succession of coastal deposition that has occurred since the late Quaternary period (approximately two million years ago) (Kendrick *et al.* 1991) and, as a result, they contain soils at different stages of leaching and formation.

Examination of broad scale soil mapping places the site within the Yanga association of the Pinjarra plain (Churchward and McArthur 1980). Mapping by Gozzard (2011) also places the site in the Pinjarra plain. This landform is primarily of alluvial origin, formed by the major rivers that dissect the Swan Coastal Plain. Whilst the soils are primarily clay, there is also sand in the soils, which come from sand blown inland from the dunes in the west.

The site is not known to contain any unique geomorphology but the area in the northern extremity of Lots 29-32 (and extending into Lots 52 and Lot 53 to the north of the site) contains a linear wetland surrounded by a band of higher elevation, sandy soils which appears to be a unique landform feature.

2.1.3 Topography

The elevation of the site ranges from 27 m in relation to the Australian height datum (mAHD) in the southern-eastern portion of the site to 43 mAHD in the western corner of the site (DoW 2008) (**Figure 2**).

2.1.4 Hydrology and wetlands

Wetlands include "areas of seasonally, intermittently or permanently waterlogged soils or inundated land, whether natural or otherwise, fresh and saline, e.g. waterlogged soils, ponds, billabongs, lakes, swamps, tidal flats, estuaries, rivers and their tributaries" (Wetlands Advisory Committee 1977). Wetlands can further be recognised by the presence of vegetation associated with waterlogging or the presence of hydric soils such as peat, peaty sand or carbonate mud (Hill *et al*. 1996).

Wetlands of national or international significance may be afforded special protection under Commonwealth or international agreements. The following lists of important wetlands were checked as part of this assessment:

- *Ramsar List of Wetlands of International Importance* (DBCA 2017b)
- *A Directory of Important Wetlands in Australia* (DBCA 2018a).

No Ramsar or listed 'important wetlands' are located within or near the site. The Ellen Brook Swamp System is mapped as an 'important wetland' and is located 960 m to the north east of the site. This wetland is also mapped as Bush Forever Site No. 400 (as discussed in **Section 2.3.1**).

Examination of the Department of Water and Environmental Regulation (DWER) hydrography dataset (DWER 2018) shows numerous wetland or water related features in the site including:

- One marsh area in the north-eastern portion of the site.
- Two major drains, one in the centre and one in the southern portion of the site, entering from the west.
- 13 earth dams.

On the Swan Coastal Plain the Department of Biodiversity, Conservation and Attractions (DBCA) DBCA (2017a) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period). DBCA maintains the *Geomorphic Wetlands of the Swan Coastal Plain* dataset (DBCA 2018b), which further categorises geomorphic wetland features into specific

management categories to guide land use and conservation. Note that as this dataset was drafted at a regional scale the boundaries of mapped wetland features are often inconsistent with physical wetland boundaries. Further information on geomorphic wetland types and their management categories is provided in **Appendix A**.

A review of the *Geomorphic Wetlands, Swan Coastal Plain* dataset (DBCA 2018b) indicated that much of the site is located within the 'Ellenbrook floodplain', which is a palusplain 'multiple use wetland' (MUW) ('unique feature identifier' (UFI) 15732). A smaller sumpland MUW (UFI 8936) is also present within Lots 1401, 104 and 10. A sumpland 'conservation category wetland' (CCW) UFI 8926 is present within Lot 5. A palusplain CCW (UFI 15389) also occurs to the south of the site and a small portion of Maralla Road (within the site boundary) is included within this CCW. The site also contains parts of ttwo 'resource enhancement wetlands' (REWs) in the southern half of the site. REW UFI 9185 is a sumpland and is present within Lots 8247 and 10. REW UFI 12283 is also a sumpland and is present in the northern portion of Lots 31-32 and extends beyond the site to the north.

The locations of the geomorphic wetlands in the site are shown in **Figure 3.**

2.1.5 Regional vegetation

Native vegetation is described and mapped at different scales in order to illustrate patterns in its distribution. At a continental scale the *Interim Biogeographic Regionalisation of Australia* (IBRA) divides the Swan Coastal Plain into two floristic subregions (Environment Australia 2000). The site is contained within the 'SWA02' or Perth subregion, which is characterised as mainly containing *Banksia* low woodland on leached sands with *Melaleuca* swamps where ill-drained; and woodland of *Eucalyptus gomphocephala* (tuart), *E. marginata* (jarrah) and *Corymbia calophylla* (marri) on less leached soils (Beard 1990). This subregion is recognised as a biodiversity hotspot and contains a wide variety of endemic flora and vegetation types.

Variations in native vegetation within the site can be further classified based on regional vegetation associations. Beard *et al.* (2013) mapping shows the site as comprising vegetation association 'Bassendean_949'. This association is described as 'low woodland banksia' (Beard *et al.* 2013). 'Bassendean_949' association has 60.74% of its pre-European extent remaining on the Swan Coastal Plain with 20.8% protected for conservation purposes (Government of Western Australia 2018).

Heddle *et al.* (1980) maps the site as comprising the 'Yanga' vegetation complex. This is described as a low open forest of *Casuarina obesa* with patches of *Actinostrobus pyramidalis* and *Melaleuca* spp on low lying flats. Mixture of low open forest of *Banksia* spp - *Eucalyptus todtiana* and open woodland of *Corymbia calophylla* - *Banksia* spp'. The Yanga complex has 17.75% of its pre-European extent remaining on the Swan Coastal Plain with 6.81% under formal or informal protection (PBP 2013).

Studies have indicated that the loss of biodiversity caused by habitat fragmentation is significantly greater once a habitat type falls below 30% of its original extent (Miles 2001). The national objectives and targets for biodiversity conservation (Environment Australia 2001) established an objective of retaining 30% of the original extent of each vegetation complex. However, a lower objective of 10% is applied in 'constrained urban areas' such as the Swan Coastal Plain (Ministry for Planning 1995). The percentage protected for conservation of both the 'Bassendean_949' association and the 'Yanga'

complex fall below the 30% retention objective. The 'Yanga' complex also falls below the 10% retention objective.

2.1.6 Historic land use

Review of historical images available from 1965 (WALIA 2018) onwards, shows that the majority of the central portion the site was cleared by 1965. The south and south eastern portion of the site were relatively undisturbed, as was the north western most portion. However, clearing along lot boundaries and numerous access tracks is visible throughout the remaining intact vegetation.

The wetland present above the south eastern lots within the site (with only a small area within the site boundary) is visible and largely undisturbed from 1965 to the current time but the area around the periphery of the wetland is cleared.

Additional areas of clearing within the southern half of the site is visible by 1974. The north western portion of the site remained relatively undisturbed at this time.

The north western portion shows disturbance gradually increasing between 1974 and 1995 but vegetation cover has remained relatively stable since this time.

2.2 Significant flora and vegetation

2.2.1 Threatened and priority flora

Certain flora taxa that are considered to be rare or under threat warrant special protection under Commonwealth and/or State legislation. At a Commonwealth level, flora taxa may be listed as 'threatened' pursuant to Schedule 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Any action likely to have a significant impact on a taxon listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment and Energy.

In Western Australia flora species may also be classed as 'threatened' under the Biodiversity *Conservation Act 2016* (BC Act). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Threatened flora species listed under the EPBC Act and/or BC Act are assigned a conservation status according to their national extent.

Flora species that do not currently meet the criteria for listing as threatened but are potentially rare or threatened may be added to the DBCA's *Priority Flora List*. These species are classified into 'priority' levels based on level of threat. Whilst priority species are not under direct statutory protection, they are considered during State approval processes.

Further information on threatened and priority species and their categories is provided in **Appendix A**.

A search was conducted for threatened and priority flora within a 5 km radius of the site using the *Protected Matters Search Tool* (DoEE 2017b), *NatureMap* (DPaW 2017b) and DBCA's threatened and priority flora database (reference no. 12-1018FL). A total of 17 threatened and 19 priority flora species were identified as potentially occurring in the wider local area as listed in **Table 1**. A mapped

location of *Stylidium paludicola* (P3) is located on the southern boundary within the site, just north of Maralla Road.

Of the flora species potentially occurring in the local area, those species occurring on claypans, lateritic or granitic soils were considered unlikely to occur within the site due to the absence of these soils within the site.

On this basis 11 threatened flora species and 16 priority flora species were identified as having potential to occur within the site (shaded green in **Table 2**).

Table 2: Significant flora species known or likely to occur within 5 km of the site

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
	BC Act	EPBC Act				
Darwinia foetida	T	CE	P	Grey-white sand on swampy, seasonally wet sites	Oct-Nov	Possible
Synaphea sp. Fairbridge Farm	T	CE	P	Low woodland on grey, clayey sand with lateritic pebbles (Pinjarra Plain) near winter wet flats.	Sep-Nov	Unlikely
Thelymitra dedmaniarum	T	CE	PG	Granite.	Nov-Dec (Jan)	Unlikely
Trithuria occidentalis	T	CE	A	Partly submerged on the edge of shallow winter-wet clay pans in very open shrubland.	Sep-Oct	Unlikely
Andersonia gracilis	T	E	P	White/grey sandy, sandy clay, gravelly loam. Winter-wet areas, near swamps.	Sept-Nov	Possible
Caladenia huegelii	T	E	PG	Grey or brown sand, clay loam. Banksia woodland.	Sept-Oct	Possible
Diplolaena andrewsii	T	E	P	Granite outcrops & hillsides.	Jul-Oct	Unlikely
Diuris purdiei	T	E	PG	Grey-black sand, moist.	Sept-Oct	Possible
Drakaea elastica	T	E	PG	White or grey sand in dense vegetation in low-lying winter-wet areas.	Oct-Nov	Possible
Eucalyptus x balanites	T	E	P	Light coloured sandy soils over laterite. Habitat consists of gently sloping heathlands; open mallee woodland over shrubland or heathland with emergent mallees.	Sep-Oct	Unlikely
Grevillea christineae	T	E	P	Clay loam, sandy clay, often moist.	Aug-Sep	Possible
Grevillea curviloba subsp. curviloba	T	E	P	Grey sand. Winter-wet heath.	Oct	Possible
Grevillea curviloba subsp. incurva	T	E	P	Winter-wet areas on sand over limestone, or over ironstone at sites with a high-water table.	Sep-Oct	Unlikely

Table 2: Significant flora species known or likely to occur within 5 km of the site (continued)

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
Lepidosperma rostratum	T	E	P	Peaty sand, clay.	May-June	Possible
Thelymitra stellata	T	E	PG	Sandy loam, clay or gravel over laterite or gravel. Ridges, slopes, flats, riverbanks and breakaways.	Sep-Nov	Possible
Anigozanthos viridis subsp. terraspectans	T	V	P	Grey sand, clay loam. Winter-wet depressions.	Aug-Sept	Possible
Eleocharis keigheryi	T	V	P	Clay, sandy loam. Emergent in freshwater: creeks, claypans.	Aug-Nov	Possible
Calectasia elegans	P2	-	P	Grey yellow sand on plains.	Sep-Oct	Possible
Millotia tenuifolia var.laevis	P2	-	A	Granite or lateritic soils.	Sep-Oct	Unlikely
Poranthera moorokatta	P2		A	Sandy or clay soils. Dampland or low sandy dunes.	Oct-Nov	Possible
Schoenus sp. Bullsbrook (J.J. Alford 915)	P2	-	P/A	Grey peaty sand. Low-lying flats.	Unknown	Possible
Adenanthos cygnorum subsp. chamaephyton	P3	-	P	Grey sand, lateritic gravel.	Jul-Jan	Possible
Cyathochaeta teretifolia	P3	-	P	Grey sand, sandy clay. Swamps, creek edges.	Dec	Possible
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	P3	-	P	Grey brown sand or clay in winter wet flats.	Sep-Nov	Possible
Haemodorum loratum	P3	-	P	Grey or yellow sand, gravel.	Nov	Possible
Meionectes tenuifolia	P3	-	P	Clay loam in seasonally wet areas.	Oct-Dec	Possible
Phlebocarya pilosissima subsp. pilosissima	P3	-	P	White or grey sand, lateritic gravel.	Aug-Oct	Possible
Schoenus capillifolius	P3	-	A	Brown mud. Claypans.	Oct-Nov	Unlikely
Stylidium paludicola	P3	-	P	Peaty sand over clay. Winter wet habitats. Marri and Melaleuca woodland, Melaleuca shrubland.	Oct-Dec	Possible
Stylidium trudgenii	P3	-	P	Grey sand, dark grey to black sandy peat. Margins of winter-wet swamps, depressions	Sep-Jan	Possible
Styphelia filifolia	P3	-	P	Brown over pale yellow sand.	Feb-Apr	Possible
Cyanicula ixioides subsp. Ixioides	P4	-	PG	Laterite, gravel.	Aug-Oct	Unlikely
Hydrocotyle lemnoides	P4	-	A	Floating in swamps.	Aug-Oct	Possible
Hypolaena robusta	P4	-	P	White sand. Sand plains.	Sep-Oct	Possible

Table 2: Significant flora species known or likely to occur within 5 km of the site (continued)

Species	Level of significance		Life strategy	Habitat	Flowering period	Likelihood of occurrence
Schoenus natans	P4	-	A	Aquatic, in winter-wet depressions.	Oct	Possible
Stylidium longitubum	P4	-	A	Sandy clay, clay. Seasonal wetlands.	Oct-Dec	Possible

Note: T=threatened, CE=critically endangered, E=endangered, V=vulnerable, P1=Priority 1, P2=Priority 2, P3=Priority 3, P4=Priority 4, P=perennial, PG=perennial geophyte, A=annual. Species considered to potentially occur within the site are shaded green.

2.2.2 Threatened and priority ecological communities

An ecological community is a naturally occurring group of native plants, animals and other organisms that are interacting in a unique habitat. An ecological community's structure, composition and distribution are influenced by environmental factors such as soil type, position in the landscape, altitude, climate and water availability (DoEE 2017). 'Threatened ecological communities' (TECs) are ecological communities that are recognised as rare or under threat and therefore warrant special protection.

Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Commonwealth Minister for the Environment and Energy.

TECs will be listed within Western Australia under Section 27(1) and 33 of the BC Act and under the BC Regulations. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

A plant community that is under consideration for listing as a TEC in Western Australia, but does not yet meet survey criteria or has not been adequately defined, may be listed as a 'priority ecological community' (PEC). Listing as a PEC is similarly considered during State approval processes. Further information on categories of TECs and PECs is provided in **Appendix A**.

Known locations of TECs and PECs within 10 km of the site were searched for using the publicly available *Weed and native flora dataset* (Keighery *et al.* 2012), *Protected Matters Search Tool* (DoEE 2018b) and DBCA's threatened and priority ecological communities' database. These search results indicate that 15 TECs (four of these are PECs at the State level) and one PEC occur within 10 km of the site as listed in **Table 3**.

Table 3: TECs and PECs known to occur within 10 km of the site.

Code	Community name	TEC/ PEC	Level of significance	
			State	EPBC Act
SCP08	Herb rich shrublands in clay pans	TEC	Vulnerable	Critically Endangered (Clay pans of the Swan Coastal Plain)
SCP3a	*Corymbia calophylla – Kingia australis* woodlands on heavy soils, Swan Coastal Plain	TEC	Critically Endangered	Endangered
SCP20c	Shrublands and woodlands of the eastern side of the Swan Coastal Plain	TEC	Critically endangered	Endangered
SCP3c	*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain	TEC	Critically endangered	Endangered
SCP20a	*Banksia attenuata* woodlands over species rich dense shrublands	TEC	Endangered	Endangered (Banksia woodlands of the Swan Coastal Plain)
MUCHEA LIMESTONE	Shrublands and woodlands on Muchea limestone	TEC	Endangered	Endangered
MOUND SPRINGS SCP	Communities of Tumulus (Organic Mound) Springs, Swan Coastal Plain	TEC	Endangered	Endangered (Assemblages of plants and invertebrate animals of tumulus (organic mound) springs of the Swan Coastal Plain)
BANKSIA WL SCP	Banksia dominated woodlands of the Swan Coastal Plain	PEC/ TEC	Priority 3	Endangered (Banksia woodlands of the Swan Coastal Plain)
SCP20b	Eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands	TEC	Endangered	Endangered (Banksia woodlands of the Swan Coastal Plain)
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	PEC/ TEC	Priority 3	Endangered (Banksia woodlands of the Swan Coastal Plain)
SCP22	Banksia ilicifolia woodlands	PEC/ TEC	Priority 3	Endangered (Banksia woodlands of the Swan Coastal Plain)
SCP23b	Northern *Banksia attenuata – Banksia menziesii* woodlands	PEC/ TEC	Priority 3	Endangered (Banksia woodlands of the Swan Coastal Plain)
SCP02	Southern wet shrublands, Swan Coastal Plain	TEC	Endangered	-
SCP18	Shrublands on calcareous silts of the Swan Coastal Plain	TEC	Vulnerable	-
CENTRAL GRANITE SHRUBLANDS (COM 5, MARKEY)	Central northern Darling Scarp granite shrubland community	PEC	Priority 4	-

*Communities considered to be potentially present within the site are shaded green.

Nine of these communities are considered to have potential to occur in the site based on geomorphology, soils and regional vegetation patterns (shaded green in **Table 3**):

- SCP3c: *Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain (critically endangered in WA, endangered under the EPBC Act)
- SCP20a: *Banksia attenuata* woodlands over species rich dense shrublands (endangered in WA and under the EPBC Act)
- SCP20b: eastern *Banksia attenuata* and/or *Eucalyptus marginata* woodlands (endangered in WA and under the EPBC Act)
- SCP20c: shrublands and woodlands of the eastern side of the Swan Coastal Plain (critically endangered in WA, endangered under the EPBC Act)
- SCP21c: low lying *Banksia attenuata* woodlands or shrublands (Priority 3 in WA, endangered under the EPBC Act)
- SCP22: *Banksia ilicifolia* woodlands (Priority 3 in WA, endangered under the EPBC Act)
- SCP23b: northern *Banksia attenuata – Banksia menziesii* woodlands (Priority 3 in WA, endangered under the EPBC Act)
- Shrublands and woodlands on Muchea limestone (endangered in WA and under the EPBC Act)
- Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain (endangered in WA and under the EPBC Act).

2.2.3 Local and regional significance

Flora species and ecological communities may be significant for a number of reasons irrespective of whether they have special protection under policy or legislation.

Two key reasons that vegetation within the site may be significant are listed below:

- The vegetation within the site is associated with wetlands/water courses.
- The vegetation within the site has potential value as habitat for threatened or priority fauna species including, in particular, the EPBC Act listed 'critically endangered' *Pseudemydura umbrina* (western swamp tortoise), 'endangered' *Galaxiella nigrostriatal* (black striped minnow), the 'endangered' *Calyptorhynchus latirostris* (Carnaby's black cockatoo) and the 'vulnerable' *Calyptorhynchus banksii naso* (forest red-tailed black cockatoo). These species are also listed as 'critically endangered' (western swamp tortoise) and 'endangered' (both species of black cockatoo and the black striped minnow) under the BC Act (DoEE 2012).

2.2.4 Weeds

The term 'weed' can refer to any plant that requires some form of action to reduce its effect on the economy, the environment, human health and amenity. Many non-native flora species and some native species are considered to be weeds.

A particularly invasive or detrimental weed species may be listed as a 'declared pest' pursuant to the Western Australia's *Biosecurity and Agriculture Management Act 2007* (BAM Act), indicating that it warrants special management to limit its spread. At a national level, the Australian government has compiled a list of 32 Weeds of National Significance (WoNS) (DoEE 2018c), of which many are also listed under the BAM Act. Further information on categories of declared pests is provided in **Appendix A.**

Due to historical disturbance weed species are expected to be present at the site.

2.3 Land use planning considerations

A range of legislation, regulations and polices are relevant to the evaluation of vegetation in Western Australia. Key considerations applicable to the site are described below and also shown in **Figure 4**.

2.3.1 Bush Forever

The Government of Western Australia's *Bush Forever* policy is a strategic plan for conserving regionally significant bushland within the Swan Coastal Plain portion of the Perth Metropolitan Region. The objective of *Bush Forever* is to protect comprehensive representations of all original ecological communities by targeting a minimum of 10% of each vegetation complex for protection (Government of WA 2000a). *Bush Forever* sites are representative of regional ecosystems and habitat and have a key role in the conservation of Perth's biodiversity.

Bush Forever Site No. 13 (Sawpit Road Bushland, Bullsbrook) is located in the north western portion of the site. Bush Forever Site No. 300 (Maralla Road Bushland, Ellenbrook/Upper Swan) lies directly to the south and directly to the north-west of the site. Bush Forever Site No. 400 (Twin Swamps Nature Reserve and Adjacent Bushland) is located 100 m north-east of the site. Bush Forever Site No. 13 contains plant communities characteristic of the eastern side of the Swan Coastal Plain. Bush Forever Site No. 300 contains significant flora and fauna species, outstanding flora diversity, diversity of floristic types and plant communities characteristic of the eastern side of the Swan Coastal Plain. Bush Forever Site No. 400 contains significant flora and fauna species as well as plant communities characteristic of the eastern side of the Swan Coastal Plain (Government of WA 2000b). Portions of this *Bush Forever* site are also mapped as the 'important wetland' Ellen Brook Swamp System (as discussed in **Section 2.1.4**). The locations of the *Bush Forever* sites numbers 13, 300 and 400 are shown in **Figure 4**.

2.3.2 Environmentally sensitive areas

'Environmentally sensitive areas' (ESAs) are prescribed under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* and have been identified to protect native vegetation values of areas surrounding significant, threatened or scheduled flora, vegetation communities or ecosystems. Within an ESA none of the exemptions under the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004* apply. However, exemptions under Schedule 6 of the EP Act still apply, including any clearing in accordance with a subdivision approval under the *Planning and Development Act 2005* (a recognised exemption under the Schedule 6 of the EP Act).

Three ESAs occur within and extending outside of the site. An ESA is associated with Bush Forever Site 13 in the north west of the site. A circular ESA is present in the centre of the site, and is associated with a mapped location of FCT 18 (Shrublands on calcareous silts of the Swan Coastal Plain). An ESA is associated with Bush Forever Site 300 (to the south of the site) and includes the southern-most portion of the site. The location of this ESA is shown in **Figure 4**.

2.3.3 Ecological linkages

Ecological linkages are linear landscape elements that allow the movement of fauna, flora and genetic material between areas of remnant habitat. The movement of fauna and the exchange of genetic material between vegetation remnants improve the viability of those remnants by allowing greater access to breeding partners and food sources, refuge from disturbances such as fire and maintenance of genetic diversity of plant communities and populations. Ecological linkages are ideally continuous or near-continuous as the more fractured a linkage is, the less ease flora and fauna have in moving within the corridor (Alan Tingay and Associates 1998).

The Perth Biodiversity Project, supported by the Western Australia Local Government Association (WALGA), have identified and mapped regional ecological linkages within the Perth Metropolitan Region (WALGA and PBP 2004). This study was extended beyond the Perth Metropolitan Region through the South West Biodiversity Project, resulting in the identification and mapping of the South West regional ecological linkages (Molloy *et al.* 2009).

An ecological linkage (no. 26) runs from east to west along vegetation included within Bush Forever Site 300 directly south of the site. The location of this linkage is shown in **Figure 4**.

2.4 Previous flora surveys

A limited survey was undertaken by Connell in 1995 of Bush Forever Site No. 13 in the north western portion of the site (Government of WA 2000b). No other previous flora and vegetation surveys are known to have been undertaken.

3 Methods

3.1 Field survey

One botanist and one environmental consultant from Emerge visited the site on 12 and 26 October and 9 November 2018 to conduct flora and vegetation assessments.

Permission to access nine lots within the site was granted by landholders as shown in **Figure 5**. Assessment was made to the remaining 11 lots over the boundary where possible or via interpretation of aerial photography.

3.1.1 Vegetation

The site was traversed on foot and the composition and condition of vegetation was recorded. Searches were conducted for threatened and priority flora species with potential to occur in the site, with a particularly focus on identifying areas of suitable habitat.

Detailed sampling of the vegetation was undertaken using a combination of non-permanent 10 x 10 m quadrats and relevés. The quadrats were established using fence droppers bound by measuring tape. The relevés were completed over an equivalent 10 x 10 m area with the central location marked with a fence dropper. Releves were included to provide a more rapid sample of vegetation in poorer condition and/or of smaller size.

A total of 25 locations were sampled, comprised of 19 quadrats and six relevés. The position of each sample location was recorded with a hand-held GPS unit, as shown on **Figure 6** and **Figure 7.**

The data recorded within each sample included:

- site details (site name, site number, observers, date, location)
- environmental information (slope, aspect, bare-ground, rock outcropping soil type and colour class, litter layer, topographical position, time since last fire event)
- biological information (vegetation structure and condition, degree of disturbance and species present).

The species percentage ‘foliage projective cover’ (FPC) was also recorded within each quadrat. Additional plant taxa not observed within samples were recorded opportunistically as the botanist traversed the site. Photographs were taken throughout the field visit to show particular site conditions.

All plant specimens collected during the field survey were dried, pressed and then named in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys. Flora species not native to Western Australia are denoted by an asterisk (‘*’) in text and raw data.

Vegetation condition was assigned at each sample and changes in vegetation condition were also noted and mapped across the site. The condition of the vegetation was assessed using methods from Keighery (1994). For vegetation in the site containing *Banksia* spp., the condition scale provided in

the conservation advice for the 'Banksia Woodlands of the Swan Coastal Plain TEC' (DoEE 2016) was applied in addition to the Keighery scale (as shown in **Table 4**).

Table 4: Vegetation condition scale applied during the field assessment

Condition category	Definition (Keighery 1994)	Indicator (DoEE 2016).	
		Typical native vegetation composition	Typical weed cover
Pristine	Pristine or nearly so, no obvious signs of disturbance.	Native plant species diversity fully retained or almost so	Zero or close to
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.	High native plant species diversity	Less than 10%
Very good	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing	Moderate native plant species diversity	5-20%
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.	Low native plant species diversity	5-50%
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.	Very low native plant species diversity	20-70%
Completely degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.	Very low to no native species diversity	Greater than 70%

3.2 Mapping and data analysis

3.2.1 Plant community identification and description

The local plant communities within the site were identified from the sample data collected during the field survey. Once a group was defined, the vegetation was described according to the dominant species present using the structural formation descriptions of the *National Vegetation Inventory System* (NVIS) (ESCAVI 2003). The identified plant community was then mapped on aerial photography (1:20,000) from the sample locations and boundaries were interpreted from aerial photography and notes taken in the field. Vegetation condition was mapped on aerial photography (1:20,000) based on the locations recorded during the field survey to define areas with differing condition.

3.2.2 Floristic community type assignment

The identified plant communities were then compared to the regional 'floristic community type' (FCT) dataset *A floristic survey of the southern Swan Coastal Plain* by Gibson *et al.* (1994). The sample data (presence/absence) was reconciled with Gibson *et al*. (1994) by standardising the names of taxa with those used in the earlier study. This was necessary due to changes in nomenclature in the intervening period. Taxa that were only identified to genus level were excluded, while some infra-species that have been identified since 1994 were reduced to species level. The combined dataset was then imported into the statistical analysis package PRIMER v6 (Clarke and Gorley 2006). As data from a localised survey is often spatially correlated, data for each sample was compared to Gibson *et al*. (1994) separately. This removed the influence of spatial correlation when assigning a FCT. Classification was then undertaken using a group-average hierarchical clustering technique using the Bray-Curtis distance measure (as described above for plant community determination).

Where the sample tended to cluster with a grouping of different FCTs, samples were assessed separately to differentiate between FCTs. Ultimately the cluster analysis, as well as contextual information relating to the soils, landforms and known locations of FCTs within the region, was considered in the final determination of an FCT for vegetation within the site.

3.2.3 Threatened and priority ecological communities

Areas of native vegetation potentially representing a TEC were assessed against key diagnostic characteristics and, if available, size and/or vegetation condition thresholds provided in the following document:

- *Approved Conservation Advice (incorporating listing advice) for the Banksia Woodlands of the Swan Coastal Plain ecological community* (TSSC 2016).

3.2.4 Species accumulation curve

A species accumulation curve was plotted from sample data by generating a trendline (log) in Microsoft Excel. The trendline was forecast to locate the asymptote of the curve (the point at which the curve flattens), which provides an indication of amount of sampling that would be required before it can be assumed few species remain undetected. PRIMER v6 also offers a range of estimators to predict minimum species richness (Clarke and Gorley 2006). Both the Jacknife1 and Chao2 non-parametric estimators are reported, as these are known to perform well in comparison to simulated and real data sets and are also recommended for small sample sizes (Gotelli and Colwell 2011). Comparison between actual and estimated species accumulation assists in evaluating the adequacy of sampling effort.

3.3 Survey limitations

It is important to note the specific constraints imposed on surveys and the degree to which these may have limited survey outcomes. An evaluation of the survey methodology against standard constraints outlined in the EPA document *Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016) is provided in **Table 5**.

Table 5: Evaluation of survey methodology against standard constraints outlined in EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment

Constraint	Degree of limitation	Details
Availability of contextual information	No limitation	The broad scale contextual information described in **Section 2** is adequate to place the site and vegetation in context.
	Minor limitation	FCT assignment was undertaken through comparison to the authoritative floristic study of the SCP by Gibson *et al*. (1994). Gibson *et al*. (1994) surveyed 10 m x 10 m quadrats across the SCP in the spring main flowering period and in many cases sampled plots multiple times to provide a complete species list. Having a regional study to compare survey results provides the ability to classify vegetation to a formal scheme. However, the Gibson *et al*. (1994) data is now more than 20 years out of date and was necessarily derived from a limited sample of vegetation within largely publicly owned land. The analysis used to define groups of communities in Gibson *et al*. (1994) also has limitations. Due to the high degree of local endemism / spatial variation in vegetation on the Swan Coastal Plain it is likely that the groups identified in Gibson *et al*. (1994) do not adequately reflect the patterns in vegetation at the ecological community level (that is some Gibson *et al*. (1994) FCTs may represent super communities that could be further separated based on differences in floristics evident at local scales). Therefore while Gibson *et al*. (1994) is a useful resource the relevance of outputs derived from comparison to this dataset cannot always be assured.
Experience level of personnel	No limitation	This flora and vegetation assessment was undertaken by a qualified botanist with eight years of botanical experience in Western Australia. Technical review was undertaken by a senior environmental consultant with 16 years' experience in environmental science in Western Australia.
Suitability of timing	Minor limitation	The survey was conducted in October and November and thus within the main flowering season. High rainfall was recorded from May to September 2018 in the months preceding the site visit. Therefore it is likely that many plant species would have been in flower and/or visible at the time of survey. It is possible that some annuals or perennial geophytes had largely finished flowering by the time of survey (or when access to specific lots was available). However, a number of common orchids and geophytes were recorded during the survey, indicating that the timing was appropriate to detect these species and anecdotal evidence for 2018 suggests some species flowered later and for longer due to higher (albeit average) rainfall. The survey timing was therefore considered adequate to allow the detection of species for which seasonal timing is critical.
Temporal coverage	Minor limitation	Comprehensive flora and vegetation assessments can require multiple visits, at different times of year, and over a period of a number of years, to enable observation of all species present. The site was visited multiple times in October and November 2018. Although only sampled once, the site data was considered conclusive as it was collected in the spring main flowering period and much of the vegetation present within the site is still relatively intact. The survey was therefore considered to meet the requirements of a 'detailed' survey.

Table 5 (cont.): Evaluation of survey methodology against standard constraints outlined in EPA Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment

Constraint	Degree of limitation	Details
Spatial coverage and access	No limitation	Site coverage was representative (track logged).
	Limitation	Some lots could not be accessed during the surveys. For the most part these lots contained limited native vegetation however, but Lot 2, 3, 5, 10, 106 and 8247 appear to contain some areas of intact native vegetation. Observations were made from lot boundaries or the adjacent road reserves where ever possible but these areas could not be assessed in detail.
Sampling intensity	No limitation	A total of 165 species were recorded, of which 158 were recorded from 25 sample locations and seven were recorded opportunistically. Minimum species richness within site is estimated at between 197 (Jacknife1) and 199 (Chao2) species (refer species accumulation curve and estimates shown in **Plate 25**). This indicates that between 79 and 80% of the estimated 197-199 species in the site were recorded. Considering the degraded nature of the majority of the site and the time over multiple days spent sampling the intact areas of vegetation, the survey effort was considered to be adequate to prepare a representative species inventory.
Influence of disturbance	Minor limitation	Time since fire is greater than 60 years as interpreted form aerial imagery and therefore short lived species more common after fire may not have been visible.
	No limitation	Historical ground disturbance was evident throughout most of the site. The disturbance history of the site was considered when undertaking field sampling.
Adequacy of resources	No limitation	All resources required to perform the survey were available.

4 Results

4.1 General site conditions

The site is generally low lying with localised sandy rises (**Plate 1**), particularly in the north west, south west and south eastern portions of the site.

A number of small creeks and drains run through the site. Some of these waterways comprise intact native vegetation (**Plate 2**) whilst other portions are completely cleared (**Plate 3**).

Much of the site comprised cleared pastures with scattered individual or patches of native trees (**Plate 4**). Intact native vegetation was generally concentrated in the western portion of the site.

The site has historically been grazed by livestock, and more recently by kangaroos.

Plate 1: Sandy rise located within Lot 4. Low lying vegetation to the left.

Plate 2: Vegetated portion of the creek line within Lot 110.

Plate 3: Portions of the creekline/ drain in Lot 15 with no intact native vegetation.

Plate 4: Cleared paddocks with scattered remnant native trees.

4.2 Flora

A total of 105 native and 60 non-native (weed) species were recorded within the site during the field survey, representing 49 families and 124 genera. The dominant families containing native taxa were Myrtaceae (17 native and two weed/planted taxa) and Fabaceae (11 native taxa and nine weed taxa). The most common genera were *Eucalyptus* with five taxa and *Juncus, Drosera* and *Isolepis* with four taxa each. Of the species recorded 158 were recorded in sample locations and seven were recorded opportunistically. A complete species list and species list by plant community are provided in **Appendix B** and sampled data in **Appendix C**.

4.2.1 Threatened and priority flora

No threatened or priority flora species were recorded within the site.

4.2.2 Locally and regionally significant flora

Four species (*Croninia kingiana, Dielsia stenostachya*, *Melaleuca ryeae* and *Verticordia nitens*) were recorded in the site and are listed as significant flora species for either the Bassendean Dunes or the Foothills/Pinjarra Plain (Government of WA 2000b).

Croninia kingiana has significant populations on the Bassendean Dunes and was recorded in the area in the south western corner of the site.

Dielsia stenostachya is endemic to the Swan Coastal Plain and was common through the northern portion of the site.

The population of *Melaleuca ryeae* within the site occurs at the southern limit of their known geographic range and was recorded at one location in the north western portion of the site.

Verticordia nitens was recorded in the south western corner of the site with a small number of individuals present and is listed as having significant populations (Government of WA 2000b).

4.2.3 Declared pests

Four species, **Zantedeschia aethiopica* (arum lily), **Asparagus asparagoides* (bridal creeper), **Moraea flaccida* (one-leaf cape tulip) and **Solanum linnaeanum* listed as declared pests (s22(2) (exempt)) pursuant to the BAM Act were recorded within the site.

Bridal creeper is also listed as a weed of national significance (WoNS).

4.3 Vegetation

4.3.1 Plant communities

A total of 22 native plant communities were identified within the site. These communities are concentrated in the western portion of the site and comprise seven upland communities, three transitional communities and 14 wetland/low-lying communities, which occupy 140.59 ha of the site. The remainder of the site (360.16 ha) contains non-native vegetation with bare soil, pasture weeds, planted trees and scattered remnant trees and shrubs (**Plate 4**).

A description and the area of each plant community is provided in **Table 6** and representative photographs of each are provided in **Plate 7** to **Plate 30**. The location of each plant community is shown on **Figure 6**.

Table 6: Plant communities identified within the site

Plant community	Description	Area (ha)
Parkland cleared	Cleared or parkland cleared areas consisting of scattered *Corymbia calophylla*, *Eucalyptus rudis* and *Melaleuca* spp. trees, bare ground or planted/non-native vegetation (**Plate 4**).	337.73
Dryland		
Ac	Tall open shrubland to shrubland *Adenanthos cygnorum* over pasture weeds (**Plate 7**).	3.71
BaBm	Open woodland *Banksia attenuata* and *Banksia menziesii* over shrubland *Allocasuarina humilis, Stirlingia latifolia, Hibbertia hypericoides* and *Eremaea pauciflora* over forbland *Patersonia occidentalis*, *Dampiera linearis*, **Ursinia anthemoides*, *Conostylis aculeata* and grassland *Neurachne alopecuroidea*, **Ehrharta calycina* and **Briza maxima* (**Plate 8**).	4.17
Bi	Sparse to open woodland *Banksia ilicifolia* over forbland *Dasypogon bromeliifolius* and grassland **Ehrharta calycina* and **Briza maxima* (**Plate 9**).	4.01
CcDb	Open forest of *Corymbia calophylla* over forbland of *Dasypogon bromeliifolius* and grassland of pasture weeds (**Plate 10**).	0.61
Et	Low open woodland of *Eucalyptus todtiana* over pasture weeds (**Plate 11**).	2.11
Jf	Open tall shrubland of *Jacksonia furcellata* over sparse shrubland *Xanthorrhoea preissii* and *Macrozamia riedlei* over open forbland *Dasypogon bromeliifolius*, *Haemodorum spicatum, Podotheca gnaphalioides* and **Ursinia anthemoides* (**Plate 12**).	5.77

Table 6 : Plant communities identified within the site (continued)

Plant community	Description	Area (ha)
X	Shrubland *Xanthorrhoea* spp over forbland of *Podotheca gnaphalioides, Desmocladus flexuosus, *Gladiolus caryophyllaceus*, **Wahlenbergia capensis* and Trachymene pilosa (**Plate 13**).	17.77
Transitional		
Cc	Open forest of *Corymbia calophylla* over grassland of pasture weeds (**Plate 14**).	6.76
CcDs	Open forest of *Corymbia calophylla* over open shrubland *Astartea scoparia* (or absent) over forbland of *Dielsia stenostachya, Isolepis stellata* and *Cotula coronopifolia* (**Plate 15**).	3.36
RcX	Shrubland of *Regelia ciliata* and *Xanthorrhoea* spp. over grassland of pasture weeds (**Plate 16**).	1.84
Wetland		
Asc	Shrubland of *Astartea scoparia* (**Plate 18**).	0.81
AsRcDs	Sparse woodland of *Melaleuca preissiana* over shrubland to closed shrubland of *Astartea scoparia, Regelia ciliata* and *Hypocalymma angustifolium* over forbland of *Dielsia stenostachya*, *Isolepis stellata*, *I. prolifera* and *Aphelia cyperoides* and grassland of pasture weeds (**Plate 19**).	3.65
CcMp	Open woodland of *Corymbia calophylla* and *Melaleuca preissiana* over open to closed shrubland of *Astartea scoparia*, *Pericalymma ellipticum*, *Hypocalymma angustifolium* and *Xanthorrhoea* spp. over forbland of *Dasypogon bromeliifolius*, *Dielsia stenostachya* and open to closed grassland pasture weeds (**Plate 20**).	35.57
CcTlLl	Woodland to open forest of *Corymbia calophylla* over shrubland of *Taxandria linearifolia* over open to closed sedgeland of *Lepidosperma longitudinale* over forbland *Cycnogeton lineare, *Lotus subbiflorus* and *Lobelia anceps* and grassland of pasture grasses (**Plate 21**).	5.20
Er	Open forest of *Eucalyptus rudis* over forbland of **Zantedeschia aethiopica* and closed grassland of pasture weeds (**Plate 22**).	2.19
ErCcM	Open woodland to open forest of *Eucalyptus rudis, Melaleuca preissiana* and *Corymbia calophylla* over sparse shrubland of *Astartea scoparia* over forbland of *Cycnogeton lineare, Zantedeschia aethiopica* and open sedgeland of *Lepidosperma longitudinale* over grassland of pasture weeds (**Plate 23**).	2.73
Jp	Open rushland to rushland of *Juncus pallidus* over grassland of pasture weeds (**Plate 24**).	4.09
Mp	Low open woodland to open forest *Melaleuca preissiana* with tall shrubland of *Acacia saligna* (or layer absent) over grassland of pasture weeds (**Plate 25**).	5.38
MpErPe	Open woodland of *Eucalyptus rudis* and *Melaleuca preissiana* over shrubland of *Pteridium esculentum* and *Acacia saligna* over open rushland of *Juncus* spp. Over grassland of pasture weeds (**Plate 27**).	0.82
Mr	Low open woodland to open forest *Melaleuca rhaphiophylla* over grassland of pasture weeds (**Plate 28**).	2.15

*Plate 5: Plant community **Ac** in good to degraded condition within Lot 106 (not accessed).*

*Plate 6: Plant community **BaBm** in very good condition (Q23).*

*Plate 7: Plant community **Bi** in good condition (R24).*

*Plate 8: Plant community **CcDb** in degraded condition (Lot 110).*

*Plate 9: Plant community **Et** in degraded condition in Lot 3 (not accessed).*

*Plate 10: Plant community **Jf** in good condition (R3).*

*Plate 11: Plant community **X** in degraded condition (R10).*

*Plate 12: Plant community **Cc** in good condition (R12).*

*Plate 13: Plant community **CcDs** in good to degraded condition (R8).*

*Plate 14: Plant community **RcX** (background) in good to degraded condition (Lot 5, not sampled).*

*Plate 15: Plant community **Asc** in degraded condition (Lot 110).*

*Plate 16: Plant community **AsRcDs***

*Plate 17: Plant community **CcMp** in good condition (R25).*

*Plate 18: Plant community **CcTlLl** in very good condition (Q1).*

*Plate 19: Plant community **Er** in degraded condition (Lot 8247).*

*Plate 20: Plant community **ErCcM** in good to degraded condition (R7).*

*Plate 21: Plant community **Jp** in degraded to completely degraded condition in Lot 14.*

*Plate 22: Plant community **Mp** in degraded condition (R4).*

*Plate 23: Plant community **MpErPe** in degraded condition (R22).*

*Plate 24: Plant community **Mr** in degraded to completely degraded condition in Lot 15.*

4.3.2 Vegetation condition

The plant communities were determined to be in 'very good', 'good', 'degraded – good', 'degraded' and 'degraded – completely degraded' condition (as shown on **Figure 7**). Much of the vegetation in the site is in 'completely degraded' condition and is dominated by non-native flora species (especially the southern portion).

Relatively intact vegetation is scattered throughout the site but is concentrated in the northern and western portions of the site, particularly plant communities **CcMp**, **CcTlLl** and **BaBm**. These communities were mapped as being in very good condition as they have retained vegetation structure, did not contain a high cover of weed species and had species diversity characteristic of wetland (**CcMp** and **CcTlLl**) and dryland (**BaBm**) vegetation.

Vegetation mapped as being in 'good' condition comprised a relatively intact overstorey layer with moderate native species diversity associated with high weed loads.

Multiple plant communities were mapped as being in 'good' to 'degraded' condition. These areas tended to comprise low native species diversity and moderate weed loads or were not able to be accessed and thus assessment was undertaken at a distance.

Numerous plant communities present within the site consists of a relatively intact tree canopy over scattered native shrubs and dense pasture weeds. This vegetation was mapped as being in degraded condition as it lacks understory structure and has low species diversity. Past disturbance is significant and the lack of understorey suggest this part of the site has been used for stock grazing. Consequently, restoration would require intensive management.

Some vegetation present within the site shows a high level of disturbance with the understorey heavily dominated by weeds but retains sometimes moderate cover of one (or limited) native species. Despite reasonable native cover in parts, this vegetation was mapped as being in 'degraded' to 'completely degraded' condition, as the few native species is present are associated with disturbance (such as *Juncus pallidus* and *Podotheca gnaphalioides*) and restoration would require intensive management.

Remaining areas in the site are in 'completely degraded' condition and consist of non-native species such as pasture grasses, **Zantedeschia aethiopica* (arum lily), **Moraea flaccida* (cape lily) and

scattered native trees and shrubs. Sandy tracks within the site were also mapped as being in 'completely degraded' condition.

The extent of vegetation by condition category is detailed in **Table 7** and shown on **Figure 7.**

Table 7: Size of vegetation condition categories within the site

Condition category (Keighery (1994))	Size (ha)
Pristine	0
Excellent	0
Very Good	24.48
Good	19.54
Good – Degraded	18.50
Degraded	25.86
Degraded – Completely Degraded	26.32
Completely Degraded	337.73

4.3.3 Floristic community type assignment

Preliminary analysis of plant communities against the Gibson *et al.* (1994) dataset indicates the FCTs shown in **Table 8** are likely to occur. The majority of communities (**CcDs, CcTlLl, CcMp, Mp, Mr, ErCcM, AsRcDs, CcDb** and **RxC**) are likely to represent FCT 11 – wet forests and woodlands. This FCT was listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994).

Plant community **MpErPe** was considered to most likely represent FCT 13 – deeper wetlands on heavy soils, with R22 clustering with FCT 13 with 38% similarity. FCT 13 is considered to be 'well reserved' and 'low risk' (Gibson *et al.* 1994).

Plant communities **BaBm** and **Bi** were considered to represent FCT 21c 'low lying *Banksia* woodlands'. This FCT was listed as 'well reserved' and 'low risk' by Gibson *et al.* (1994). Both samples for plant community **BaBm** clustered with FCT 21c at 34 and 40% similarity (**Table 8**). The **Bi** vegetation (R24) did not cluster to any FCT closely but was most similar to two Gibson *et al. (1994)* sites representing FCT 21c with 29-34% similarity (**Table 8**). The relevant portions of the cluster dendrograms are provided in **Appendix D**.

Plant communities **Jf** and **Ac** are also likely to have once represented a banksia woodland FCT such as FCT 21c. However, given the degree of disturbance and their current condition, assigning this vegetation to an FCT is difficult.

Other plant communities in the site (**X, Asc, Cc**, **Er**, **Et** and **Jp**) were considered too degraded to assign to an FCT. FCTs within the site are shown on **Figure 8**.

Table 8: Plant community and likely FCT represented within the site for each sample

Plant community	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Cluster FCT and similarity (%)	Floristic community type (FCT)	Reservation and conservation status (Gibson *et al.* 1994).
CcDs	**R8**	HYMUS01 (FCT 11)	26	FCT 15 (20%)	FCT 11: Wet forests and woodlands	Well reserved Low risk
		CARAB-1 (FCT 15)	24			
		MILT-2 (FCT 13)	22			
		TWIN-10 (FCT 15)	22			
		HYMUS01 (FCT 11)	21			
	R12	HYMUS01 (FCT 11)	41	FCT 11 (41%)		
		ROWE01 (FCT 11)	36			
CcTlLl	**Q1**	ROWE01 (FCT 11)	37	FCT 11 (36%)		
		HYMUS01 (FCT 11)	27			
	R19	ROWE01 (FCT 11)	44	FCT 11 (43%)		
		CARAB-3 (FCT 11)	28			
CcMp	**R2**	CARD10 (FCT 6)	19	Multiple (4%)		
		HYMUS01 (FCT 11)	18			
	R25	HYMUS01 (FCT 11)	43	FCT 11 (43%)		
		CAPEL-3 (FCT 4)	39			
		ROWE01 (FCT 11)	39			
	Q17	CARAB-3 (FCT 11)	32	FCT 11 (32%)		
		HYMUS01 (FCT 11)	32			
Mp	**Q18**	ROWE01 (FCT 11)	41	FCT 11 (30%)		
		LOW14A (FCT 4)	36			
		HYMUS01 (FCT 11)	35			
	R4	AUSTB-3 (FCT 11)	24	Multiple (12%)		
		HYMUS01 (FCT 11)	22			
	Q21	ROWE01 (FCT 11)	25	FCT 11 (14%)		

Table 8 (cont.): Plant community and likely FCT represented within the site for each sample

Plant community	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Cluster FCT and similarity (%)	Floristic community type (FCT)	Reservation and conservation status (Gibson *et al.* 1994).
Mr	**R6**	MCLART-1 (FCT 13)	26	FCT 11 (25%)	FCT 11: Wet forests and woodlands	Well reserved Low risk
		LOW10B (FCT 11)	25			
ErCcM	**R7**	HYMUS01 (FCT 11)	39	FCT 11 (38%)		
		LOW10B (FCT 11)	33			
AsRcDs	**R5**	HYMUS01 (FCT 11)	42	FCT 11 (43%)		
		HARRY-6 (FCT 11)	32			
	Q13	TWIN-1 (FCT 6)	34	FCT 6 (34%)		
		HYMUS01 (FCT 11)	32			
		FL-9 (FCT 4)	27			
CcDb	**-**	-	-	-		
RcX	**-**	-	-	-		
BaBm	**Q11**	YULE-2 (FCT 23a)	42	FCT 21c (34%)	FCT 21c: Central *Banksia attenuata - B. menziesii* woodlands	Well reserved Susceptible
		WHITE-1 (FCT 23a)	39			
		YULE-1 (FCT 23a)	38			
	Q23	FL-6 (FCT 21c)	46	FCT 21c (40%)		
		WHITE-1 (FCT 23a)	44			
		THOM-2 (FCT 24)	44			
Bi	**R24**	FL-6 (FCT 21c)	34	Multiple (15%)		
		DEJONG-C (FCT 21c)	29			
		WAND-1 (FCT 23a)	28			
Jf	**R3**	FL-6 (FCT 21c)	32	FCT 4 (29%)	Disturbed form of FCT 21c: Central *Banksia attenuata - B. menziesii* woodlands	
		THOM-2 (FCT 24)	31			
	R20	LOW06B (FCT 21c)	35	FCT 4 (31%)		
		CARD4 (FCT 6)	33			
		PLINE-4 (FCT 4)	33			
Ac	-	-	-	-		

Table 8 (cont.): Plant community and likely FCT represented within the site for each sample

Plant community	Sample unit	Most similar Gibson *et al.* (1994) sites	Similarity (%)	Cluster FCT and similarity (%)	Floristic community type (FCT)	Reservation and conservation status (Gibson *et al.* 1994).
MpErPe	**R22**	MILT-2 (FCT 13)	38	FCT 13 (38%)	FCT 13: Deeper wetlands on heavy soils	Well reserved Low risk
		HYMUS01 (FCT 11)	26			
		PAGA-2 (FCT 13)	24			
X	R10	BOLD-1 (FCT 24)	30	FCT 6 (22 %)	Too degraded	N/A
		THOM-2 (FCT 24)	30			
		LOW07 (FCT 21c)	29			
Asc	-	-	-			
Cc	-	-	-			
Er	-	-	-			
Et	-	-	-			
Jp	-	-	-			

4.3.4 Threatened and priority ecological communities

The structure and composition of plant communities **BaBm** and **Bi** indicates that they represent the 'banksia woodlands of the Swan Coastal Plain' TEC. This TEC, herein referred to as the 'banksia woodland TEC', is listed as 'endangered' under the EPBC Act. The degraded plant community **Jf** is also likely to have once represented FCT 21c but has been disturbed. Where it occurs adjacent to plant community **BaBm** it may contribute to the overall patch of the TEC. Whether a patch of vegetation is considered to represent the banksia woodland TEC depends on a number of diagnostic criteria including geographic location, soils, landform, structure, composition, condition and patch size (DoEE 2016). As outlined in **Table 9,** the **BaBm** and **Jf** vegetation within Lot 101 (8.22 ha) satisfies the criteria to be considered part of a larger patch of the banksia woodland TEC. The **BaBm** and **Bi** vegetation present within Lot 4 (and adjacent lot 3) (1.13 ha) meets the minimum size requirements to be considered a patch of the banksia woodland TEC.

The patch of **Bi** within Lot 106 could not be assessed in detail due to lot access restrictions but observations made from Sawpit Road indicate that it contains a canopy of *Banksia ilicifolia*. The central portion of the **Bi** vegetation was mapped as being in 'good' condition (1.46 ha) and the surrounding portion was mapped as being in 'degraded - completely degraded' (2.47 ha) condition. Therefore, the **Bi** vegetation is primarily within the lower condition category and does not meet the minimum condition and size requirements to be considered a patch of banksia woodland TEC.

The 3.47 ha of **Ac** vegetation in 'good – degraded' condition within Lot 106 could not be assessed in detail due to lot access restrictions. Should the area contain over 2% canopy cover of *Banksia* spp.

and be in 'good' or better condition, it may meet the criteria to be considered a patch of the banksia woodland TEC but further investigation is required to confirm this.

Due to the presence of *Banksia attenuata* and *B. menziesii* on deep sands the plant communities **BaBm** and **Bi** represent the 'banksia dominated woodlands of the Swan Coastal Plain IBRA region' PEC (P3). There is no conservation advice for this PEC so it is unclear whether a condition threshold should be applied when identifying its presence. However, DBCA has historically applied 'good' condition as a threshold for the identification of PEC vegetation. Using 'good' condition as basis a basis for identification, 5.72 ha of the **BaBm** and **Bi** vegetation (in three separate areas) is considered to represent the PEC.

The areas of TECs and PECs within the site are shown in **Figure 9.**

Table 9: Criteria for determining presence of Banksia Woodlands of the Swan Coastal Plain TEC adapted from DoEE (2016).

Criteria	Requirements for meeting criteria	Site implications		
		Lot 101	Lot 4 and Lot 3	Lot 106
1. Must meet key diagnostic characteristics	A variety of factors relating to: • Location • Soils • Structure • Composition	• Site meets location and soils criteria. • The **BaBm** vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata* and *Banksia menziesii*. • The **BaBm** vegetation within site also meets structure and composition criterion. FCT 21c identified as one FCT of the banksia woodland TEC. • The **Jf** vegetation adjoining the **BaBm** vegetation does not include the key diagnostic feature of a tree layer of *Banksia* spp. However, the conservation advice lists percentage canopy cover for the Banksia woodlands TEC as ranging from 2% to typically less than 50% (DoEE 2016). As such the **Jf** vegetation is likely to meet the very lowest end of this range.	• Site meets location and soils criteria. • The **BaBm** and **Bi** vegetation includes the key diagnostic feature of a tree layer of *Banksia attenuata, Banksia menziesii* and *B. ilicifolia*. • The **BaBm** and **Bi** vegetation within site also meets structure and composition criterion. FCT 21c identified as one FCT of the banksia woodland TEC.	• Site meets location and soils criteria. • The **Bi** vegetation includes the key diagnostic feature of a tree layer of *Banksia ilicifolia*. • The **Bi** vegetation within site also meets structure and composition criterion. FCT 21c identified as one FCT of the banksia woodland TEC.
2. Must meet condition thresholds	• A patch should at least meet the 'good' condition category.	• The **BaBm** vegetation is present in 'good' and degraded condition, which meets this criterion. The **Jf** vegetation is present in degraded condition. The conservation advice indicates that a single patch may include areas of variable condition, meaning parts of the **BaBm** and **Jf** vegetation in 'degraded' condition may still be considered the TEC.	• The **BaBm** and **Bi** vegetation is present in 'very good' and 'good' condition, which meets this criterion.	• The **Bi** vegetation is present in 'good' and 'degraded - completely degraded' condition, which meets this criterion. The conservation advice indicates that a single patch may include areas of variable condition, meaning parts of the **Bi** vegetation in 'degraded - completely degraded' condition may still be considered the TEC.

Table 9 (cont.): Criteria for determining presence of Banksia Woodlands of the Swan Coastal Plain TEC adapted from DoEE (2016).

Criteria	Requirements for meeting criteria	Site implications		
		Lot 101	Lot 4 and Lot 3	Lot 106
3. Must meet minimum patch size	Minimum size of patch: • Pristine=no minimum size • Excellent=0.5 ha • Very Good=1 ha • Good=2 ha	• The **BaBm** vegetation in 'good' condition comprises 2.39 ha and does meet this criterion. • The adjoining **BaBm** and **Jf** vegetation in 'degraded' condition would be viewed as contiguous and part of the same patch. A large area of contiguous banksia vegetation (separated by approximately 29.5 m) is also present to the south of the site and is likely to be in very good or better condition. Therefore the mapped 8.22 ha of **BaBm** and **Jf** vegetation within Lot 101 does comprise part of a larger patch of the TEC.	• The **BaBm** vegetation in 'very good' condition comprises 0.35 ha and does not independently meet this criterion. • The adjoining **BaBm** and **Bi** vegetation in 'good' condition would be viewed as contiguous and part of the same patch. Therefore the mapped 1.13 ha of **BaBm** and **Bi** vegetation within Lot 4 and Lot 3 does comprise a patch of the TEC.	• The **Bi** vegetation in 'good' condition comprises 1.46 ha and does not independently meet this criterion. • The adjoining 2.47 ha of **Bi** vegetation in 'degraded - completely degraded' condition would be viewed as contiguous and part of the same patch. The representative condition of the patch would be 'degraded - completely degraded' based on the areas of each condition. Therefore the mapped 3.93 ha of **Bi** vegetation within Lot 106 does not comprise a patch of the TEC.
4. Must incorporate surrounding context	• Breaks (e.g. tracks) < 30 m do not separate vegetation into separate patches • Buffer zones may apply (20-50 m recommended from patch edge) • The site should be thoroughly sampled (2 surveys in same spring). • Survey timing should be appropriate. • Surrounding environment should be considered (e.g. connectivity, conservation values, fauna habitat)	• Tracks exist within and surrounding the patch. • Land surrounding the patch is a combination of agricultural and native vegetation. • This spring survey was conducted over four days in the same spring, in October and November. • Spring survey timing is appropriate. • Intact native vegetation that is likely to meet criteria as banksia woodland exists on the other side of Maralla Road.	• Tracks exist within and surrounding the patch. A small area of **Ac** vegetation is present to the east of the patch but is separated by over 30 m. • Land surrounding the patch is a combination of agricultural and native vegetation. • This spring survey was conducted over four days in the same spring, in October and November. • Spring survey timing is appropriate. • No intact native vegetation that is likely to meet criteria as banksia woodland is located close to the **BaBm** and **Bi** vegetation in Lots 3 and 4.	• Tracks exist within and surrounding the patch. • Land surrounding the patch is a combination of agricultural and native vegetation. • This spring survey was conducted over four days in the same spring, in October and November. • Spring survey timing is appropriate. • No intact native vegetation that is likely to meet criteria as banksia woodland is located close to the **Bi** vegetation.

4.3.5 Locally and regionally significant vegetation

Wetlands and associated intact native vegetation present within the site may provide habitat for the 'critically endangered' western swamp tortoise and 'endangered' black striped minnow (Bamford Consulting Ecologists 2019).

A large number of mature eucalypt trees (diameter at breast height larger than 500 mm) including *Corymbia calophylla* (marri), *Eucalyptus rudis* (flooded gum) and *Eucalyptus marginata* (jarrah) are present in the site. Due to their number and size these trees have the potential to provide foraging, roosting and nesting habitat for black cockatoos (especially forest red-tailed black cockatoo), along with other ecological services (Bamford Consulting Ecologists 2019).

4.4 Species richness and sampling adequacy

A total of 158 species were recorded from 25 samples. A species accumulation curve derived from sample data is presented in **Plate 31**. After 25 samples the curve has not yet reached its asymptote but is increasing slowly. This indicates that only a proportion of species likely remain undetected by sampling.

Species richness was estimated in PRIMER v6 to be between 197 (Jacknife1) and 199 (Chao2). Based on the trend of the species accumulation curve approximately 30 to 40 samples would be required to capture that many species. Including the seven additional species recorded opportunistically, a total of 165 species was recorded in the site. This indicates that between 79 and 80% of the estimated 197-199 species in the site were recorded. Considering the degraded nature of the majority of the site and the time over multiple days spent sampling the intact areas of vegetation, the survey effort was considered to be adequate to prepare a representative species inventory.

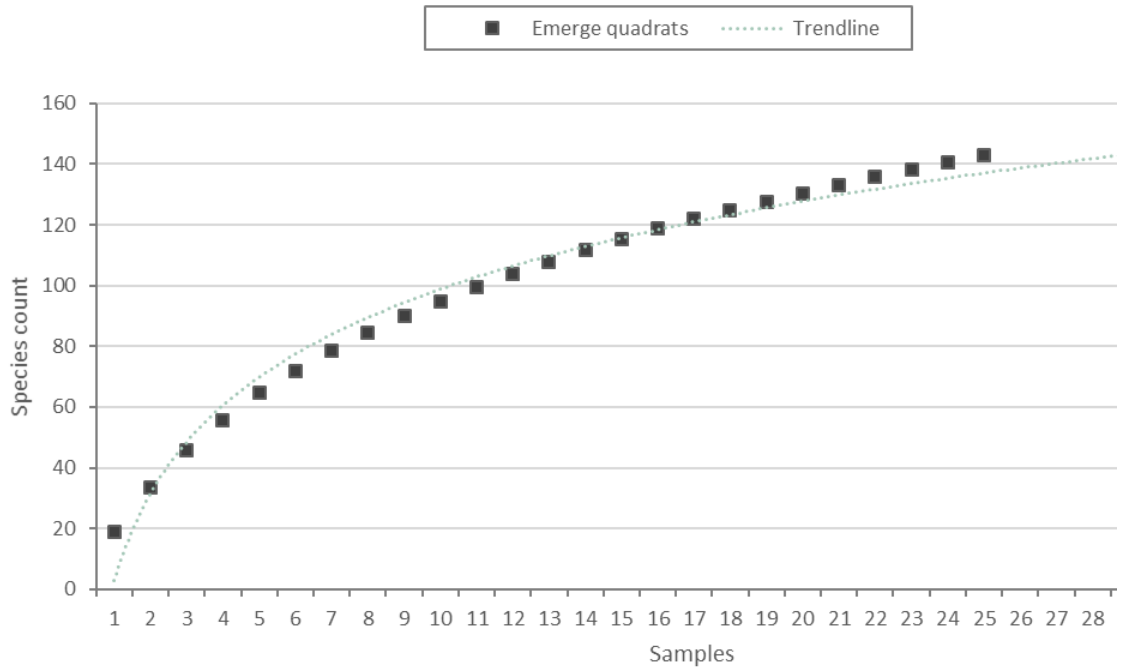

Plate 25: Species accumulation curve derived from sample data (y =44.174ln(x) + 2.6833, R^2 = 0.9798).

5 Discussion

The vegetation within the site has been subject to significant past disturbance and over two thirds of the site (337.73 ha) is covered by non-native vegetation in completely degraded condition.

The most intact native vegetation exists in the north western portion of the site where the plant communities **CcMp, CcTlLl**, **Mp** and a small area of **BaBm** are present.

Access was granted by landowners to the majority of lots containing native vegetation. Those lots that could not be accessed (as shown on **Figure 5**) were assessed over the boundary where possible and via interpretation of aerial photography. These lots have the potential to contain additional flora and vegetation values that could not be observed during this survey.

5.1 Threatened and priority flora

The record of *Stylidium paludicola* on the southern boundary of the site within the DBCA database was not considered to be accurate. The mapped location does not contain any intact native vegetation. The locality information for the record states that this occurrence is located within the Maralla Nature Reserve, which is located to the south of Maralla Road and not included within the site boundary. As such the location provided for this *S. paludicola* record is likely to be erroneous and any occurrence of this species is likely to be found further south and outside of the site boundary. The species was not recorded within the site.

No other threatened or priority flora species were recorded within the lots that could be accessed. The absence of the larger perennial species such as *Darwinia foetida* and *Andersonia gracilis* was relatively easy to confirm. However, due to their size and seasonality, smaller geophytic species such as *Caladenia huegelii* and *Thelymitra stellata* can be more difficult to detect.

Areas of intact vegetation within the site were traversed in detail over three survey days in October and November (within the main flowering period). *T. stellata* flowers from October to November, thus the timing was appropriate for the detection of this species (Western Australian Herbarium 2019). *C. huegelii* is found on sandy soils in banksia woodland, and typically flowers from September to October (Western Australian Herbarium 2019). Thus *C. huegelii* may have largely finished flowering at the time of the survey. It is notable that in 2018 many species in the south-west were still in flower later than usual due to the higher (albeit average) rainfall compared to previous years. A number of common orchids and geophytes were recorded during the survey, indicating that the timing was appropriate to detect these geophytic species. Thus should conservation significant geophytic species have been present it is likely that they would have been detected. However, such species may remain undetected within those lots that could not be accessed.

5.2 Vegetation condition

Much of the site has been subject to significant historical disturbance and was in completely degraded condition. Where native vegetation remains, it varied from comprising a highly limited range of native species with high weed loads to comprising a moderate native species diversity with low to moderate weed loads in good and very good condition.

Assigning condition using a categorical scale is always most difficult when vegetation qualities are close to the boundary between two categories. Categorical schemes may also invariably yield different results when applied by different assessors, because of differences in skill levels or personal bias.

A compound 'good - degraded' condition category was included as some vegetation was not able to be assessed in detail due to access restrictions. Where possible observation of the vegetation present was made from the boundary, thus canopy species and larger shrubs were observable, but is it possible that additional small herbaceous species were present that could not be seen. Further survey in these areas may determine that they are degraded if such species are limited.

A compound 'degraded - completely degraded' condition category was included in the results of this survey for disturbed vegetation which had relatively high native cover by a limited number of native species, but was otherwise completely degraded.

5.3 Threatened and priority ecological communities

The DBCA dataset of known TECs contains a record of 'SCP 18 - shrublands on calcareous silts of the Swan Coastal Plain' which is focused over Lot 12 in the centre of the site. This TEC is listed at the state level but is not listed at the Commonwealth level pursuant to the EPBC Act. The record of SCP18 in the site does not contain any collection information, but an occurrence of FCT 18 in the area is included within the *Weed and native flora data for the Swan Coastal Plain* dataset (Keighery *et al.* 2012). The *Weed and native flora data for the Swan Coastal Plain* dataset record (ELE13) indicates that the site was surveyed by E. Griffin in 1993. Historical aerials available for around this time (1985 and 1995) indicate that the area surveyed was almost entirely cleared in 1993. As such, the location of the record is not considered to be accurate. SCP18 is not considered to be present at the recorded location, or elsewhere within the site.

One Commonwealth listed TEC, banksia woodlands of the Swan Coastal Plain, was determined to occur within the site based on assessment against diagnostic features and thresholds.

5.3.1 Banksia woodlands of the Swan Coastal Plain TEC (Commonwealth)

The **BaBm** and **Bi** (and **Jf** and **Ac** to a lower extent) vegetation was determined to represent 'FCT 21c – low lying *Banksia attenuata* woodlands and shrublands', which is one of the regional FCTs identified in the banksia woodland TEC conservation advice (DoEE 2016). However, to be considered as the Commonwealth listed banksia woodland TEC a patch of banksia vegetation must also meet diagnostic characteristics and thresholds for condition and minimum patch size (refer to **Table 4**).

One diagnostic characteristic of the banksia woodland TEC is a tree(canopy) layer of particular banksia species. The **BaBm** and **Bi** vegetation includes this diagnostic feature with *Banksia attenuata*/*B. menziesii* and *Banksia ilicifolia* trees present. The **Jf** and **Ac** vegetation does not include this diagnostic tree layer. However, the conservation advice lists banksia canopy cover for the TEC as ranging from 2% to typically less than 50% (DoEE 2016). As such, the **Jf** and **Ac** vegetation is likely to meet the very lowest end of this range and would meet this diagnostic characteristic.

The DoEE (2016) conservation advice also states that a patch of banksia woodland vegetation in 'very good' or 'good' condition must be greater than 1 ha or 2ha in size respectively to be considered the

TEC. A patch may include areas of variable condition and the condition that is most representative should be used to assign overall condition of a patch (DoEE 2016).

The **BaBm**, **Bi, Jf** and **Ac** communities exist in six separate areas of the site that are each separated by over 30 m. As such each of these areas are considered to be separate patches. Two of the patches were clearly not considered to represent the banksia woodland TEC on the basis of their size or condition as discussed in **Section 4.3.4**. Two patches, within Lot 101 and Lot 3 and 4, met the criteria to represent the banksia woodland TEC. The two remaining patches are located within Lot 106 that was not accessible during the survey and of which one would require further investigation in order to confirm its status in relation to the banksia woodland TEC.

The **BaBm** vegetation within Lot 101 in the south western corner of the site was mainly mapped as being in 'good' condition (2.39 ha) with a small area (0.74 ha) in 'degraded' condition. This vegetation is connected to banksia woodland vegetation to the north and south, including a large area of banksia woodland to the south of Maralla Road within Bush Forever Site 300, which appears to be in 'good' or better condition. As there are no breaks of 30 m or more, the **BaBm** vegetation within Lot 101 and the adjacent vegetation was understood to comprise a single patch. Given that the area of **BaBm** in 'good' condition is over the 2 ha threshold and is connected to vegetation in 'good' or better condition to the south, the **BaBm** and **Jf** vegetation in Lot 101 comprises 8.22 ha of the banksia woodland TEC, which is part of a larger patch of the TEC.

The **BaBm** and **Bi** vegetation within Lot 3 and 4 was mapped as being in 'very good' and 'good' condition. As there are no breaks of 30 m or more to separate the areas of vegetation, these areas were understood as a single patch. The **BaBm** and **Bi** vegetation in these lots is not connected to any other banksia woodland vegetation. The **BaBm** and **Bi** vegetation in these lots meets the 1 ha threshold for 'very good' condition and is therefore considered to be a 1.13 ha patch of the banksia woodland TEC.

The two patches within Lot 106 could not be accessed. Based on its size and features viewed from outside of the lot, the western patch is considered to potentially represent the banksia woodland TEC but requires further investigation. The eastern patch within Lot 106 could be viewed from Sawpit Road and, as discussed in **Section 4.3.4**, does not meet the size and condition criteria to be considered a patch of the banksia woodland TEC.

Despite qualifying as a remnant of the TEC, given their small size and relatively disturbed state, the patches within Lot 101 and Lot 3 and 4 are unlikely to be considered particularly significant remnants of banksia woodland.

5.3.2 Banksia dominated woodlands of the Swan Coastal Plain IBRA region PEC (State)

Due to the presence of *Banksia attenuata* and *B. menziesii,* on deep sands, the **BaBm** and **Bi** communities also represents the State listed PEC 'Banksia dominated woodlands of the Swan Coastal Plain IBRA region'. Conservation advice for PECs is less specific than that for TECs, but it is likely that only the area of **BaBm** and **Bi** vegetation in 'good' condition would be consider to represent this PEC. The **Ac** vegetation in Lot 106 could not be assessed and may represent this PEC, depending on species composition.

5.4 Local and regional significance

The numerous large, mature marri and jarrah trees within areas of vegetation within the site are likely to be locally and/or regionally significant as potential habitat for threatened species of black cockatoo (Bamford Consulting Ecologists 2019)

Wetlands and associated intact native vegetation present within the site may provide habitat for the 'critically endangered' western swamp tortoise or the 'endangered' black striped minnow (Bamford Consulting Ecologists 2019).

6 Conclusions

The majority of vegetation within the site is highly disturbed and modified. Approximately 337.73 ha of the site contains completely degraded, non-native vegetation. The remaining 70.68 ha of the site includes native vegetation that is present in predominantly 'degraded – completely degraded' (26.32 ha), 'degraded' (25.86 ha) or 'good – degraded' (18.50 ha) condition. However, the site contains some areas of relatively intact native vegetation in 'good' (19.54 ha) and 'very good' (24.48 ha) condition, particularly in Lot 5 in the northern portion of the site.

No threatened or priority flora species were recorded or are considered likely to occur within the parts of the site that were accessed.

The site contains a 1.13 ha patch of the Commonwealth listed TEC 'banksia woodlands of the Swan Coastal Plain' in Lots 3 and 4. In addition, the **BaBm** and **Jf** vegetation in Lot 101 contributes 8.22 ha to a larger patch of the same Commonwealth listed banksia woodland TEC, which extends beyond the site to the south of Maralla Road and includes vegetation within Bush Forever Site 300. The site also supports three patches of the State listed PEC 'banksia dominated woodlands of the Swan Coastal Plain IBRA region'), which comprises 5.72 ha in total.

Numerous large remnant native trees across the site may be locally or regionally significant due to their potential to provide black cockatoo habitat. The wetlands and associated intact native vegetation present within the site may also provide habitat for the western swamp tortoise and the black striped minnow.

7 References

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Figures

Figure 1: Site Location

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Figure 5: Site Access

Figure 6: Plant Communities

Figure 7: Vegetation Condition

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Figure 9: Threatened and Priority Ecological Communities

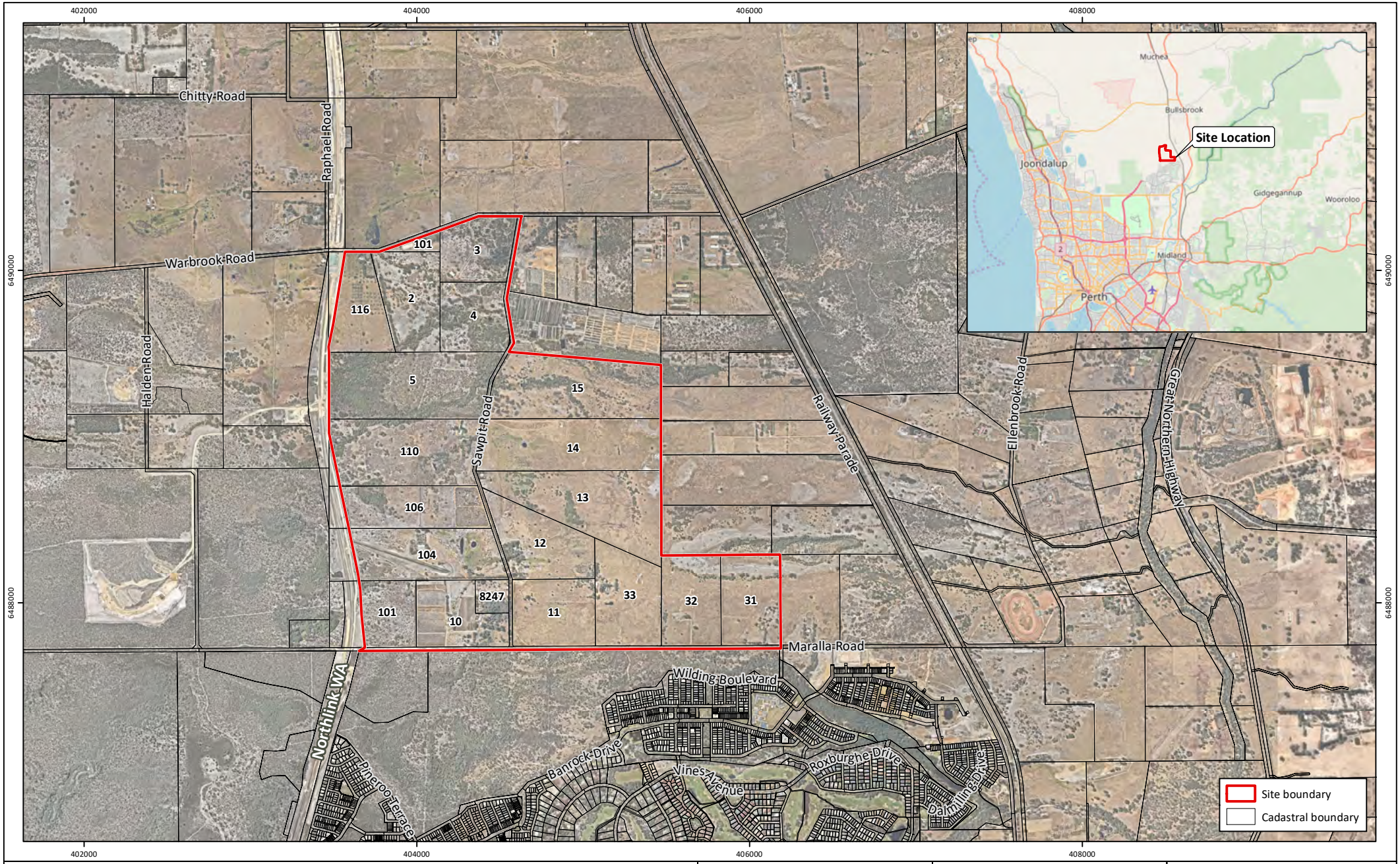

Figure 1: Site Location

Project:	Flora and Vegetation Assessment North Ellenbrook Environmental Support
Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
EP18-018(04)--F42a

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Date:	06/12/2019
Checked:	RAW
Approved:	TAA
Date:	18/12/2019

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GDA 1994 MGA Zone 50

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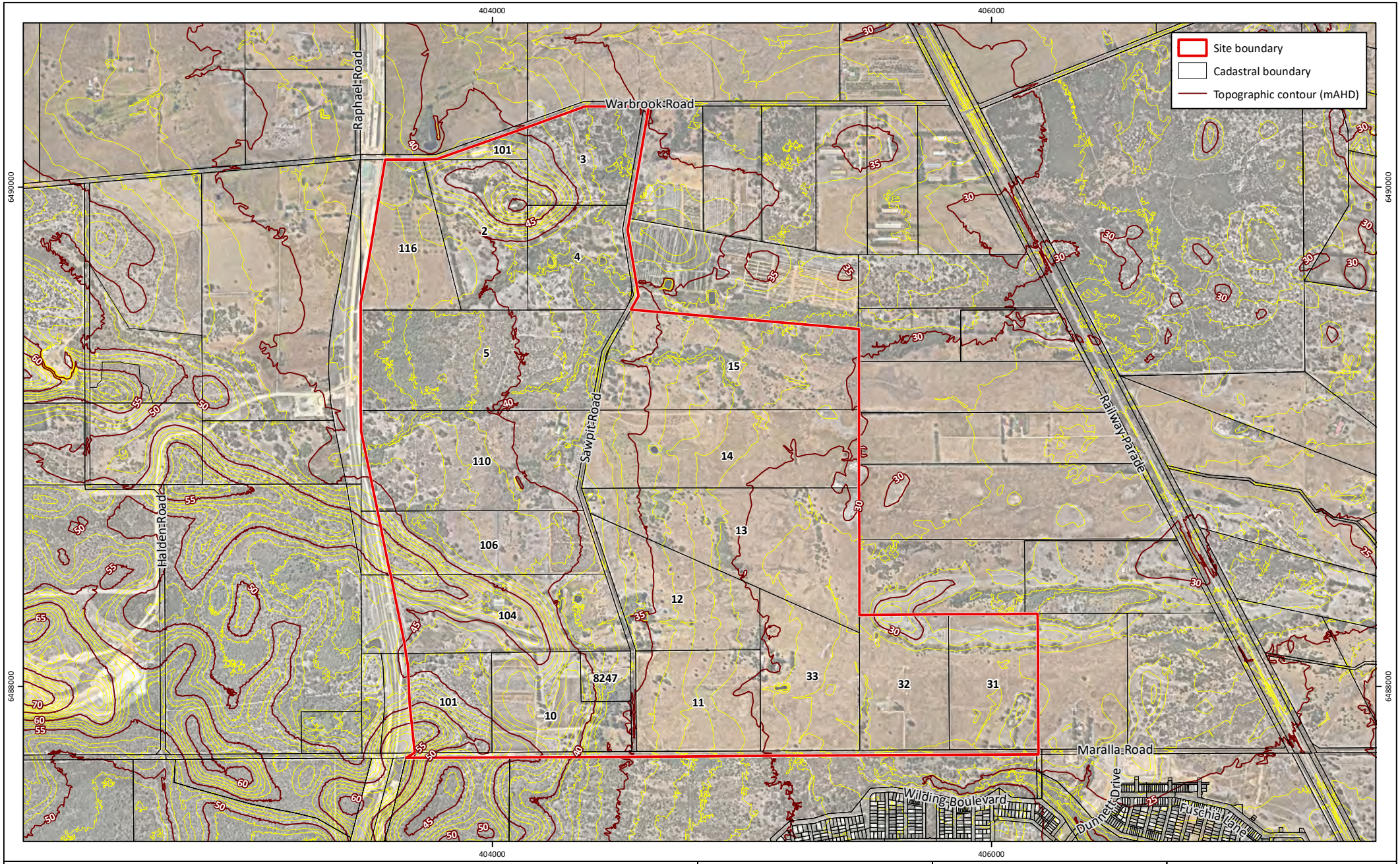

Figure 2: Topography

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Client:	Lendlease Communities (Ellenbrook) Pty Ltd

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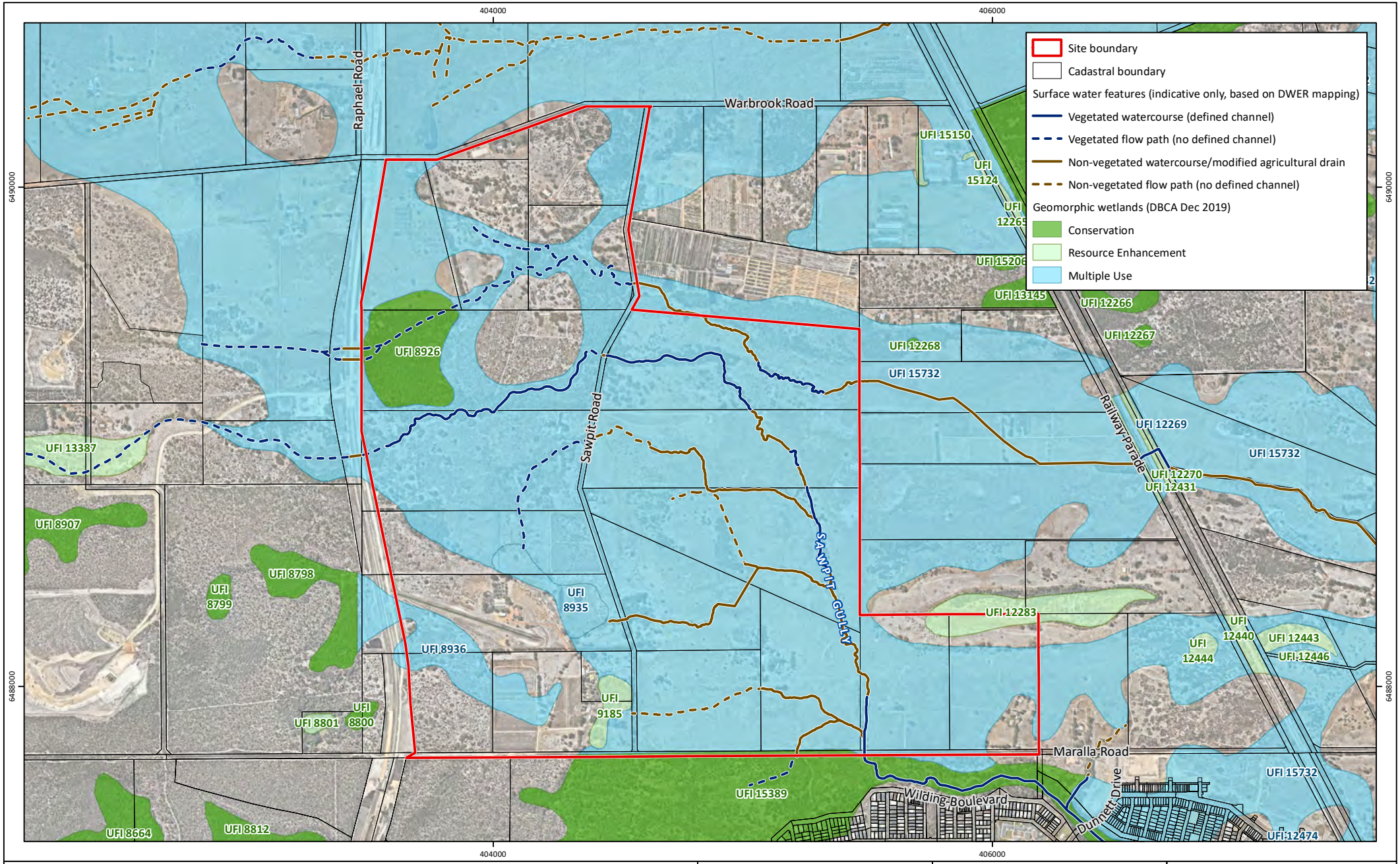

Figure 3: Hydrological Features

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Client:	Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
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Approved:	TAA
Date:	18/12/2019

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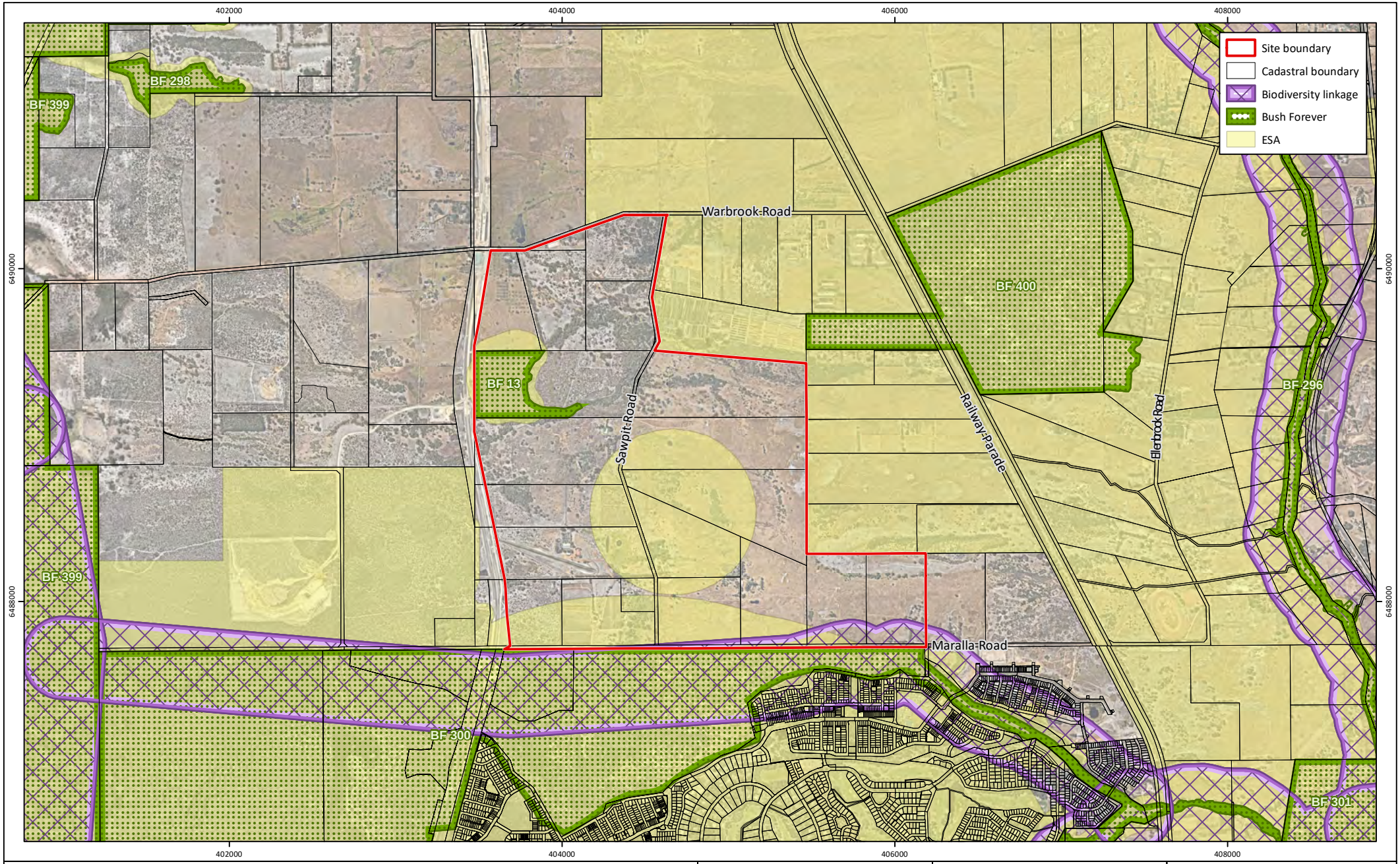

Figure 4: Environmental Features

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North Ellenbrook Environmental Support
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
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Approved:	TAA
Date:	18/12/2019

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GDA 1994 MGA Zone 50

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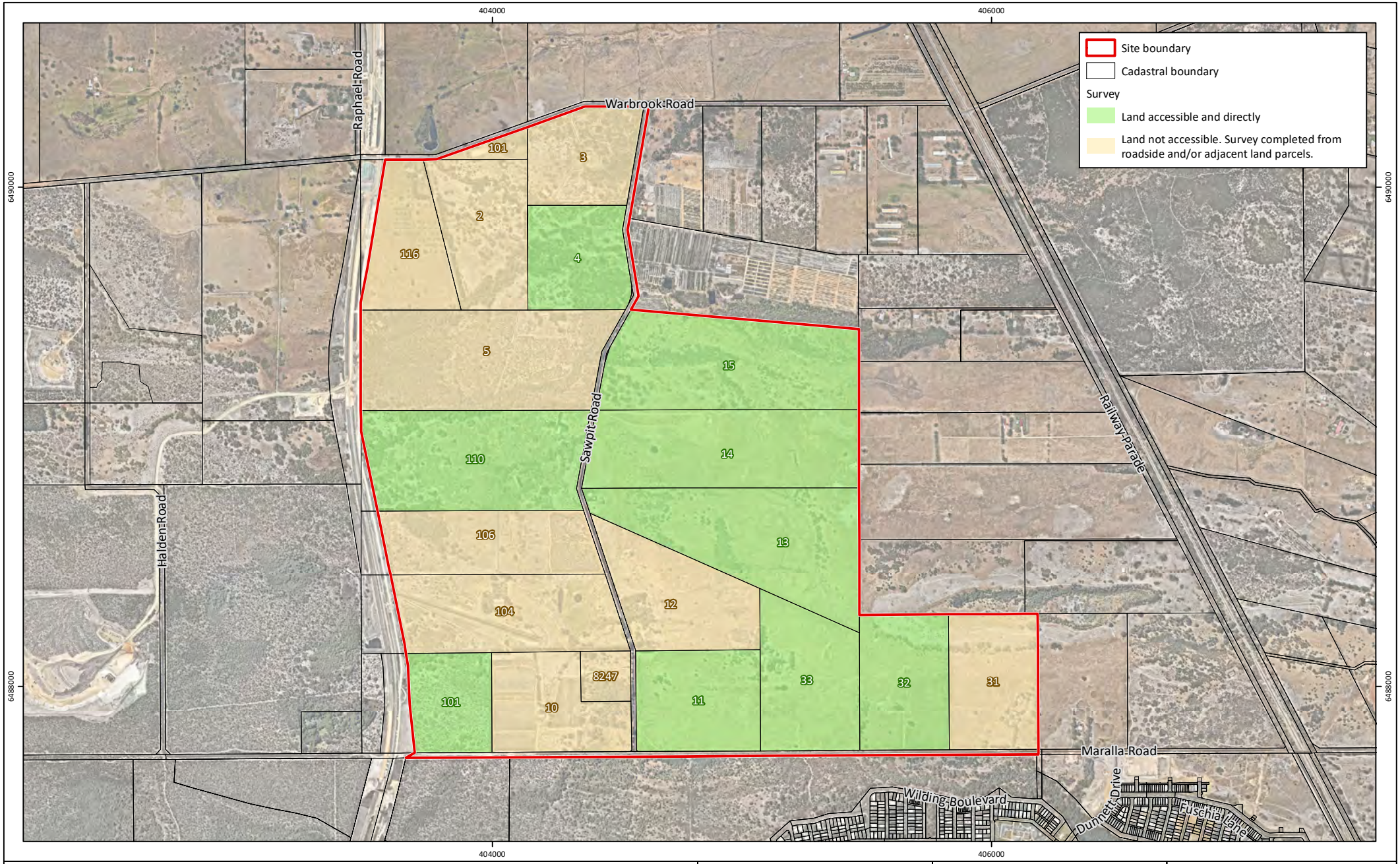

Figure 5: Survey Access

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Client:	Lendlease Communities (Ellenbrook) Pty Ltd

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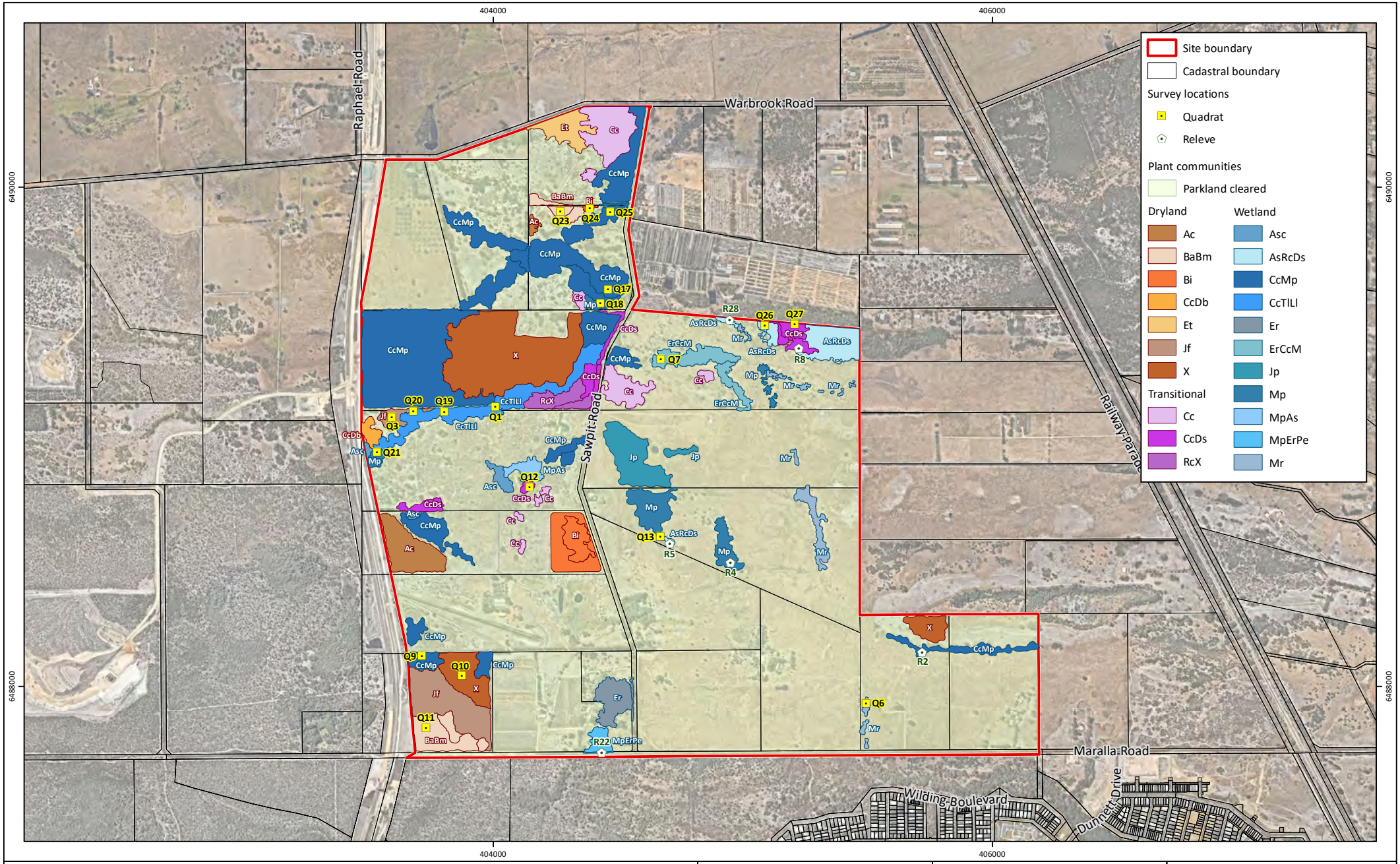

Figure 6: Plant Communities

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Date:	18/12/2019

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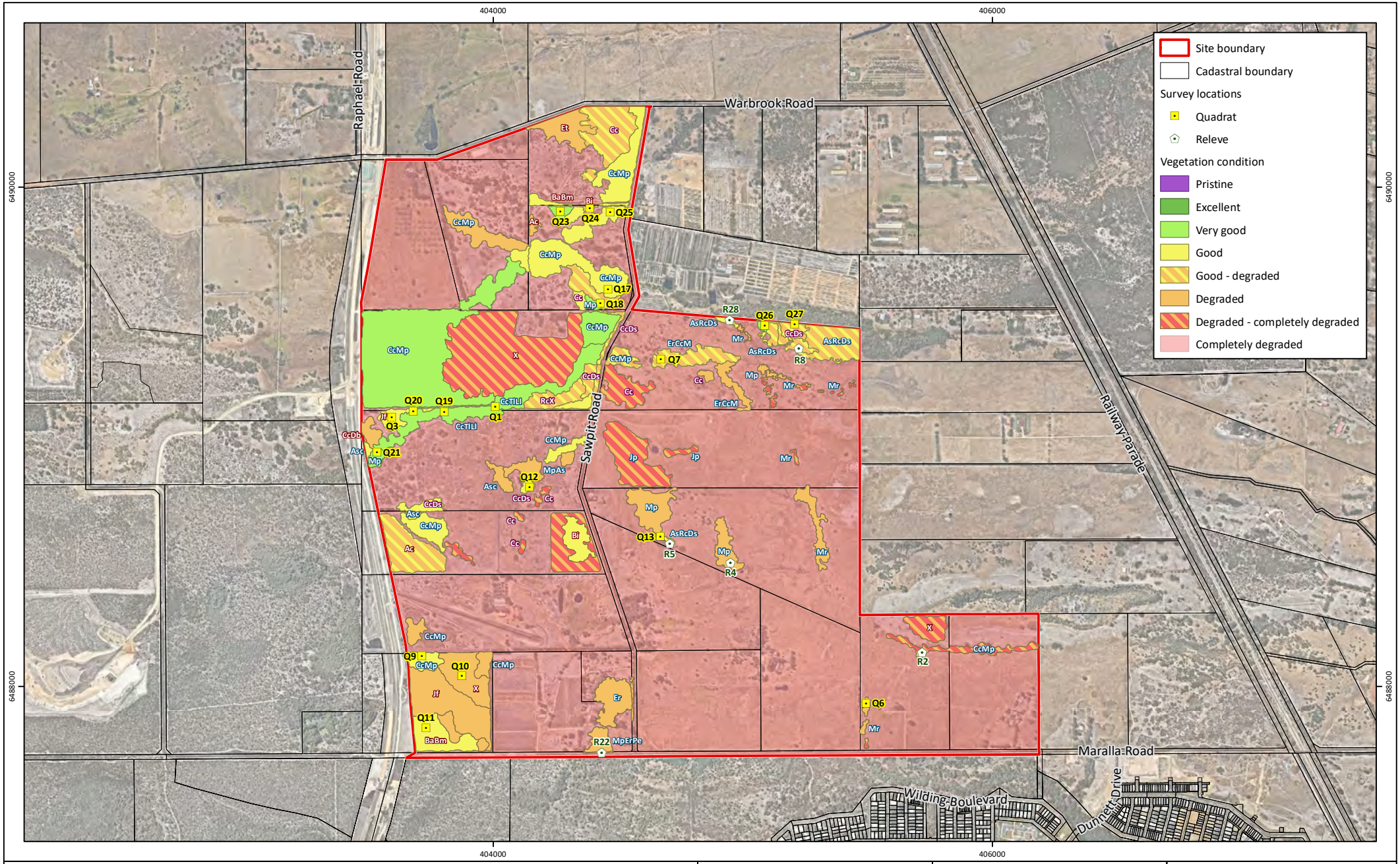

Figure 7: Vegetation Condition

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Date:	06/12/2019
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Approved:	TAA
Date:	18/12/2019

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GDA 1994 MGA Zone 50

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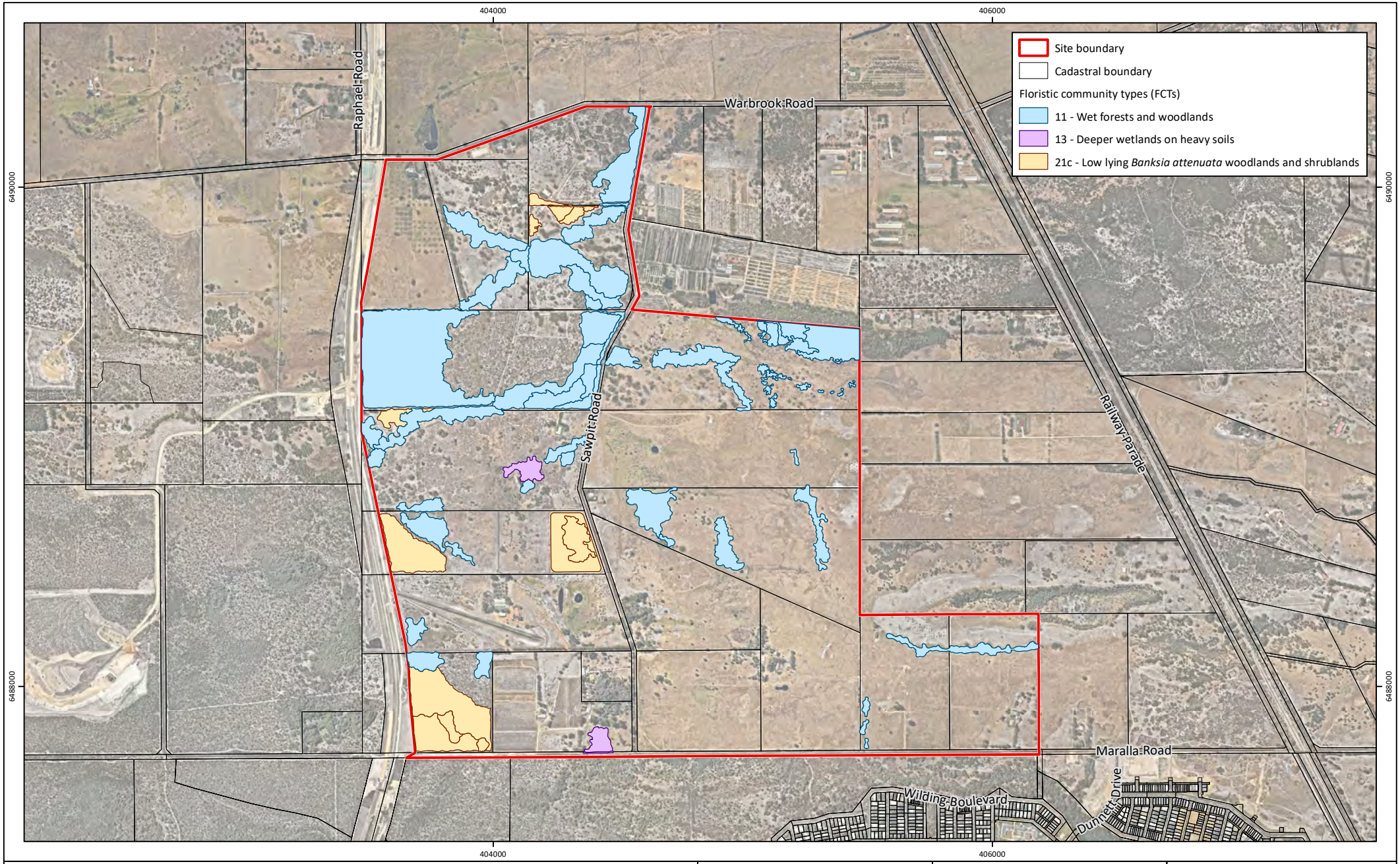

Figure 8: Floristic Community Types (FCTs)

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North Ellenbrook Environmental Support
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
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Drawn: KNM
Date: 09/12/2019
Checked: RAW
Approved: TAA
Date: 18/12/2019

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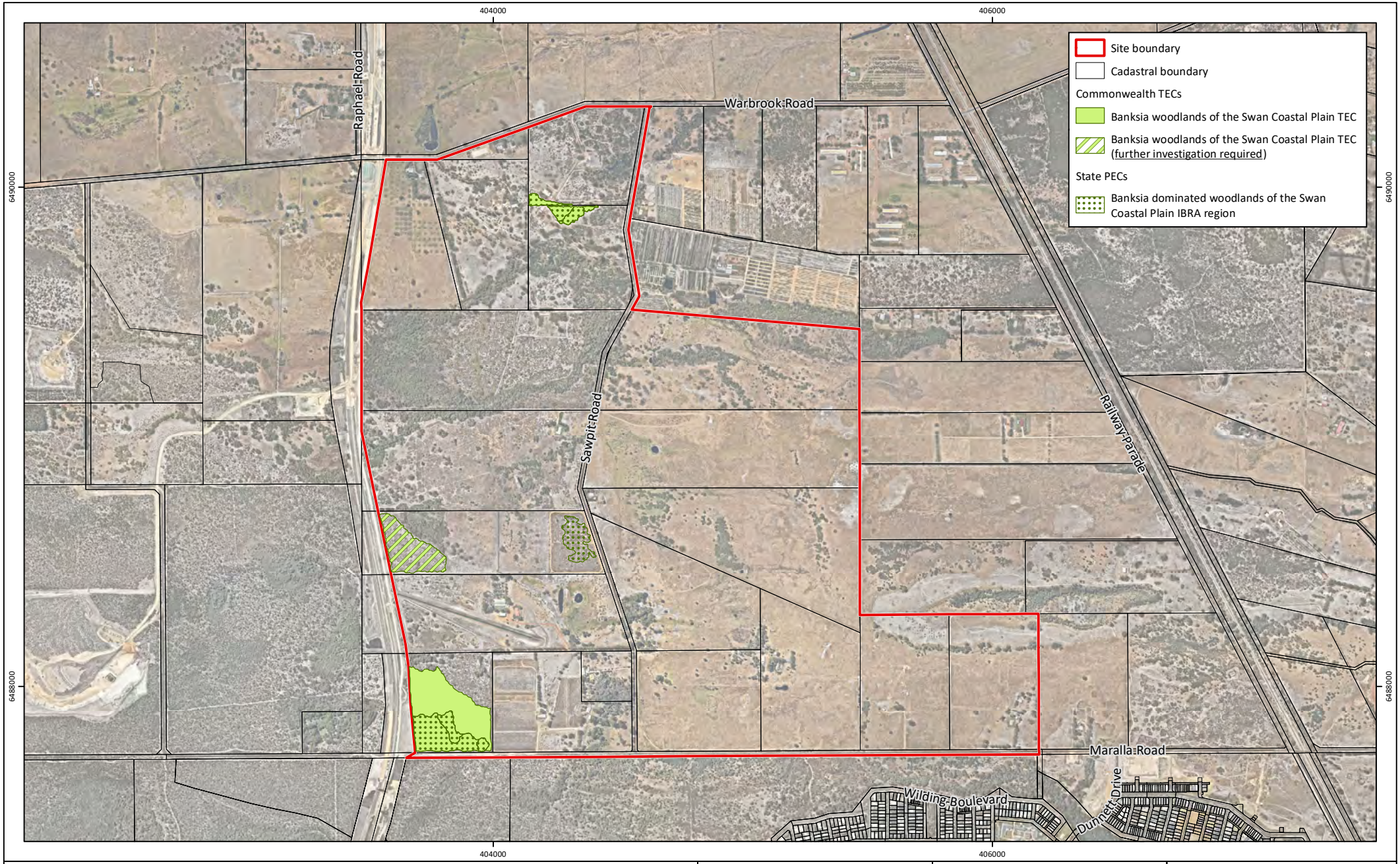

Figure 9: Threatened and Priority Ecological Communities

Project: Flora and Vegetation Assessment
North Ellenbrook Environmental Support
Client: Lendlease Communities (Ellenbrook) Pty Ltd

Plan Number:
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Date: 09/12/2019
Checked: RAW
Approved: TAA
Date: 18/12/2019

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Metres
Scale: 1:20,000@A4
GDA 1994 MGA Zone 50

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Appendix A

Additional Background Information

Conservation Significant Flora and Vegetation

Threatened and priority flora

Flora species considered rare or under threat warrant special protection under Commonwealth and/or State legislation. At the Commonwealth level, flora species can be listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Flora species considered 'threatened' pursuant to Schedule 1 of the EPBC Act are assigned categories according to their conservation status, as outlined in **Table 1**.

In Western Australia, plant taxa may be classed as 'threatened' under the *Biodiversity Conservation Act 2016* (BC Act) which is enforced by Department of Biodiversity Conservation and Attractions (DBCA). Threatened flora species are listed under sections 19(1) and 26(2) of the BC Act. It is an offence to 'take' or disturb threatened flora without Ministerial approval. Section 5(1)1 of the Act defines to take as including "… to gather, pluck, cut, pull up, destroy, dig up, remove, harvest or damage flora by any means" or to cause or permit the same to be done. The definition of threatened flora under the BC Act is provided in **Table 1**.

Section 43 of the BC Act requires that an occurrence of a threatened species or threatened ecological community is reported to DBCA where the occurrence has been identified as part of field work completed:

- as part of an assessment under Part IV of the *Environmental Protection Act 1986*; or
- in relation to an application for a clearing permit under the *Environmental Protection Act 1986* section 51E(1)(d).

Penalties apply to individuals and organisations that fail to provide accurate reports of threatened species or communities.

The *Biodiversity Conservation Regulations 2018* (BC Regulations 2018) came into effect on January 1 2019. The BC Regulations include provisions for licencing, charges, penalties and other provisions associated with the BC Act.

Flora species that may be threatened or near threatened but lack sufficient information to be listed under the BC Act may be added to the DBCA's *Priority Flora List* (DBCA 2018c). Priority flora species are considered during State approval processes. Priority flora categories and definitions are listed in **Table 1**.

Table 1: Definitions of conservation significant flora species pursuant to the EPBC Act and BC Act and on DBCA's Priority Flora List (DBCA 2018c)

Conservation code	Description
EX†	Threatened Flora – Presumed Extinct Taxa which have not been collected, or otherwise verified, over the past 50 years despite thorough searching, or of which all known wild populations have been destroyed more recently, and have been gazetted as such.
T^†	Threatened Flora – Extant Taxa which are declared to be likely to become extinct or is rare, or otherwise in need of special protection.
CR^	Threatened Flora – Critically Endangered Taxa which are considered to be facing an extremely high risk of extinction in the wild.
EN^	Threatened Flora – Endangered Taxa which are considered to be facing a very high risk of extinction in the wild.
VU^	Threatened Flora – Vulnerable Taxa which are considered to be facing a high risk of extinction in the wild.
P1	Priority One – Poorly Known Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat e.g. road verges, urban areas, farmland, active mineral leases etc., or the plants are under threat, e.g. from disease, grazing by feral animals etc. May include taxa with threatened populations on protected lands. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey.
P2	Priority Two – Poorly Known Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat (i.e. not currently endangered). Such taxa are under consideration for declaration as 'rare flora', but urgently need further survey.
P3	Priority Three – Poorly Known Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora' but needs further survey.
P4	Priority Four – Rare Taxa which are considered to have been adequately surveyed and which, whilst being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years.

^pursuant to the EPBC Act, †pursuant to the BC Act, on DBCA's *Priority Flora List*

Threatened and priority ecological communities

'Threatened ecological communities' (TECs) are recognised as ecological communities that are rare or under threat and therefore warrant special protection. Selected TECs are afforded statutory protection at a Commonwealth level under section 181 of the EPBC Act. TECs nominated for listing under the EPBC Act are considered by the Threatened Species Scientific Committee and a final decision is made by the Commonwealth Minister for the Environment and Energy. Once listed under the EPBC Act, communities are categorised as either 'critically endangered', 'endangered' or 'vulnerable' as defined in **Table 2**. Any action likely to have a significant impact on a community listed under the EPBC Act requires approval from the Minister for the Environment and Energy.

Within Western Australia TECs are determined by the Western Australian Threatened Ecological Communities Scientific Advisory Committee (WATECSAC) and endorsed by the State Minister for the Environment. The WATECSAC is an independent group comprised of representatives from organisations including tertiary institutions, the Western Australian Museum and DBCA. The TECs endorsed by the State Minister are published by DBCA (DBCA 2018b).

TECs are assigned to one of the categories outlined in **Table 2** according to their status (in relation to the level of threat). TECs will be afforded direct statutory protection at a State level under the BC Act and BC Regulations. Ecological communities are listed under Section 27(1) and 33 of the BC Act. Their significance is also acknowledged through other state environmental approval processes such as 'environmental impact assessment' pursuant to Part IV of the *Environmental Protection Act 1986* (EP Act) and the *Environmental Protection (Clearing of Native Vegetation) Regulations 2004*.

Table 2: Categories of threatened ecological communities (English and Blyth 1997; DEC 2009).

Conservation code	Description
PD	Presumably Totally Destroyed An ecological community that has been adequately searched for but for which no representative occurrences have been located.
CE	Critically Endangered An ecological community that has been adequately surveyed and is found to be facing an extremely high risk of total destruction in the immediate future.
E	Endangered An ecological community that has been adequately surveyed and is not critically endangered but is facing a very high risk of total destruction in the near future.
V	Vulnerable An ecological community that has been adequately surveyed and is not critically endangered or endangered but is facing a high risk of total destruction or significant modification in the medium to long-term future.

An ecological community that is under consideration for listing as a TEC, but does not yet meet survey criteria or has not been adequately defined may be listed as a 'priority ecological community' (PEC). PECs are categorised as priority category 1, 2 or 3 as described in **Table 3**. Ecological communities that are adequately known and are rare but not threatened, or meet criteria for 'near threatened', or that have been recently removed from the threatened list, are placed in 'priority 4'. These ecological communities require regular monitoring. Conservation dependent ecological communities are placed in 'priority 5' (DEC 2009). Listed PECs are published by DBCA (DBCA 2017b).

Table 3: Categories of priority ecological communities (DEC 2009).

Priority code	Description
P1	Priority One Ecological communities with apparently few, small occurrences, all or most not actively managed for conservation (e.g. within agricultural or pastoral lands, urban areas, active mineral leases) and for which current threats exist. Communities may be included if they are comparatively well-known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under immediate threat from known threatening processes across their range.
P2	Priority Two Communities that are known from few small occurrences, all or most of which are actively managed for conservation (e.g. within national parks, conservation parks, nature reserves, State forest, unallocated Crown land, water reserves, etc.) and not under imminent threat of destruction or degradation. Communities may be included if they are comparatively well known from one or more localities but do not meet adequacy of survey requirements, and/or are not well defined, and appear to be under threat from known threatening processes.
P3	Priority Three Communities that are known from several to many occurrences, a significant number or area of which are not under threat of habitat destruction or degradation or: (i) communities known from a few widespread occurrences, which are either large or within significant remaining areas of habitat in which other occurrences may occur, much of it not under imminent threat, or; (ii) communities made up of large, and/or widespread occurrences, that may or not be represented in the reserve system, but are under threat of modification across much of their range from processes such as grazing by domestic and/or feral stock, and inappropriate fire regimes. Communities may be included if they are comparatively well known from several localities but do not meet adequacy of survey requirements and/or are not well defined, and known threatening processes exist that could affect them.
P4	Priority Four Ecological communities that are adequately known, rare but not threatened or meet criteria for Near Threatened or that have been recently removed from the threatened list. These communities require regular monitoring.
P5	Priority Five Ecological communities that are not threatened but are subject to a specific conservation program, the cessation of which would result in the community becoming threatened within five years.

Weeds

A number of legislative and policy documents exist in relation to weed management at state and national levels. The *Biosecurity and Agriculture Management Act 2007* (BAM Act) is the principle legislation guiding weed management in Western Australia and lists declared pest species. At a national level, the Australian government has compiled a list of 32 Weeds of National Significance (WoNS) (DoEE 2018), of which many are also listed under the BAM Act.

Declared Pests

Part 2.3.23 of the BAM Act requires a person must not; "*a) keep, breed or cultivate the declared pest; b) keep, breed or cultivate an animal, plant or other thing that is infected or infested with the declared pest; c) release into the environment the declared pest, or an animal, plant or other thing that is infected or infested with the declared pest; or d) intentionally infect or infest, or expose to infection or infestation, a plant, animal or other thing with a declared pest*".

Under the BAM Act, all declared pests are assigned a legal status, as described in **Table 4**. Species assigned to the 'declared pest, prohibited - s12' category are placed in one of three control categories, as described in

Table 5.

The *Biosecurity and Agriculture Management Regulations 2013* specify keeping categories for species assigned to the 'declared pest - s22(2)' category, which relate to the purposes of which species can be kept, as well as the entities that can keep them. The categories are described in

Table *6*.

The Western Australian Organism List (WAOL) provides the status of organisms which have been categorised under the BAM Act (DAFWA 2016).

Table 4: Legal status of declared pest species listed under the BAM Act (DAFWA 2016).

Category	Description
Declared Pest Prohibited - s12	May only be imported and kept subject to permits. Permit conditions applicable to some species may only be appropriate or available to research organisations or similarly secure institutions.
Declared Pest s22(2)	Must satisfy any applicable import requirements when imported, and may be subject to an import permit if they are potential carriers of high-risk organisms. They may also be subject to control and keeping requirements once within Western Australia

Table 5: Control categories of declared pest species listed under the BAM Act (DAFWA 2016).

Category	Description
C1	Exclusion Not established in Western Australia and control measures are to be taken, including border checks, in order to prevent them entering and establishing in the State.
C2	Eradication Present in Western Australia in low enough numbers or in sufficiently limited areas that their eradication is still a possibility.
C3	Management Established in Western Australia but it is feasible, or desirable, to manage them in order to limit their damage. Control measures can prevent a C3 pest from increasing in population size or density or moving from an area in which it is established into an area which currently is free of that pest.

Table 6: Keeping categories of declared pest species listed under the BAM Act (DAFWA 2016).

Category	Description
Prohibited	Can only be kept under a permit for public display and education purposes, and/or genuine scientific research, by entities approved by the state authority.
Exempt	No permit or conditions are required for keeping.
Restricted	Organisms which, relative to other species, have a low risk of becoming a problem for the environment, primary industry or public safety and can be kept under a permit by private individuals.

Wetland Habitat

Geomorphic wetland types

On the Swan Coastal Plain DBCA (2017a) have used the geomorphic wetland classification system developed by Semeniuk (1987) and Semeniuk and Semeniuk (1995) to classify wetlands based on the landform shape and water permanence (hydro-period) as outlined in **Table 7**.

Table 7: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017a)

Level of inundation	Geomorphology			
	Basin	Flat	Channel	Slope
Permanently inundated	Lake	-	River	-
Seasonally inundated	Sumpland	Floodplain	Creek	-
Seasonally waterlogged	Dampland	Palusplain	-	Paluslope

Wetland management categories

DBCA maintains the *Geomorphic Wetland of the Swan Coastal Plain* dataset (DBCA 2018a), which also categorises individual wetlands into specific management categories as described in **Table 8**.

Table 8: Geomorphic Wetlands of the Swan Coastal Plain classification categories (DBCA 2017a)

Management category	Description of wetland	Management objectives
Conservation (CCW)	Support high levels of attributes	Preserve wetland attributes and functions through reservation in national parks, crown reserves and state owned land. Protection provided under environmental protection policies.
Resource enhancement (REW)	Partly modified but still supporting substantial functions and attributes	Restore wetland through maintenance and enhancement of wetland functions and attributes. Protection via crown reserves, state or local government owned land, environmental protection policies and sustainable management on private properties.
Multiple use (MUW)	Few wetland attributes but still provide important hydrological functions	Use, development and management considered in the context of water, town and environmental planning through land care.

The management categories of wetland features are determined based on hydrological, biological and human use features. The DBCA document *A methodology for the evaluation of specific wetland types on the Swan Coastal Plain, Western Australia* (DBCA 2017a) details the methodology by which wetlands on the Swan Coastal Plain are assigned management categories based on a two tiered evaluation system, with preliminary and secondary evaluation stages. The preliminary evaluation aims to identify any features of conservation significance that would immediately place the wetland within the CCW management category. Examples of these significant features include presence on significant wetland lists, presence of TECs or PECs (Priority 1 and 2), presence of threatened flora and

over 90% of vegetation in good or better condition based on the Keighery (1994) scale. If such environmental values are identified the wetland would be categorised as CCW without further evaluation.

Should the preliminary evaluation indicate that no such features occur, the secondary evaluation and site assessment are then applied. In the secondary evaluation, an appropriate management category is determined through the assessment of a range of environmental attributes, functions and values.

Wetland reclassification

DBCA have a protocol for proposing changes to the wetland boundaries and management categories of the existing geomorphic wetland dataset (DEC 2007). The procedure involves a wetland desktop evaluation and site assessment which culminates in a recommended management category. Relevant information should be obtained in the optimal season for vegetation condition and water levels, which is usually spring (DEC 2007). In the case of larger wetlands that have undergone a degree of disturbance, a separate management category may be assigned to parts of the wetland in order to reflect the current values.

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Appendix B

Species Lists

Flora Taxa List - Various Lots, North Ellenbrook

Note: * denotes introduced (weed) species, D denotes 'declared pest' species, P denotes planted native species that would not naturally occur in the area.

Family		Species
Aizoaceae		
	*	*Carpobrotus edulis*
Anacardiaceae		
	*	*Schinus terebinthifolia*
Anarthriaceae		
		Lyginia imberbis
Apiaceae		
		Centella asiatica
Araceae		
	D	*Zantedeschia aethiopica*
Araliaceae		
		Trachymene pilosa
Asparagaceae		
	D	*Asparagus asparagoides*
		Laxmannia squarrosa
		Lomandra caespitosa
		Lomandra hermaphrodita
		Lomandra sp.
		Sowerbaea laxiflora
		Thysanotus sp.
Asteraceae		
	*	*Arctotheca calendula*
	*	*Cotula coronopifolia*
	*	*Hypochaeris glabra*
		Podotheca gnaphalioides
	*	*Sonchus oleraceus*
	*	*Ursinia anthemoides*
Campanulaceae		
		Lobelia anceps
	*	*Wahlenbergia capensis*
Casuarinaceae		
		Allocasuarina fraseriana
		Allocasuarina humilis
Centrolepidaceae		
		Aphelia cyperoides
		Aphelia drummondii

Flora Taxa List - Various Lots, North Ellenbrook

Note: * denotes introduced (weed) species, D denotes 'declared pest' species, P denotes planted native species that would not naturally occur in the area.

Family		Species
		Centrolepis aristata
Colchicaceae		
		Burchardia congesta
Crassulaceae		
		Crassula colorata var. *colorata*
Cyperaceae		
		Baumea ?riparia
		Baumea vaginalis
	*	*Cyperus congestus*
		Gahnia trifida
		Isolepis cernua
		Isolepis marginata
	*	*Isolepis prolifera*
		Isolepis stellata
		Lepidosperma longitudinale
		Schoenus efoliatus
Dasypogonaceae		
		Dasypogon bromeliifolius
Dennstaedtiaceae		
		Pteridium esculentum
Dilleniaceae		
		Hibbertia hypericoides
		Hibbertia racemosa
Droseraceae		
		Drosera erythrorhiza
		Drosera gigantea
		Drosera glanduligera
		Drosera macrantha
Ericaceae		
		Astroloma xerophyllum
		Croninia kingiana
		Leucopogon ?australis
		Leucopogon conostephioides
Fabaceae		
	*	*Acacia iteaphylla*
	*	*Acacia longifolia*
		Acacia pulchella var. pulchella

Flora Taxa List - Various Lots, North Ellenbrook

Note: * denotes introduced (weed) species, D denotes 'declared pest' species, P denotes planted native species that would not naturally occur in the area.

Family		Species
		Acacia saligna
		Aotus gracillima
	*	*Chamaecytisus palmensis*
		Daviesia triflora
		Gastrolobium ebracteolatum
		Gompholobium tomentosum
		Hardenbergia comptoniana
		Jacksonia floribunda
		Jacksonia furcellata
		Jacksonia sternbergiana
		Kennedia prostrata
	*	*Lotus subbiflorus*
	*	*Lupinus angustifolius*
	*	*Ornithopus compressus*
	*	*Trifolium arvense*
	*	*Trifolium campestre*
	*	*Vicia sativa*
Geraniaceae		
	*	*Pelargonium capitatum*
Goodeniaceae		
		Dampiera linearis
Haemodoraceae		
		Anigozanthos humilis subsp. humilis
		Conostylis aculeata
		Conostylis setigera
		Haemodorum spicatum
		Phlebocarya ciliata
Hemerocallidaceae		
		Arnocrinum preissii
		Tricoryne elatior
Iridaceae		
	*	*Gladiolus caryophyllaceus*
	*	*Hesperantha falcata*
	D	*Moraea flaccida*
		Patersonia occidentalis
	*	*Romulea rosea*
	*	*Watsonia meriana*
Juncaceae		
	*	*Juncus bufonius*
		Juncus pallidus

Flora Taxa List - Various Lots, North Ellenbrook

Note: * denotes introduced (weed) species, D denotes 'declared pest' species, P denotes planted native species that would not naturally occur in the area.

Family		Species
		Juncus pauciflorus
		Juncus subsecundus
Juncaginaceae		
		Cycnogeton lineare
Loranthaceae		
		Nuytsia floribunda
Molluginaceae		
		Macarthuria australis
Moraceae		
	*	*Ficus carica*
Myrtaceae		
		Astartea scoparia
		Calytrix angulata
		Calytrix flavescens
		Corymbia calophylla
		Eremaea pauciflora var. pauciflora
	*	*Eucalyptus camaldulensis*
	P	*Eucalyptus gomphocephala*
		Eucalyptus marginata
		Eucalyptus rudis
		Eucalyptus todtiana
		Hypocalymma angustifolium
		Melaleuca preissiana
		Melaleuca rhaphiophylla
		Melaleuca ryeae
		Pericalymma ellipticum
		Regelia ciliata
		Scholtzia involucrata
		Taxandria linearifolia
		Verticordia nitens
Oleaceae		
	*	*Olea europaea*
Orchidaceae		
		Caladenia latifolia
		Caladenia marginata
	*	*Disa bracteata*
		Microtis media subsp. media
		Pterostylis pyramidalis
		Thelymitra macrophylla

Flora Taxa List - Various Lots, North Ellenbrook

Note: * denotes introduced (weed) species, D denotes 'declared pest' species, P denotes planted native species that would not naturally occur in the area.

Family		Species
Orobanchaceae		
	*	*Orobanche minor*
Oxalidaceae		
	*	*Oxalis pes-caprae*
	*	*Oxalis purpurea*
Papaveraceae		
	*	*Fumaria capreolata*
Phytolaccaceae		
	*	*Phytolacca octandra*
Pinaceae		
	*	*Pinus* sp.
Poaceae		
	*	*Aira* sp.
		Austrostipa compressa
	*	*Avena barbata*
	*	*Briza maxima*
	*	*Briza minor*
	*	*Bromus diandrus*
	*	*Cynodon dactylon*
	*	*Ehrharta calycina*
	*	*Ehrharta longiflora*
	*	*Eragrostis curvula*
	*	*Holcus lanatus*
	*	*Lagurus ovatus*
	*	*Lolium rigidum*
		Microlaena stipoides
		Neurachne alopecuroidea
	*	*Poa annua*
	*	*Vulpia bromoides*
	*	*Vulpia myuros*
Polygonaceae		
	*	*Rumex acetosella*
	*	*Rumex vesicarius*
Primulaceae		
	*	*Lysimachia arvensis*
Proteaceae		
		Adenanthos cygnorum

Flora Taxa List - Various Lots, North Ellenbrook

Note: * denotes introduced (weed) species, D denotes 'declared pest' species, P denotes planted native species that would not naturally occur in the area.

Family		Species
		Banksia attenuata
		Banksia ilicifolia
		Banksia menziesii
		Hakea varia
		Petrophile linearis
		Stirlingia latifolia
Ranunculaceae		
	*	*Ranunculus muricatus*
Restionaceae		
		Desmocladus flexuosus
		Dielsia stenostachya
Rutaceae		
		Philotheca spicata
Santalaceae		
		Leptomeria cunninghamii
Solanaceae		
	D	*Solanum linnaeanum*
	*	*Solanum nigrum*
Stylidiaceae		
		Stylidium brunonianum
		Stylidium rigidulum
Xanthorrhoeaceae		
		Xanthorrhoea brunonis
		Xanthorrhoea preissii
Zamiaceae		
		Macrozamia riedlei

| | | Plant Community | | |

| | | Plant Community | | |

| | | Plant Community | | |

| | | Plant Community | | |

Appendix C

Sample Data

Vegetation Sample Data

Sample Name: Q1

Project no.: 18-018
Date: 12/10/2018
Author: SKP,TAA
Status Permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404009.1498	NW corner northing:	6489121.197
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	saturated	Landform:	waterway
Time since fire:	no evidence	Disturbance:	low - weeds, loss grazing
Soil type/texture	other/ with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	/
Litter:	5% (leaves,,)	Vegetation condition:	very good-

Strata	Cover (%)	Height (m)
Upper:	30 to 70	<10
Mid:	<10	0
Ground layer 1:	30 to 70	>0.5
Ground layer 2:	10 to 30	<0.5

Vegetation description

Low open woodland *Melaleuca preissiana* and *Corymbia calophylla* over sparse shrubland *Taxandria linearifolia and Astartea scoparia* over tall sedgeland *Lepidosperma longiftudinale* over low herbland *Cycnogeton lineare, Lobelia anceps, Dielsia stenostachya.*

Vegetation Sample Data

Sample Name: Q1

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca preissiana	40
	Corymbia calophylla	20
	Taxandria linearifolia	5
	Astartea scoparia	3
	Lepidosperma longitudinale	55
	Cycnogeton lineare	20
	Juncus pallidus	2
*	*Rumex acetosella*	3
*	*Lotus subbiflorus*	5
	Lobelia anceps	5
*	*Ehrharta calycina*	10
	Dielsia stenostachya	10
	Patersonia occidentalis	opp
	Leucopogon ?australis	opp
*	*Briza maxima*	opp
	Phlebocarya ciliata	opp
*	*Isolepis prolifera*	opp
	Lepidosperma longitudinale	opp
	Dasypogon bromeliifolius	opp
	Kennedia prostrata	opp
*	*Solanum nigrum*	opp
	Acacia saligna	opp
	Jacksonia sternbergiana	opp
*	*Hypochaeris glabra*	opp
*	*Vicia sativa*	opp
	Lomandra sp.	opp
	Drosera erythrorhiza	opp
	Microlaena stipoides	opp
*	*Bromus diandrus*	opp
*	*Zantedeschia aethiopica*	opp
*	*Moraea flaccida*	opp
*	*Arctotheca calendula*	opp
*	*Carpobrotus edulis*	opp
	Baumea vaginalis	opp

Vegetation Sample Data

Sample Name: Q1

Project no.: 18-018
Date: 12/10/2018 **Status** Permanent
Author: SKP,TAA

Species Data

* denotes non-native species

Status		Confirmed name	Cover (%)
	*	*Lagurus ovatus*	opp
	*	*Gladiolus caryophyllaceus*	opp
		Xanthorrhoea preissii	opp
		Aotus gracillima	opp
		Acacia pulchella subsp. pulchella	opp
		Sowerbaea laxiflora	opp
	*	*Orobanche minor*	opp
		Lomandra caespitosa	opp
		Conostylis setigera	opp
	*	*Cotula coronopifolia*	opp
		Juncus subsecundus	opp
		Xanthorrhoea brunonis	opp
		Schoenus efoliatus	opp
		Cyperus congestus	opp
		Baumea ?riparia	opp
		Pterostylis pyramidalis	opp
		Lomandra sp.	opp
	*	*Acacia longifolia*	opp
		Microtis media subsp. media	opp
		Gastrolobium ebracteolatum	opp
		Juncus subsecundus	opp

Vegetation Sample Data

Sample Name: R2

Project no.: 18-018
Date: 12/10/2018
Author: SKP,TAA

Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	405720.8277	NW corner northing:	6488137.179
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Clearing, weeds, grazing
Soil type/texture	sand/other with organic layer	Bare ground (%):	4
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,twigs,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)
Upper:	<10	<10
Mid:	0%	0
Ground layer 1:	10 to 30	>0.5
Ground layer 2:	70 to 100	<0.5

Vegetation description

Low open woodland *Melaleuca preissiana* over tall open rushland *Juncus* spp. over low closed grassland forbland of weed species

Vegetation Sample Data

Sample Name: R2

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP,TAA R2: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca preissiana	
	Juncus pallidus	
	Isolepis stellata	
*	*Holcus lanatus*	
*	*Lolium rigidum*	
*	*Hypochaeris glabra*	
*	*Lotus subbiflorus*	
	Juncus pauciflorus	
*	*Moraea flaccida*	
*	*Cynodon dactylon*	
	Corymbia calophylla	
*	*Rumex acetosella*	
*	*Oxalis purpurea*	sandy rise opps
*	*Trifolium arvense*	sandy rise opps
*	*Lupinus angustifolius*	sandy rise opps
	Podotheca gnaphalioides	sandy rise opps
*	*Ursinia anthemoides*	sandy rise opps
*	*Ehrharta calycina*	sandy rise opps
*	*Arctotheca calendula*	sandy rise opps
*	*Moraea flaccida*	sandy rise opps
	Xanthorrhoea preissii	sandy rise opps
*	*Chamaecytisus palmensis*	

Vegetation Sample Data

Sample Name: Q3

Project no.: 18-018
Date: 12/10/2018
Author: SKP,TAA

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403594.4067	NW corner northing:	6489080.153
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - Weeds, partial clearing
Soil type/texture	sand/	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (twigs,leaves,)	Vegetation condition:	good-

Strata	Cover (%)	Height (m)
Upper:	<10	<10
Mid:	10 to 30	>2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:		

Vegetation description

Low open woodland *Corymbia calophylla* and *Nuytsia floribunda* over open shrubland *Jacksonia* spp. and *Xanthorrhoea* spp. over low open herbland **Carpobrotus edulis, Haemodorum spicatum, Podotheca gnaphalioides* and **Ursinia anthemoides*

Vegetation Sample Data

Sample Name: Q3

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP, TAA Q3: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Corymbia calophylla	2
	Nuytsia floribunda	4
	Xanthorrhoea preissii	5
	Xanthorrhoea brunonis	10
	Jacksonia furcellata	15
*	*Carpobrotus edulis*	10
	Regelia ciliata	3
	Lyginia imberbis	4
	Phlebocarya ciliata	3
	Patersonia occidentalis	2
	Gompholobium tomentosum	2
*	*Ursinia anthemoides*	5
*	*Gladiolus caryophyllaceus*	3
	Haemodorum spicatum	3
	Burchardia congesta	2
	Podotheca gnaphalioides	6
	Lomandra caespitosa	1
*	*Ehrharta calycina*	10
	Hibbertia hypericoides	2
	Gastrolobium ebracteolatum	opp along creekline
	Caladenia marginata	opp along creekline
	Drosera macrantha	opp along creekline
	Drosera erythrorhiza	opp along creekline
*	*Acacia iteaphylla*	opp along creekline
*	*Acacia longifolia*	opp along creekline
	Pericalymma ellipticum	opp along creekline
*	*Eucalyptus camaldulensis*	opp along creekline

Vegetation Sample Data

Sample Name: R4

Project no.: 18-018
Date: 12/10/2018
Author: SKP,TAA
Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	404951.9689	NW corner northing:	6488497.396
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Clearing, weeds, grazing
Soil type/texture	sand/other with organic layer	Bare ground (%):	20
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (leaves,twigs,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)
Upper:	30 to 70	<10
Mid:	0%	0
Ground layer 1:	10 to 30	>0.5
Ground layer 2:	70 to 100	<0.5

Vegetation description

Low open woodland *Melaleuca preissiana* over over tall open rushland *Juncus pallidus* over low closed forbland weed species

Vegetation Sample Data

Sample Name: R4

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP, TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca preissiana	
	Juncus pallidus	
*	*Poa annua*	
*	*Briza minor*	
*	*Juncus bufonius*	
*	*Cotula coronopifolia*	
*	*Ranunculus muricatus*	
	Centella asiatica	
	Isolepis stellata	
*	*Trifolium arvense*	
*	*Moraea flaccida*	
*	*Holcus lanatus*	
*	*Zantedeschia aethiopica*	
*	*Romulea rosea*	
	Sowerbaea laxiflora	
	Microtis media subsp. media	
	Centrolepis aristata	
*	*Rumex vesicarius*	

Vegetation Sample Data

Sample Name: R5

Project no.: EP18-018
Date: 12/10/2018
Author: SKP,TAA

Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	404707.0701	NW corner northing:	6488572.327
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Weeds, clearing, planted trees
Soil type/texture	Sand/ with organic layer	Bare ground (%):	10
Rocks (%) and type:	No rocks	Soil colour:	Brown/
Litter:	% (,,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)	
Upper:	30 to 70	<10	
Mid:	<10	0	Dense patch of *E. camaldulensis to south
Ground layer 1:	30 to 70	<0.5	
Ground layer 2:	10 to 30	<0.5	

Vegetation description

Low open woodland *Melaleuca preissiana* over shrubland *Regelia preissiana, Astartea scoparia* and *Hypocalymma angustifolium o* ver low rushland *Dielsia stenostachya* over low open herbland *Lobelia anceps, Trifolium campestre, Lotus subbiflorus*

Vegetation Sample Data

Sample Name: R5

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP, TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
*	*Eucalyptus camaldulensis*	
	Melaleuca preissiana	
	Regelia ciliata	
	Astartea scoparia	
	Lobelia anceps	
	Hypocalymma angustifolium	
	Dielsia stenostachya	
	Isolepis stellata	
*	*Lotus subbiflorus*	
*	*Hypochaeris glabra*	
*	*Trifolium campestre*	
*	*Watsonia meriana*	
	Microtis media subsp. media	
	Eucalyptus rudis	

Vegetation Sample Data

Sample Name: Q6

Project no.: EP18-018
Date: 12/10/2018
Author: SKP,TAA

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	405494.3768	NW corner northing:	6487931.876
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	saturated	Landform:	depression
Time since fire:	no evidence	Disturbance:	high - Weeds, grazing
Soil type/texture	/	Bare ground (%):	3
Rocks (%) and type:	No rocks	Soil colour:	/
Litter:	2% (branches,,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)	
Upper:	10 to 30	<10	drainage line running north to south through patch
Mid:	0%	0	
Ground layer 1:	30 to 70	<0.5	
Ground layer 2:	10 to 30	<0.5	

Vegetation description

Low woodland *Melaleuca rhaphiophylla* over tall open rushland *Juncus pallidus* over low closed forbland weed species

Vegetation Sample Data

Sample Name: Q6

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP,TAA

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca rhaphiophylla	10
*	*Ehrharta longiflora*	5
*	*Zantedeschia aethiopica*	1
*	*Rumex acetosella*	1
*	*Cotula coronopifolia*	<1
*	*Arctotheca calendula*	50
	Juncus pallidus	10
	Isolepis cernua	2
*	*Romulea rosea*	1
*	*Bromus diandrus*	5
*	*Moraea flaccida*	10
*	*Lupinus angustifolius*	25

Vegetation Sample Data

Sample Name: Q7

Project no.: EP18-018
Date: 12/10/2018
Author: SKP,TAA

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404672.3275	NW corner northing:	6489311.031
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	saturated	Landform:	waterway
Time since fire:	no evidence	Disturbance:	moderate - Weeds, grazing
Soil type/texture	/	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	/
Litter:	3% (branches,,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)
Upper:	30 to 70	<10
Mid:	0%	0
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	0%	0

Vegetation description

Low open forest *Eucalyptus rudis, Melaleuca preissiana* and *Corymbia calophylla* over sparse shrubland *Astartea scoparia* and *Taxandria linearifolia* over open sedgeland *Lepidosperma longitudinale* over low open herbland *Cycnogeton lineare* and grassland of pasture weeds.

Vegetation Sample Data

Sample Name: Q7

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP,TAA Q7: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Corymbia calophylla	5
	Eucalyptus rudis	30
	Melaleuca preissiana	5
*	*Zantedeschia aethiopica*	3
	Lepidosperma longitudinale	5
*	*Ficus carica*	opp
	Cycnogeton lineare	10
*	*Lotus subbiflorus*	5
*	*Fumaria capreolata*	2
*	*Ornithopus compressus*	1
	Dielsia stenostachya	3
*	*Briza maxima*	10
*	*Vulpia bromoides*	3
	Acacia saligna	2
*	*Holcus lanatus*	2
*	*Ehrharta longiflora*	1
	Taxandria linearifolia	3
*	*Olea europaea*	opp
	Lobelia anceps	1
	Astartea scoparia	2
	Kennedia prostrata	opp
*	*Pelargonium capitatum*	2
*	*Rumex acetosella*	2
	Isolepis cernua	0.5
*	*Hesperantha falcata*	2
*	*Solanum nigrum*	1
	Microlaena stipoides	1
*	*Lupinus angustifolius*	1
*	*Solanum linnaeanum*	1

Vegetation Sample Data

Sample Name: R8

Project no.: EP18-018
Date: 12/10/2018
Author: SKP,TAA

Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	405226.2187	NW corner northing:	6489354.382
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Clearing, weeds, grazing
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (leaves,branches,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)	
Upper:	10 to 30	10 to 30	Area appears to have been mown, retains a number of native u/s species
Mid:	0%	0	
Ground layer 1:	30 to 70	<0.5	
Ground layer 2:	10 to 30	<0.5	

Vegetation description

Open woodland *Corymbia calophylla* over grassland of pasture weeds and low herbland *Dielsia stenostachya, *Cotula coronopifolia, Isolepis stellata*

Vegetation Sample Data

Sample Name: R8

Project no.: 18-018
Date: 12/10/2018 **Status** Non-permanent
Author: SKP,TAA

Species Data

* denotes non-native species

Status	Confirmed name	
	Corymbia calophylla	
	Melaleuca preissiana	
	Melaleuca rhaphiophylla	
	Isolepis stellata	
*	*Disa bracteata*	
	Dielsia stenostachya	
*	*Cotula coronopifolia*	
*	*Moraea flaccida*	
*	*Cynodon dactylon*	
	Drosera glanduligera	opp
*	*Hypochaeris glabra*	opp
*	*Carpobrotus edulis*	opp
*	*Pinus sp.*	opp
	Aphelia drummondii	opp
	Centrolepis aristata	opp

Vegetation Sample Data

Sample Name: Q9

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403714.3434	NW corner northing:	6488121.185
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	moderate - Weeds, partial clearing
Soil type/texture	sand/clay with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	5% (leaves,branches,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)
Upper:	10 to 30	<10
Mid:	10 to 30	1 to 2
Ground layer 1:	30 to 70	<0.5
Ground layer 2:	10 to 30	<0.5

Vegetation description

Low woodland *Melaleuca preissiana* over open shrubland *Taxandria linearifolia* , *Astartea scoparia* and *Xanthorrhoea preissii* over low closed rushland *Dielsia stenostachya* over low open herbland *Centella asiatica* and **Moraea flaccida a* nd grassland of pasture weeds

Vegetation Sample Data

Sample Name: Q9

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other Q9: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia saligna	2
	Anigozanthos humilis subsp. humilis	opp
*	*Arctotheca calendula*	opp
*	*Asparagus asparagoides*	1
	Astartea scoparia	3
*	*Briza maxima*	5
*	*Briza minor*	2
*	*Bromus diandrus*	5
*	*Carpobrotus edulis*	5
	Centella asiatica	10
	Corymbia calophylla	5
	Dielsia stenostachya	50
*	*Ehrharta longiflora*	1
*	*Hesperantha falcata*	1
	Hypocalymma angustifolium	2
	Juncus pallidus	3
	Kennedia prostrata	1
*	*Lupinus angustifolius*	1
*	*Lysimachia arvensis*	3
	Melaleuca preissiana	20
*	*Moraea flaccida*	3
	Nuytsia floribunda	opp
*	*Ornithopus compressus*	2
*	*Oxalis pes-capre*	1
	Patersonia occidentalis	1
*	*Phytolacca octandra*	1
*	*Rumex vesicarius*	1
*	*Schinus terebinthefolius*	opp
*	*Sonchus oleraceus*	1
	Taxandria linearifolia	2
*	*Ursinia anthemoides*	2
*	*Vulpia myuros*	2
*	*Wahlenbergia capensis*	1
	Xanthorrhoea preissii	5

Vegetation Sample Data

Sample Name: Q10

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403874.3309	NW corner northing:	6488043.212
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	lower slope
Time since fire:	no evidence	Disturbance:	high - Weeds, clearing
Soil type/texture	sand/	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	grey/
Litter:	10% (Twigs,leaves,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)
Upper:	<10	<10
Mid:	30 to 70	1 to 2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	0%	0

Vegetation description

Shrubland *Xanthorrhoea* spp. over low open herbland *Podotheca gnaphalioides, *Ursinia anthemoides, Desmocladuas flexuosus* and **Hypochaeris glabra* and grassland of pasture weeds.

Vegetation Sample Data

Sample Name: Q10

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other Q10: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	
	Xanthorrhoea preissii	20
	Xanthorrhoea brunonis	10
*	*Carpobrotus edulis*	5
*	*Ursinia anthemoides*	5
	Podotheca gnaphalioides	4
*	*Bromus diandrus*	4
	Desmocladus flexuosus	1
	Trachymene pilosa	0.5
*	*Hypochaeris glabra*	3
*	*Lupinus angustifolius*	2
*	*Aira sp.*	2
*	*Ornithopus compressus*	1
*	*Gladiolus caryophyllaceus*	2
	Banksia attenuata	opp
	Eucalyptus marginata	opp
	Banksia ilicifolia	opp
	Haemodorum spicatum	2
	Patersonia occidentalis	0.5
*	*Ehrharta calycina*	5
*	*Wahlenbergia capensis*	2
	Crassula colorata var. colorata	1
	Isolepis marginata	0.5
*	*Lolium rigidum*	2

Vegetation Sample Data

Sample Name: Q11

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403731.5086	NW corner northing:	6487833.896
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	upper slope
Time since fire:	no evidence	Disturbance:	moderate - Weeds, clearing, grazing
Soil type/texture	sand/	Bare ground (%):	30
Rocks (%) and type:	No rocks	Soil colour:	grey/
Litter:	10% (Twigs,leaves,)	Vegetation condition:	good-

Strata	Cover (%)	Height (m)	
Upper:	10 to 30	<10	banksia veg also located to the south of Maralla Road
Mid:	10 to 30	1 to 2	
Ground layer 1:	10 to 30	<0.5	
Ground layer 2:	10 to 30	<0.5	

Vegetation description

Low woodland *Banksia attenuata (* and occasional *Eucalyptus todtiana* and *Nuytsia floribunda* in wider area) over open shrubland *Regelia ciliata* and *Adenanthos cygnorum* over low open herbland **Carpobrotus edulis,* , *Podotheca gnaphalioides* and **Ursinia anthemoides* over low open grassland pasture weeds.

Vegetation Sample Data

Sample Name: Q11

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other Q11: Page 2 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Banksia attenuata	20
	Scholtzia involucrata	15
	Petrophile linearis	2
*	*Carpobrotus edulis*	20
	Dasypogon bromeliifolius	2
	Macrozamia riedlei	opp
	Nuytsia floribunda	opp
	Eucalyptus todtiana	opp
	Podotheca gnaphalioides	2
*	*Ursinia anthemoides*	5
*	*Gladiolus caryophyllaceus*	1
*	*Ehrharta calycina*	4
*	*Aira sp.*	5
	Patersonia occidentalis	1
*	*Wahlenbergia capensis*	1
	Croninia kingiana	2
	Banksia menziesii	opp
	Trachymene pilosa	1
	Adenanthos cygnorum	1
*	*Briza maxima*	5
	Austrostipa compressa	1
*	*Hypochaeris glabra*	1
	Trachymene pilosa	1
*	*Gladiolus caryophyllaceus*	1
*	*Ehrharta calycina*	5
	Stylidium rigidulum	opp
	Macarthuria australis	opp
	Eremaea pauciflora subsp. pauciflora	opp
	Verticordia nitens	opp
	Calytrix angulata	opp
	Hibbertia hypericoides	opp
	Laxmannia squarrosa	opp
	Hibbertia racemosa	opp
	Stirlingia latifolia	opp

Vegetation Sample Data

Sample Name: Q11

Project no.: EP18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP, ADB Q11: Page 3 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Leptomeria cunninghamii	opp

Vegetation Sample Data

Sample Name: Q12

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404146.2483	NW corner northing:	6487833.896
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - Weeds, clearing, dam
Soil type/texture	sand/clay	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	30% (Twigs,leaves,)	Vegetation condition:	good-

Strata	Cover (%)	Height (m)	
Upper:	10 to 30	<10	Localised patch in good condition with higher cover of U/S species compared to adjacent veg
Mid:	10 to 30	1 to 2	
Ground layer 1:	10 to 30	<0.5	
Ground layer 2:	<10	<0.5	

Vegetation description

Low closed forest *Corymbia calophylla* over open shrubland *Astartea scoparia* and *Aotus gracillima* over low grassland pasture qweeds and low open forbland *Sowerbaea laxiflora, *Zantedeschia aethiopica* and *Centella asiatica*

Vegetation Sample Data

Sample Name: Q12

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Corymbia calophylla	40
	Dielsia stenostachya	15
	Microtis media subsp. media	1
	Aotus gracillima	3
	Astartea scoparia	15
*	*Moraea flaccida*	1
*	*Zantedeschia aethiopica*	2
	Hypocalymma angustifolium	2
*	*Carpobrotus edulis*	2
*	*Bromus diandrus*	3
*	*Ehrharta longiflora*	2
	Acacia saligna	3
	Burchardia congesta	1
*	*Briza maxima*	3
	Juncus pallidus	1
	Melaleuca preissiana	opp
	Sowerbaea laxiflora	2
	Centella asiatica	3
*	*Isolepis prolifera*	opp
	Isolepis cernua	opp

Vegetation Sample Data

Sample Name: Q13

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404670.3615	NW corner northing:	6488601.429
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - Weeds, clearing, planted trees, t
Soil type/texture	sand/clay	Bare ground (%):	20
Rocks (%) and type:	No rocks	Soil colour:	grey/
Litter:	10% (Twigs,leaves,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)	
Upper:	10 to 30	<10	previously cleared track through middle of quadrat but populated by Ds, Ac and Is sedge/forbs
Mid:	30 to 70	1 to 2	
Ground layer 1:	10 to 30	<0.5	
Ground layer 2:	0%	0	

Vegetation description

low woodland *Eucalyptus camaldulensis* and *Melaleuca preissiana* over shrubland *Astartea scoparia, Regelia ciliata* and *Hypocalymma angustifolium* over low open rushland *Dielsia stenostachya* over low open grassland pasture weeds

Vegetation Sample Data

Sample Name: Q13

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Astartea scoparia	25
*	*Eucalyptus camaldulensis*	10
	Melaleuca preissiana	5
	Sowerbaea laxiflora	2
	Dielsia stenostachya	10
	Microtis media subsp. media	1
*	*Hypochaeris glabra*	2
	Juncus pallidus	3
*	*Ehrharta calycina*	5
	Aphelia cyperoides	0.5
*	*Isolepis prolifera*	0.5
*	*Holcus lanatus*	1
*	*Lotus subbiflorus*	1
	Isolepis stellata	1
*	*Disa bracteata*	0.5
	Thelymitra macrophylla	0.5
	Hypocalymma angustifolium	5
	Regelia ciliata	10
*	*Lolium rigidum*	2
	Schoenus efoliatus	1

Vegetation Sample Data

Sample Name: Q14

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	406397.7247	NW corner northing:	6488241.338
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	saturated	Landform:	depression
Time since fire:	no evidence	Disturbance:	high - Weeds
Soil type/texture	/ with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	/
Litter:	5% (Twigs,leaves,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)
Upper:	0%	Treeless
Mid:	10 to 30	>2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	30 to 70	<0.5

Vegetation description

Low woodland *Melaleuca rhaphiophylla* and *Melaleuca teritifolia* over low herbland *Azolla rubra* and *Lemnadisperma* over tussock grassland pasture weeds.

Vegetation Sample Data

Sample Name: Q14

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other Q14: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca rhaphiophylla	10
	Melaleuca teretifolia	10
*	*Moraea flaccida*	5
	Lemna disperma	20
	Azolla rubra	10
	Juncus pallidus	3
*	*Cynodon dactylon*	40
*	*Lolium rigidum*	5
*	*Ehrharta calycina*	10
*	*Cotula coronopifolia*	5
*	*Lotus subbiflorus*	3

Vegetation Sample Data

Sample Name: Q15

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	406936.0269	NW corner northing:	6488104.425
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Weeds, recolonised Acacia
Soil type/texture	sand/ with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	grey/
Litter:	5% (Twigs,leaves,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)
Upper:	~0	<10
Mid:	30 to 70	>2
Ground layer 1:	30 to 70	<0.5
Ground layer 2:	<10	<0.5

Vegetation description

Low woodland Acacia saligna and *Melaleuca* spp. over grassland of **Cortaderia selloana* and pasture weeds and low open herbland **Arctotheca calendula, Moraea flaccida, Burchardia congesta*

Vegetation Sample Data

Sample Name: Q15

Project no.: 18-018
Date: 26/10/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia saligna	30
	Melaleuca rhaphiophylla	5
*	*Cortaderia selloana*	5
	Burchardia congesta	0.5
*	*Eragrostis curvula*	10
*	*Arctotheca calendula*	5
*	*Ehrharta calycina*	20
*	*Avena barbata*	5
*	*Moraea flaccida*	5
*	*Lolium rigidum*	10
*	*Lotus subbiflorus*	10
	Gahnia trifida	opp
T	*Grevillea ?curviloba subsp. curviloba*	opp

Vegetation Sample Data

Sample Name: R16

Project no.: EP18-018
Date: 26/10/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	406770.4228	NW corner northing:	6487788.85
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Weeds, grazing, clearing
Soil type/texture	sand/	Bare ground (%):	40
Rocks (%) and type:	No rocks	Soil colour:	grey/
Litter:	10% (Twigs,leaves,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)
Upper:	<10	<10
Mid:	10 to 30	>2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	10 to 30	<0.5

Vegetation description

low sparse woodland *Eucalyptus todtiana* over open shrubland *Jacksonia furcellata, Xanthorrhoea preissii* over low open forbland *Dasypogon bromeliifolius, *Ursinia anthemoides, Podotheca gnaphalioides* over low grassland pasture weeds

Vegetation Sample Data

Sample Name: R16

Project no.: 18-018
Date: 26/10/2018
Author: SKP,other

Status Non-permanent

Species Data

* denotes non-native species

Status	Confirmed name
	Jacksonia furcellata
	Desmocladus flexuosus
	Patersonia occidentalis
	Ptilotus polystachyus
*	*Aira sp.*
	Podotheca gnaphalioides
*	*Gladiolus caryophyllaceus*
*	*Ursinia anthemoides*
	Macrozamia riedlei
	Xanthorrhoea preissii
	Eucalyptus todtiana
	Dasypogon bromeliifolius
	Haemodorum spicatum
	Lyginia imberbis
	Hypolaena exsulca
*	*Petrorhagia dubia*
	Podotheca gnaphalioides
	Scholtzia involucrata
	Acacia huegelii
	Microtis media subsp. media
*	*Ehrharta calycina*
*	*Briza maxima*

Vegetation Sample Data

Sample Name: Q17

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404459.9596	NW corner northing:	6489591.414
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - weeds, clearing
Soil type/texture	sand/clay with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	5% (logs,,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)
Upper:	10 to 30	<10
Mid:	10 to 30	1 to 2
Ground layer 1:	30 to 70	<0.5
Ground layer 2:	<10	>0.5

Vegetation description

Low woodland *Melaleuca preissiana* and *Corymbia calophylla* over open shrubland *Acacia saligna, Hakea varia* over grassland of pasture weeds and low open forbland *Centella asiatica* and **Moraea flaccida*

Vegetation Sample Data

Sample Name: Q17

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other Q17: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Acacia saligna	20
	Melaleuca preissiana	10
	Corymbia calophylla	opp
	Astartea scoparia	2
	Juncus pallidus	5
	Centella asiatica	10
	Hakea varia	5
*	*Moraea flaccida*	3
*	*Briza maxima*	10
	Lepidosperma longitudinale	5
*	*Holcus lanatus*	3
*	*Hypochaeris glabra*	1
*	*Lysimachia arvensis*	1
*	*Briza minor*	2
*	*Sonchus oleraceus*	1
*	*Bromus diandrus*	3
*	*Ehrharta longiflora*	4
*	*Orobanche minor*	1
	Patersonia occidentalis	1

Vegetation Sample Data

Sample Name: Q18

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404430.5922	NW corner northing:	6489534.811
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - weeds
Soil type/texture	sand/clay with organic layer	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	10% (twigs,bark,)	Vegetation condition:	very good-

Strata	Cover (%)	Height (m)
Upper:	30 to 70	<10
Mid:	<10	1 to 2
Ground layer 1:	70 to 100	<0.5
Ground layer 2:	<10	<0.5

Vegetation description

Low closed forest *Melaleuca preissiana* over open shrubland *Astartea scoparia* over low rushland of *Dielsia stenostachya* and *Juncus pallidus* , open segdeland of *Lepidopserma longitudinale* and forbland *Sowerbaea laxiflora, Lobelia anceps, Drosera gigantea, Microtis media* subsp. *media* and **Moraea flaccida* over low open grassland **Briza* spp.

Vegetation Sample Data

Sample Name: Q18

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other Q18: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca preissiana	50
	Astartea scoparia	4
	Dielsia stenostachya	50
	Lepidosperma longitudinale	5
	Juncus pallidus	3
	Xanthorrhoea preissii	2
	Microtis media subsp. media	1
	Lobelia anceps	2
*	*Moraea flaccida*	2
*	*Briza maxima*	10
	Patersonia occidentalis	opp
	Sowerbaea laxiflora	3
*	*Holcus lanatus*	3
*	*Hypochaeris glabra*	3
*	*Lotus subbiflorus*	1
*	*Briza minor*	1
	Hardenbergia comptoniana	1
	Drosera gigantea	1
	Burchardia congesta	0
	Corymbia calophylla	0
*	*Acacia iteaphylla*	0
	Regelia ciliata	0

Vegetation Sample Data

Sample Name: Q19

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403680.2534	NW corner northing:	6489104.165
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	low - weeds
Soil type/texture	sand/ with organic layer	Bare ground (%):	1
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	40% (leaves,twigs,)	Vegetation condition:	very good-good

Strata	Cover (%)	Height (m)	
Upper:	30 to 70	10 to 30	
Mid:	0%	0	Upslope from creekline
Ground layer 1:	70 to 100	<0.5	
Ground layer 2:	0%	0	

Vegetation description

Low open forest *Corymbia calophylla* over open shrubland *Jacksonia* spp. over sedgeland *Lepidosperma longitudinale,* rushland *Dielsia stenostachya* and open forbland *Dasypogon bromeliifolius* and *Patersonia occidentalis*

Vegetation Sample Data

Sample Name: Q19

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Corymbia calophylla	25
	Jacksonia sternbergiana	5
	Patersonia occidentalis	2
	Dielsia stenostachya	10
	Lepidosperma longitudinale	20
	Juncus pallidus	3
*	*Bromus diandrus*	3
*	*Trifolium arvense*	1
*	*Carpobrotus edulis*	1
*	*Watsonia meriana*	1
	Leucopogon ?australis	0.5
	Microtis media subsp. media	0.5
	Dasypogon bromeliifolius	3
	Jacksonia furcellata	3
*	*Briza maxima*	5
*	*Hypochaeris glabra*	1
	Acacia saligna	2

Vegetation Sample Data

Sample Name: Q20

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403804.1271	NW corner northing:	6489099.888
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	flat
Time since fire:	no evidence	Disturbance:	moderate - weeds clearing
Soil type/texture	sand/	Bare ground (%):	5
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	25% (leaves,twigs,)	Vegetation condition:	degraded-good

Strata	Cover (%)	Height (m)	
Upper:	<10	<10	Close to junction of riparan community and more dryland community to the north and west
Mid:	10 to 30	1 to 2	
Ground layer 1:	10 to 30	<0.5	
Ground layer 2:	10 to 30	<0.5	

Vegetation description

Low open woodland *Corymbia calophylla* and *Melaleuca preissiana* over open shrubland *Jacksonia* spp., *Acacia saligna* and *Xanthorrhoea* spp. over forbland *Haemodorum spicatum, Dasypogon bromeliifolius, Patersonia occidentalis* and **Ursinia anthemoides* and open grassland of pasture weeds.

Vegetation Sample Data

Sample Name: Q20

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Corymbia calophylla	5
	Jacksonia furcellata	10
	Jacksonia sternbergiana	3
	Dasypogon bromeliifolius	10
	Patersonia occidentalis	3
	Lomandra caespitosa	2
	Haemodorum spicatum	7
*	*Ehrharta calycina*	20
	Pericalymma ellipticum	1
	Regelia ciliata	1
	Melaleuca preissiana	2
	Acacia saligna	2
	Gompholobium tomentosum	1
*	*Briza maxima*	5
*	*Ursinia anthemoides*	5
*	*hypochaeris glabra*	3
	Xanthorrhoea brunonis	5
	Xanthorrhoea preissii	2
*	*Vicia sativa*	1
	Tricoryne elatior	1
	Podotheca gnaphalioides	3

Vegetation Sample Data

Sample Name: Q21

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	403535.3183	NW corner northing:	6488939.078
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	moderate - Weeds
Soil type/texture	sand/	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (bark,twigs,)	Vegetation condition:	very good-good

Strata	Cover (%)	Height (m)
Upper:	30 to 70	<10
Mid:	<10	1 to 2
Ground layer 1:	70 to 100	<0.5
Ground layer 2:	0%	<0.5

Vegetation description

Low closed forest of *Melaleuca preissiana* over open shrubland *Gastrolobium ebracteolatum, Taxandria linearifolia* and *Acacia saligna* overclosed sedgeland of *Lepidosperma longitudinale*

Vegetation Sample Data

Sample Name: Q21

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other Q21: Page 2 of 2

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Melaleuca preissiana	70
	Lepidosperma longitudinale	80
	Gastrolobium ebracteolatum	3
*	*Zantedeschia aethiopica*	1
	Acacia saligna	1
	Taxandria linearifolia	1
*	*Bromus diandrus*	1
	Juncus pallidus	1
*	*Holcus lanatus*	1

Vegetation Sample Data

Sample Name: R22

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	404269.4537	NW corner northing:	6489904.034
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	near saturated	Landform:	depression
Time since fire:	no evidence	Disturbance:	high - Weeds
Soil type/texture	/	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	/
Litter:	Not visible	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)	
Upper:	10 to 30	<10	Vegetation assessed from road (not accessed)
Mid:	30 to 70	>2	
Ground layer 1:	<10	>0.5	
Ground layer 2:	0%	0	

Vegetation description

Low woodland *Melaleuca preissiana, Eucalyptus rudis* over tall shrubland *Acacia saligna, Pteridium esculentum* and *Astartea scoparia* over open rushland of *Juncus pallidus* and grassland of pasture weeds

Vegetation Sample Data

Sample Name: R22

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name
	Melaleuca preissiana
	Acacia saligna
	Pteridium esculentum
	Eucalyptus rudis
	Astartea scoparia
*	*Lotus subbiflorus*
*	*Cynodon dactylon*
*	*Juncus bufonius*
	Taxandria linearifolia
	Juncus pallidus
	Corymbia calophylla

Vegetation Sample Data

Sample Name: Q23

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404434.7887	NW corner northing:	6487736.355
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	mid-slope
Time since fire:	no evidence	Disturbance:	moderate - Weeds
Soil type/texture	sand/	Bare ground (%):	15
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	10% (leaves,twigs,)	Vegetation condition:	very good-

Strata	Cover (%)	Height (m)
Upper:	10 to 30	<10
Mid:	10 to 30	1 to 2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	10 to 30	<0.5

Vegetation description

Low woodland *Banksia* ssp., *Nuytsia floribunda* and *Eucalyptus todtiana* over shrubland *Allocasuarina humilis, Melaleuca ryeae, Eremaea pauciflora and Hibbertia hypericoides* over low forbland *Patersonia occidentalis, Conostylis aculeata, Phlebocarya ciliata, *Ursinia anthemoides* and low grassland *Neurachne alopecuroidea* , **Ehrharta calycina* and **Briza maxima*

Vegetation Sample Data

Sample Name: Q23

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Banksia attenuata	15
	Banksia menziesii	15
	Allocasuarina humilis	5
	Stirlingia latifolia	4
	Eremaea pauciflora subsp. pauciflora	5
	Scholtzia involucrata	3
	Desmocladus flexuosus	2
	Petrophile linearis	2
	Jacksonia floribunda	2
	Patersonia occidentalis	3
	Dampiera linearis	3
	Lomandra hermaphrodita	1
	Anigozanthos humilis subsp. humilis	1
*	*Aira sp.*	1
	Lomandra hermaphrodita	1
*	*Ehrharta calycina*	5
*	*Ursinia anthemoides*	4
	Calytrix angulata	2
	Calytrix flavescens	2
	Conostylis aculeata	3
*	*Carpobrotus edulis*	3
	Hibbertia hypericoides	4
	Nuytsia floribunda	5
	Arnocrinum preissii	2
	Neurachne alopecuroidea	3
	Laxmannia squarrosa	2
	Macarthuria australis	3
	Gompholobium tomentosum	3
	Lyginia imberbis	2
	Macrozamia riedlei	4
	Eucalyptus todtiana	5
	Melaleuca ryeae	4
	Acacia pulchella subsp. pulchella	2
	Thysanotus sp.	1

Vegetation Sample Data

Sample Name: Q23

Project no.: EP18-018
Date: 9/11/2018 **Status** Non-permanent
Author: 5% (leaves,,) Q23: Page 3 of 3

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Phlebocarya ciliata	3
	Haemodorum spicatum	2
*	*Briza maxima*	5
*	*Gladiolus caryophyllaceus*	2
	Daviesia triflora	3
	Dasypogon bromeliifolius	3
	Podotheca gnaphalioides	2
	Astroloma xerophyllum	1

Vegetation Sample Data

Sample Name: Q24

Project no.: EP18-018
Date: 9/11/2018
Author: SKP,other
Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404387.3062	NW corner northing:	6489916.544
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	dry	Landform:	lower slope
Time since fire:	no evidence	Disturbance:	- Weeds, adj to track
Soil type/texture	sand/	Bare ground (%):	15
Rocks (%) and type:	No rocks	Soil colour:	brown/grey
Litter:	% (,,)	Vegetation condition:	good-

Strata	Cover (%)	Height (m)
Upper:	10 to 30	<10
Mid:	10 to 30	1 to 2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	10 to 30	<0.5

Vegetation description

Low woodland *Banksia ilicifoliaand Allocasuarina fraseriana* over shrubland *Melaleuca ryeae, Eremaea pauciflora, Macarthuria australis and Hibbertia hypericoides* over low forbland *Dasypogon bromeliifolius, Phlebocarya ciliata, Dampiera linearis and *Ursinia anthemoides* and grassland of pasture weeds

Vegetation Sample Data

Sample Name: Q24

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP,other

Species Data

* denotes non-native species

Status	Confirmed name	
	Banksia ilicifolia	7
P	*Eucalyptus gomphocephala*	opp
	Eremaea pauciflora subsp. pauciflora	3
	Scholtzia involucrata	2
	Gompholobium tomentosum	2
	Dampiera linearis	2
	Desmocladus flexuosus	5
*	*Ehrharta calycina*	10
	Patersonia occidentalis	2
	Melaleuca ryeae	2
*	*Ursinia anthemoides*	3
*	*Carpobrotus edulis*	2
	Macarthuria australis	3
	Hibbertia hypericoides	2
	Dasypogon bromeliifolius	3
	Xanthorrhoea brunonis	1
	Acacia pulchella subsp. pulchella	2
	Jacksonia furcellata	2
	Phlebocarya ciliata	2
	Leucopogon conostephioides	1
	Allocasuarina fraseriana	3

Vegetation Sample Data

Sample Name: Q25

Project no.: EP18-018
Date: 9/11/2018
Author: SKP, MS
Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	404469.1139	NW corner northing:	6489900.159
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	depression
Time since fire:	no evidence	Disturbance:	moderate - Weeds
Soil type/texture	sand/	Bare ground (%):	3
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	20% (leaves,leaves,)	Vegetation condition:	good-

Strata	Cover (%)	Height (m)
Upper:	30 to 70	10 to 30
Mid:	10 to 30	1 to 2
Ground layer 1:	30 to 70	<0.5
Ground layer 2:	0%	0

Vegetation description

Open forest *Corymbia calophylla* and *Melaleuca preissiana* over shrubland *Astartea scoparia* and *Regelia ciliata* over low rushland *Dielsia stenostachya* , low forbland of *Dasypogon bromeliifolius* , **Hypochaeris glabra* and open grassalnd of pasture weeds.

Vegetation Sample Data

Sample Name: Q25

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP, MS

Species Data

* denotes non-native species

Status	Confirmed name	
	Corymbia calophylla	50
	Melaleuca preissiana	15
	Astartea scoparia	10
	Regelia ciliata	5
	Dielsia stenostachya	20
*	*Acacia iteaphylla*	2
	Kennedia prostrata	1
*	*Briza maxima*	5
*	*Ehrharta calycina*	5
*	*Hypochaeris glabra*	2
	Xanthorrhoea brunonis	2
	Hypocalymma angustifolium	3
	Schoenus efoliatus	1
	Microtis media subsp. media	0.5
	Xanthorrhoea preissii	2
	Dasypogon bromeliifolius	2
	Pericalymma ellipticum	2

Vegetation Sample Data

Sample Name: Q26

Project no.: EP18-018
Date: 9/11/2018
Author: SKP, MS

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	other
NW corner easting:	405088.7032	NW corner northing:	6489447.621
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Clearing, weeds, grazing
Soil type/texture	sand/clay	Bare ground (%):	0
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (TwigsFALSE,)	Vegetation condition:	very good-

Strata	Cover (%)	Height (m)
Upper:	<10	<10
Mid:	30 to 70	1 to 2
Ground layer 1:	30 to 70	>0.5
Ground layer 2:	0%	0

Vegetation description

Sparse woodland *Melaleuca preissiana* and *Corymbia calophylla* over tall closed shrubland *Astartea scoparia* over rushland of *Dielsia stenostachya* and *Juncus pallidus* and open forbland of *Lobelia anceps* and *Microtis media* subsp. *media*

Vegetation Sample Data

Sample Name: Q26

Project no.: 18-018
Date: 9/11/2018
Author: SKP, MS

Status Non-permanent

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Astartea scoparia	50
	Melaleuca preissiana	10
	Corymbia calophylla	5
	Eucalyptus marginata	opp
	Dielsia stenostachya	30
	Lobelia anceps	3
*	*Carpobrotus edulis*	1
	Juncus pallidus	3
	Microtis media subsp. media	1
*	*Disa bracteata*	0.5
*	*Aira sp.*	1
*	*Rumex acetosella*	1
*	*Cynodon dactylon*	10

Vegetation Sample Data

Sample Name: Q27

Project no.: EP18-018
Date: 9/11/2018
Author: SKP, MS

Status Non-permanent

Quadrat and landform details

Sample type:	quadrat	Size:	10 m x 10 m
NW corner easting:	405209.155	NW corner northing:	6489452.737
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Clearing, weeds, grazing
Soil type/texture	sand/clay	Bare ground (%):	4
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (Twigs,leaves,)	Vegetation condition:	good-degraded

Strata	Cover (%)	Height (m)
Upper:	10 to 30	<10
Mid:	10 to 30	1 to 2
Ground layer 1:	10 to 30	<0.5
Ground layer 2:	0%	0

Vegetation description

Sparse woodland *Melaleuca preissiana* over shrubland *Regelia ciliata, Hypocalymma angustifolium* and *Astartea scoparia* over open rushland of *Dielsia stenostachya,* open forbland of *Stylidium brunonianu, Isolepis stellata* and **Carpobrotus edulis* and open grassland of pasture weeds

Vegetation Sample Data

Sample Name: Q27

Project no.: 18-018
Date: 9/11/2018 **Status** Non-permanent
Author: SKP, MS

Species Data

* denotes non-native species

Status	Confirmed name	Cover (%)
	Regelia ciliata	20
	Melaleuca preissiana	10
	Stylidium brunonianum	1
	Xanthorrhoea brunonis	3
	Dielsia stenostachya	15
	Hypocalymma angustifolium	5
*	*Briza maxima*	10
*	*Vulpia bromoides*	10
*	*Holcus lanatus*	3
*	*Carpobrotus edulis*	2
*	*Aira sp.*	1
*	*Hypochaeris glabra*	2
	Isolepis stellata	0.5

Vegetation Sample Data

Sample Name: R28

Project no.: EP18-018
Date: 9/11/2018
Author: SKP, MS

Status Non-permanent

Quadrat and landform details

Sample type:	releve	Size:	other
NW corner easting:	404948.1651	NW corner northing:	6489468.92
Altitude (m):	Not recorded	Geographic datum/zone:	GDA94/Zone 50
Soil water content:	slightly damp	Landform:	flat
Time since fire:	no evidence	Disturbance:	high - Clearing, weeds, grazing
Soil type/texture	sand/clay	Bare ground (%):	3
Rocks (%) and type:	No rocks	Soil colour:	brown/
Litter:	5% (Twigs,leaves,)	Vegetation condition:	degraded-

Strata	Cover (%)	Height (m)
Upper:	<10	<10
Mid:	30 to 70	1 to 2
Ground layer 1:	<10	<0.5
Ground layer 2:	30 to 70	<0.5

Vegetation description

Sparse woodland *Melaleuca preissiana* over shrubland *Regelia ciliata* and *Astartea scoparia* over open rushland of *Dielsia stenostachya,* open forbland of *Centella asiatica, *Cotula coronopifolia* and **Carpobrotus edulis* and grassland of pasture weeds

Vegetation Sample Data

Sample Name: R28

Project no.: 18-018
Date: 9/11/2018
Author: SKP, MS

Status Non-permanent

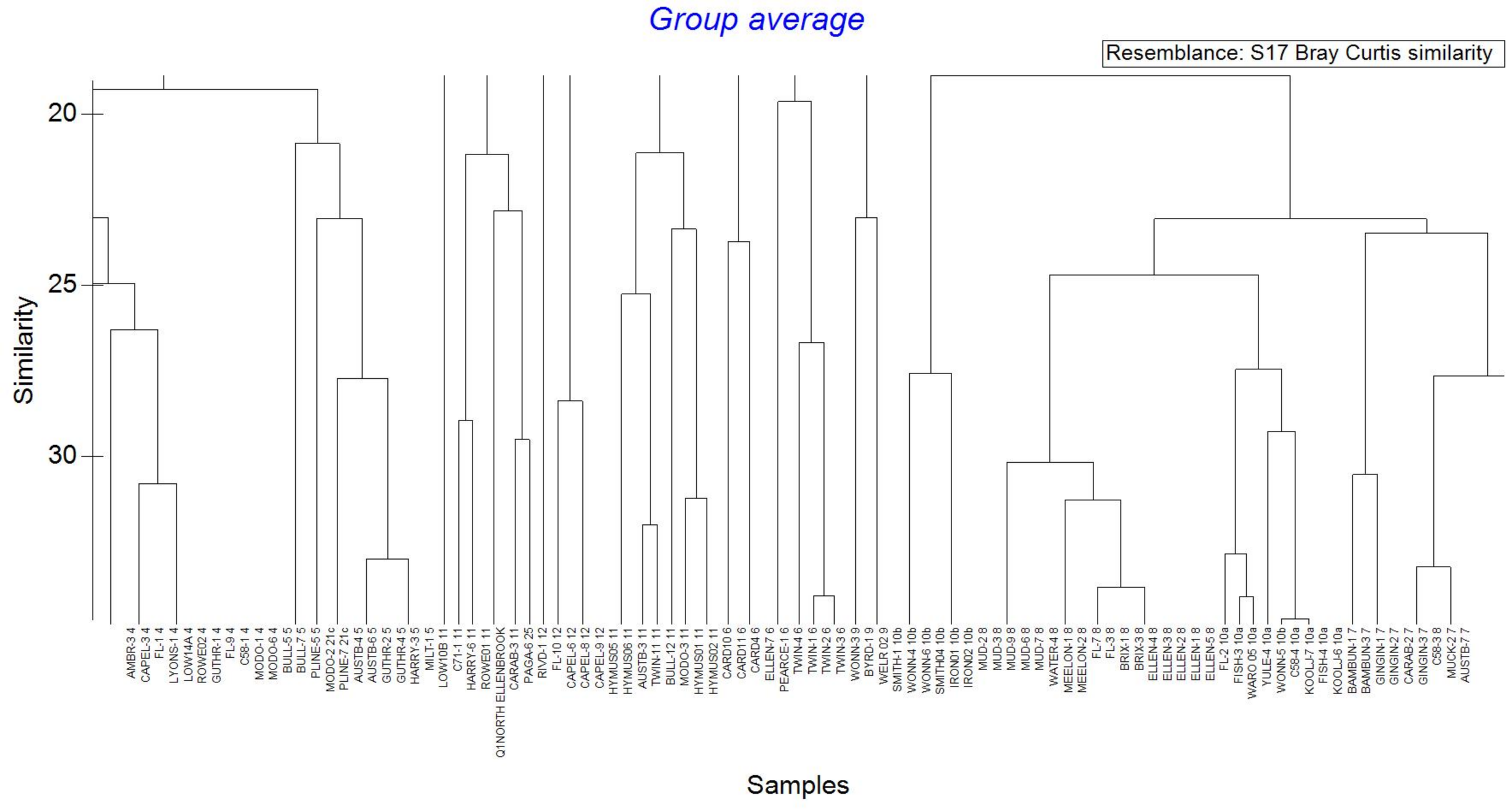
Species Data

* denotes non-native species

Status	Confirmed name
	Astartea scoparia
	Regelia ciliata
	Dielsia stenostachya
*	*Moraea flaccida*
*	*Cynodon dactylon*
*	*Vulpia bromoides*
	Juncus pallidus
*	*Carpobrotus edulis*
	Centella asiatica
	Acacia saligna
*	*Cotula coronopifolia*
*	*Lotus subbiflorus*

Appendix D

Cluster Dendrograms


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
20
25
30
Samples
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
LOW10B 11
C71-1 11
HARRY-6 11
ROWE01 11
Q1NORTH ELLENBROOK
CARAB-3 11
PAGA-6 25
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

5

10

15

WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
R2NORTH ELLENBROOK
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
POSSUM5 17
COOL04 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOL01 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13
PAGA-2 13
ELLIS-2 18
ELLIS-3 18
COOL09 19
PB-1 19
PB-6 19
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1A 13
CAPEL-4 13
RUAB-3 13

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

25
30
35
40

KELLY01 1a
DARD01 1a
DARD03 1a
KEMP01 1a
WICHERO1 1a
ACTON-1 1a
SMITH02 1a
SMITH03 1a
WONN01 1a
CARB-1 1b
CARB-4 1b
YALLIN-1 1b
AMBR-6 1b
AMBR-9 1b
AMBR-4 1b
AMBR-1 1b
AMBRAL-1 1b
GIBSOND2 1a
WILL04 1a
WATER-3 3c
YARLD1 3c
ELLEN-6 3c
DUCK-1 3c
DUCK-2 3c
LAMB1 3a
LAMB2 3a
BRICK5 3a
WARO 06 3a
BRICK1 3a
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
YAN-18 22
YAN-17 22
YAN-22 22
R3NORTH ELLENBROOK
PLINE-4 4
WHITE-2 4
YAN-6 28
NEER-8 28
YAN-4 28
WABL-4 28
MILT-4 28
SHE-2 28
WATERRD1 28
YAN-25 28
SEAB-6 28
YAN-8 28
YAN-9 28
KERO-1 24
THOM-2 24
KERO-2 24
MTB-1 24
HARRY-1 28
HARRY-2 28
TAM-1 21a
WELL-1 21a
PAGA-4 21a
PAGA-7 21a
HARRY-5 21a
WELL-2 21a
NEER-23 28
NEER-22 28
NEER-20 28
NEER-21 28
NEER-2 28
NEER-6 28
WOODV-1 28
WOODV-2 28
DEPOT-1 28
NEER-5 28
YAN-3 28
NEER-3 28
NEER-4 28
TRIG-4 28
KING-1 28
KING-2 28
WARI-1 28
WARI-2 28
SHENT-1 28
TRIG-3 28
TRIG-6 24
NEER-1 24
NEER-11 24
PEPB-1 30b
C71-4 25
MINN-1 25
MINN-2 25
MEAL-2 26b
YALG-2 26b
YALG-6 26b
YALG-7 26b
WHILL-5 26b
YALG-1 26b
PAGA-8 25
MEAL-1 25
MYALUP-2 25
CORON-2 25
KEME-1 25
LYONS-2 25
MINN-3 25
FL-4 21a
BULLER-3 21c
KEME-3 21c
LOW01 21c
LOW06A 21c
LOW04 21a
LOW06B 21c

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

15

20

25

WARO 06 3a
BRICK1 3a
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
R4NORTH ELLENBROOK
LOW10B 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

35

40

45

FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
LOW10B 11
PAGA-6 25
CARAB-3 11
ROWE01 11
MILT-5 14
YAN-21 14
HARRY-6 11
HYMUS01 11
R5NORTH ELLENBROOK
C71-1 11
MODO-3 11
NAVB-4 24
MTB-2 24
MTB-3 24
MTB-4 24
COOL08 24
COOL02 24
COOL03 24
NAVB-3 24
PTWALT-1 24
BOLD-3 24
BOLD-4 24
TRIG-5 24
BOLD-1 24
BOLD-2 24
TRIG-1 29b
WHILL-2 29b
PB-5 29b
PB-3 29b
PB-2 29b
PB-4 29b
SEAB-4 29a
SEAB-5 29a
SEAB-7 29b
SEAB-2 29b
SEAB-3 29b
NWIL-1 29b
NWIL-3 29b
NPRES-1 29b
WHILL-1 29b
WHILL-3 27
YALG-3 27
YALG-8 27
SVH-2 27
WHILL-4 27
YALG-4 27
YALG-5 27
SHE-6 26b
WABL-2 26b

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

15

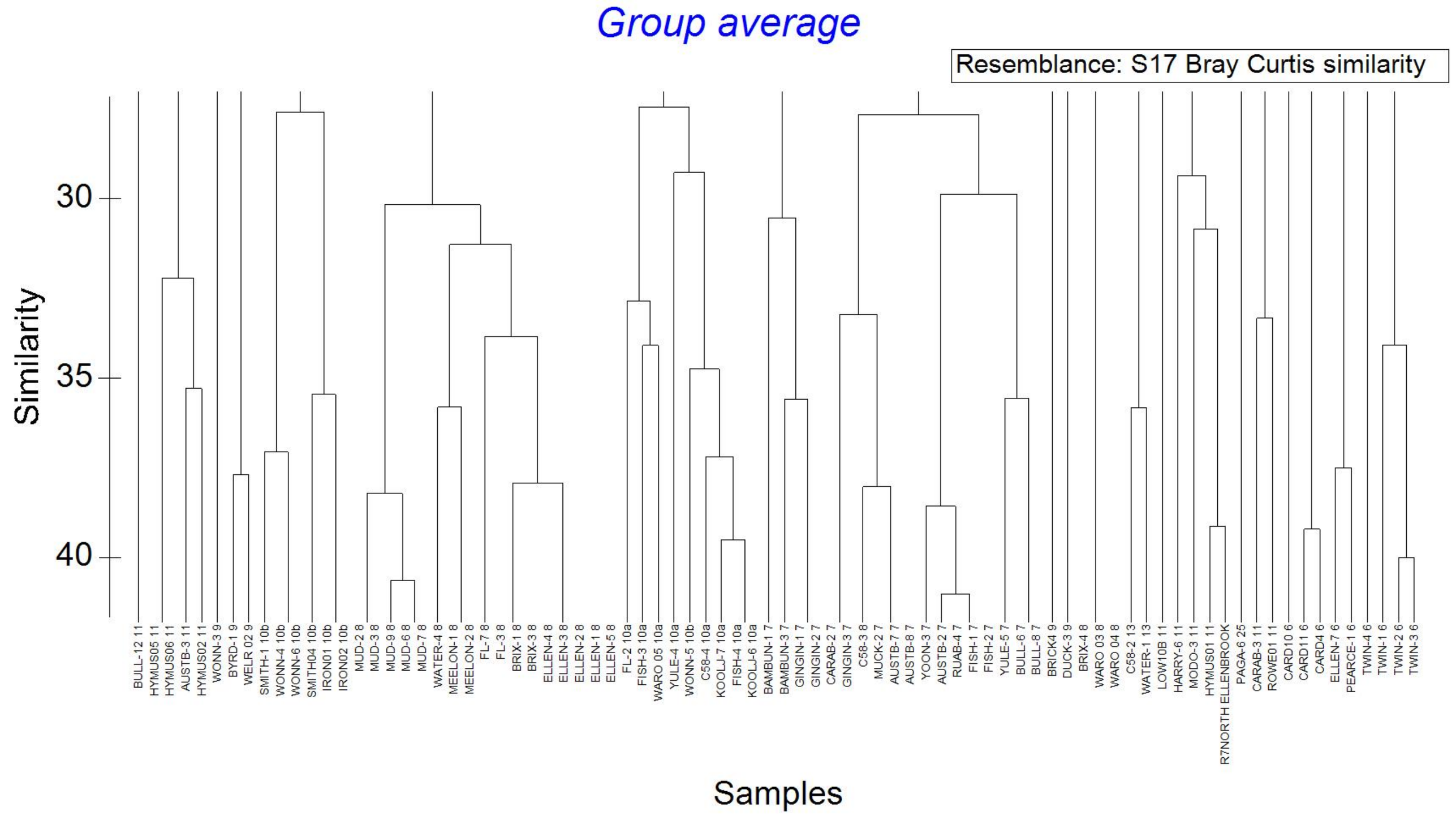
20

25

30

CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB87
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK49
DUCK-3 9
BRIX-4 8
WARO03 8
WARO04 8
C58-2 13
WATER-1 13
LOW10B 11
R6NORTH ELLENBROOK
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWED1 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
POSSUM5 17
COOLD4 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOLD1 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13
PAGA-2 13
ELLIS-2 18
ELLIS-3 18
COOLD9 19
PB-1 19
PB-6 19
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1A 13
CAPEL-4 13
RUAB-3 13

Samples


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
30
35
40
Samples
BULL-12 11
HYMUS05 11
HYMUS06 11
AUSTB-3 11
HYMUS02 11
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
LOW10B 11
HARRY-6 11
MODO-3 11
HYMUS01 11
R7NORTH ELLENBROOK
PAGA-6 25
CARAB-3 11
ROWE01 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

15

20

25

MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
R8NORTH ELLENBROOK
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
POSSUM5 17
COOL04 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOL01 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13
PAGA-2 13
ELLIS-2 18
ELLIS-3 18
COOL09 19
PB-1 19
PB-6 19
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1A 13
CAPEL-4 13
RUAB-3 13

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

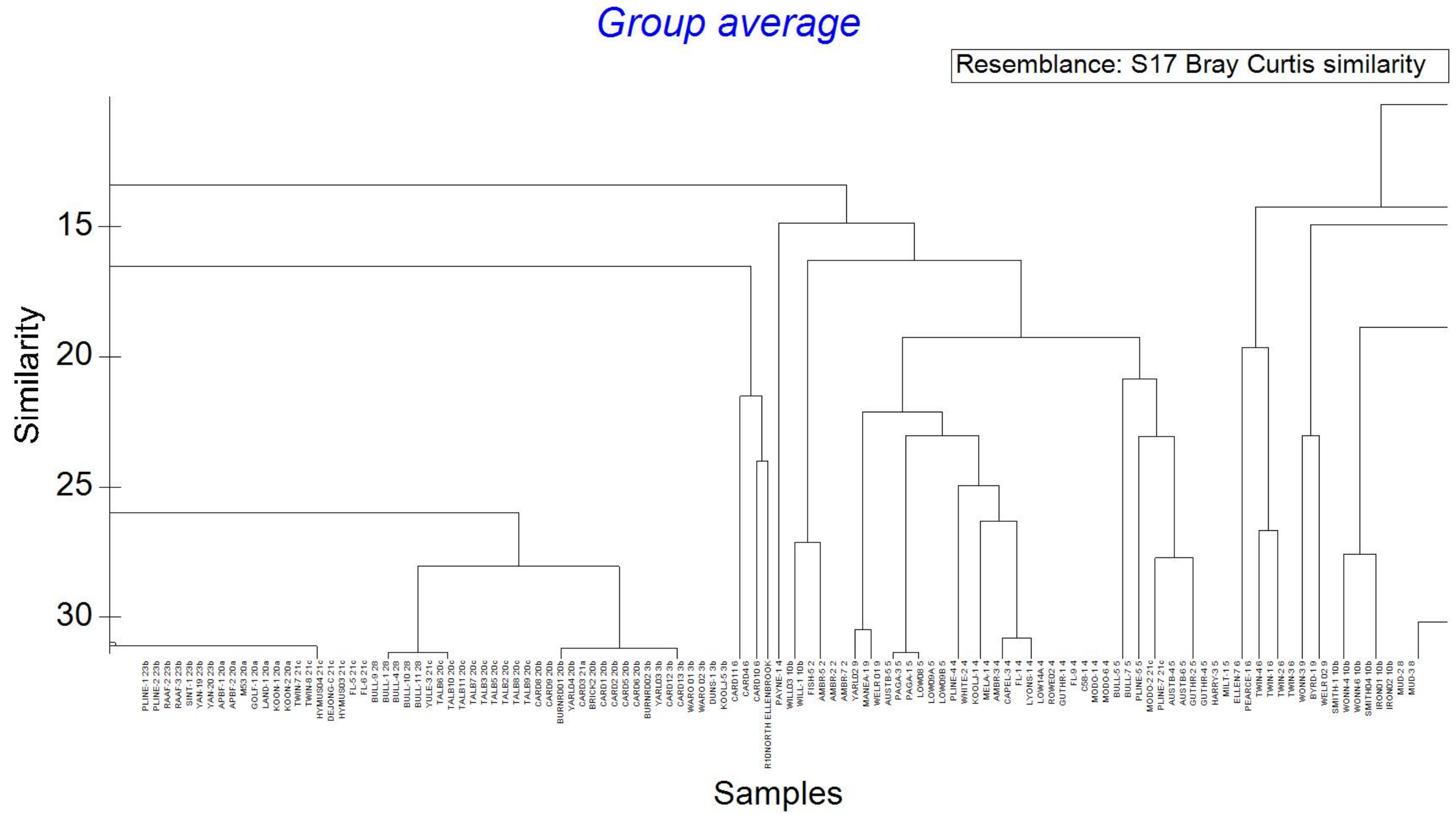
20

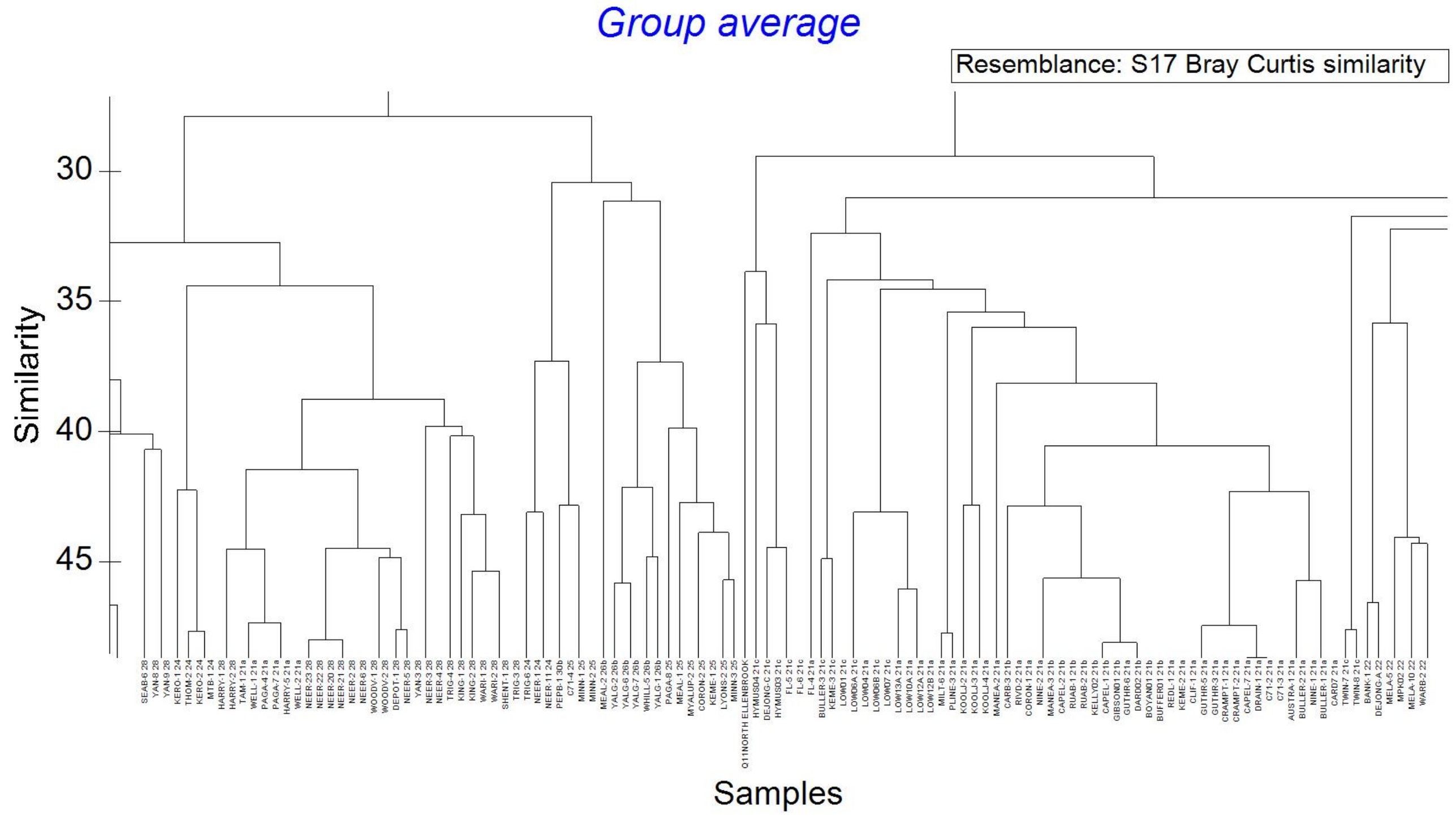
25

30

Samples

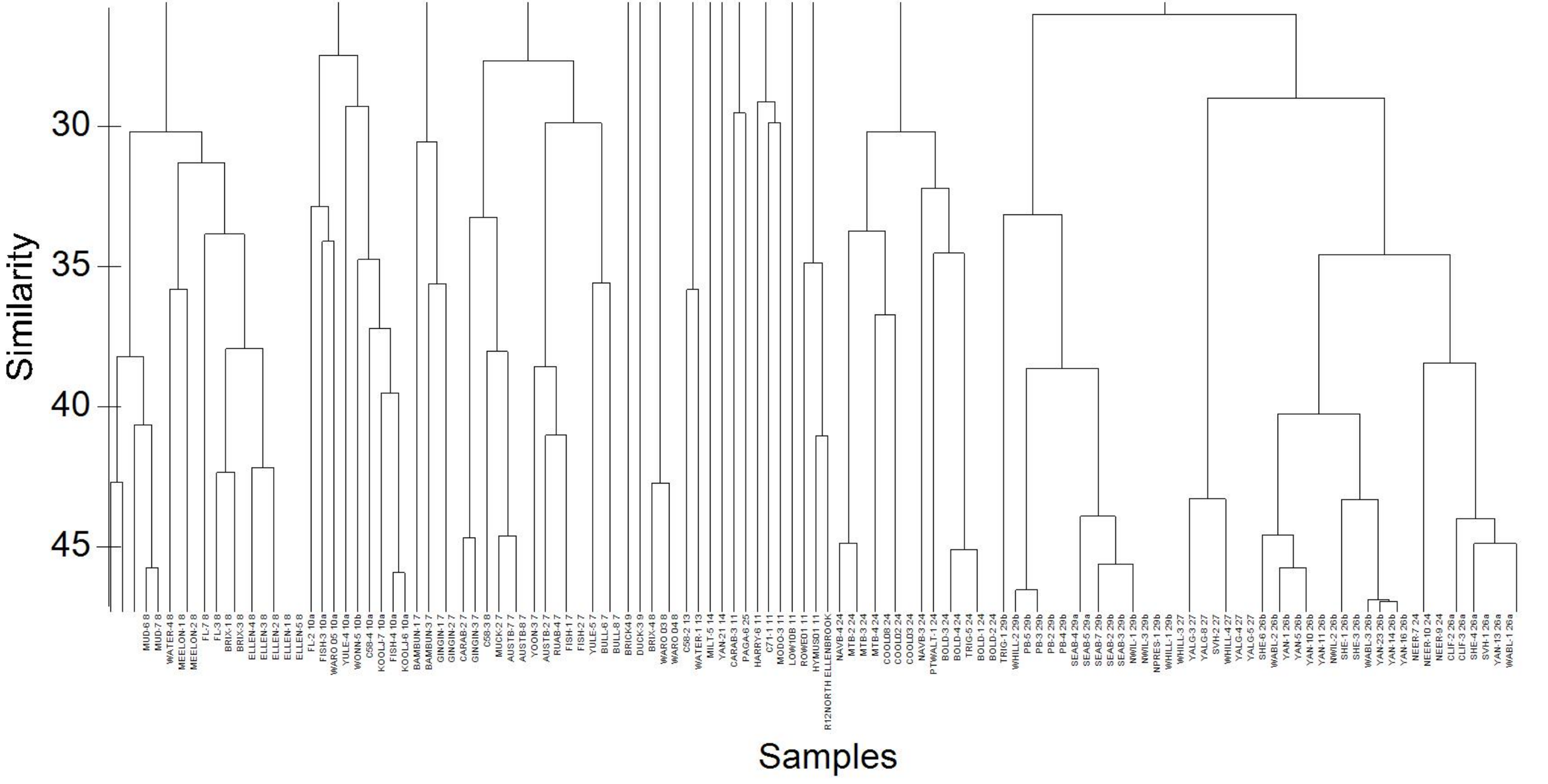
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
LOW10B 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
CARD11 6
CARD4 6
CARD10 6
R9NORTH ELLENBROOK
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
15
20
25
30
Samples
PLINE-1 23b
PLINE-2 23b
RAAF-2 23b
RAAF-3 23b
SINT-1 23b
YAN-19 23b
YAN-20 23b
APBF-1 20a
APBF-2 20a
M53 20a
GOLF-1 20a
LAND-1 20a
KOON-1 20a
KOON-2 20a
TWIN-7 21c
TWIN-8 21c
HYMUS04 21c
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
YULE-3 21c
TALB6 20c
TALB10 20c
TALB11 20c
TALB7 20c
TALB3 20c
TALB5 20c
TALB2 20c
TALB8 20c
TALB9 20c
CARD8 20b
CARD9 20b
BURNRD01 20b
YARL04 20b
CARD3 21a
BRICK2 20b
CARD1 20b
CARD2 20b
CARD5 20b
CARD6 20b
BURNRD02 3b
YARL03 3b
CARD12 3b
CARD13 3b
WARO 01 3b
WARO 02 3b
DUNS-1 3b
KOOLJ-5 3b
CARD11 6
CARD4 6
CARD10 6
R10NORTH ELLENBROOK
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOWD8 5
LOWD9A 5
LOWD9B 5
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
30
35
40
45
Samples
SEAB-6 28
YAN-8 28
YAN-9 28
KERO-1 24
THOM-2 24
KERO-2 24
MTB-1 24
HARRY-1 28
HARRY-2 28
TAM-1 21a
WELL-1 21a
PAGA-4 21a
PAGA-7 21a
HARRY-5 21a
WELL-2 21a
NEER-23 28
NEER-22 28
NEER-20 28
NEER-21 28
NEER-2 28
NEER-6 28
WOODV-1 28
WOODV-2 28
DEPOT-1 28
NEER-5 28
YAN-3 28
NEER-3 28
NEER-4 28
TRIG-4 28
KING-1 28
KING-2 28
WARI-1 28
WARI-2 28
SHENT-1 28
TRIG-3 28
TRIG-6 24
NEER-1 24
NEER-11 24
PEPB-1 30b
C71-4 25
MINN-1 25
MINN-2 25
MEAL-2 26b
YALG-2 26b
YALG-6 26b
YALG-7 26b
WHILL-5 26b
YALG-1 26b
PAGA-8 25
MEAL-1 25
MYALUP-2 25
CORON-2 25
KEME-1 25
LYONS-2 25
MINN-3 25
Q11NORTH ELLENBROOK
HYMUS04 21c
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
FL-4 21a
BULLER-3 21c
KEME-3 21c
LOW01 21c
LOW06A 21c
LOW04 21a
LOW06B 21c
LOW07 21c
LOW13A 21a
LOW10A 21a
LOW12A 21a
LOW12B 21a
MILT-6 21a
PLINE-3 21a
KOOLJ-2 21a
KOOLJ-3 21a
KOOLJ-4 21a
MANEA-2 21a
CARB-3 21b
RIVD-2 21a
CORON-1 21a
NINE-2 21a
MANEA-3 21b
CAPEL-2 21b
RUAB-1 21b
RUAB-2 21b
KELLY02 21b
CAPEL-1 21b
GIBSON01 21b
GUTHR-6 21a
DARD02 21b
BOYAN01 21b
BUFFER01 21b
REDL-1 21a
KEME-2 21a
CLIF-1 21a
GUTHR-5 21a
GUTHR-3 21a
CRAMPT-1 21a
CRAMPT-2 21a
CAPEL-7 21a
DRAIN-1 21a
C71-2 21a
C71-3 21a
AUSTRA-1 21a
BULLER-2 21a
NINE-1 21a
BULLER-1 21a
CARD7 21a
TWIN-7 21c
TWIN-8 21c
BANK-1 22
DEJONG-A 22
MELA-5 22
MPKD2 22
MELA-10 22
WARB-2 22

Group average

Resemblance: S17 Bray Curtis similarity



Group average

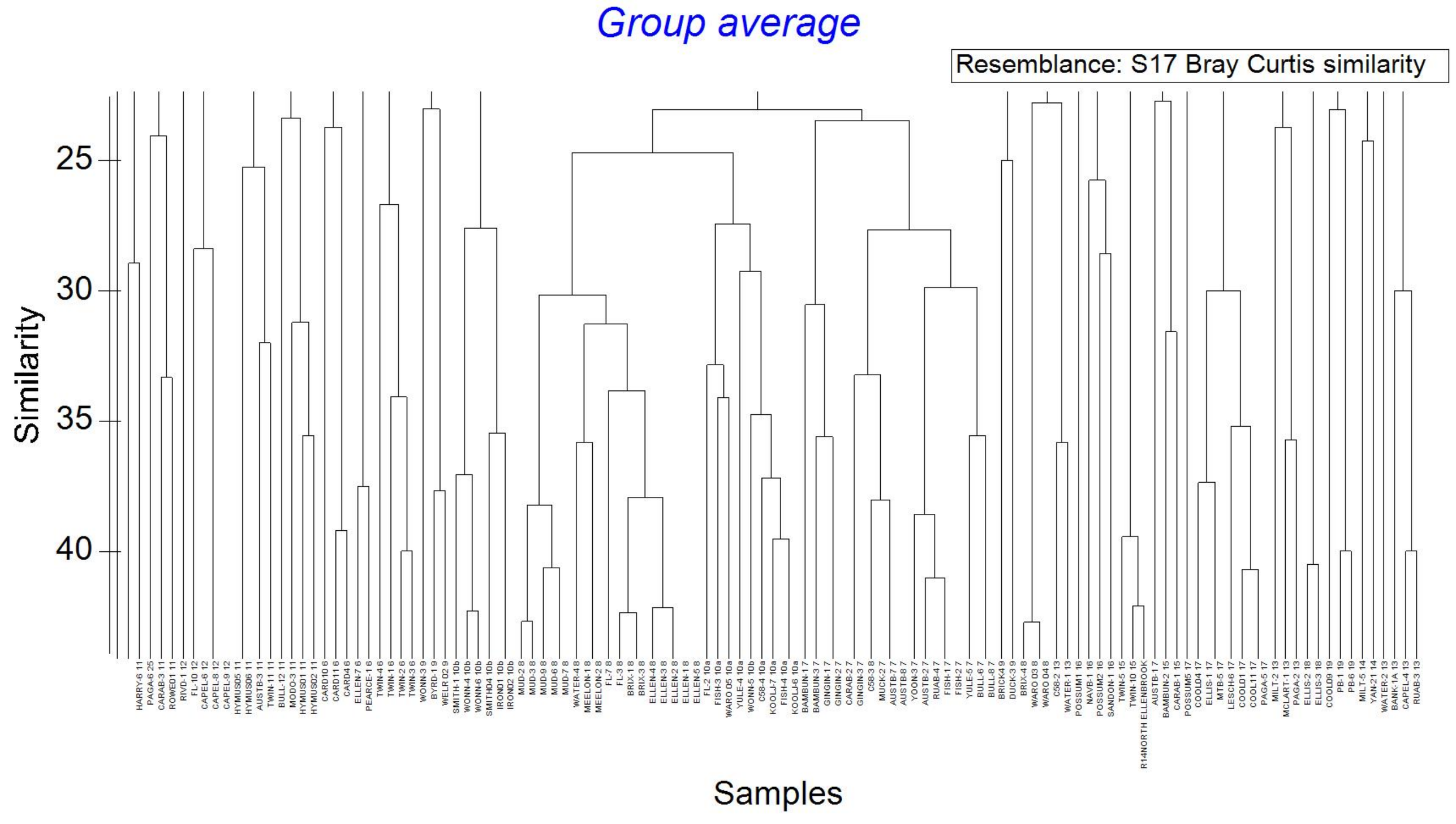
Resemblance: S17 Bray Curtis similarity

Similarity

20
25
30
35

RAAF-2 23b
RAAF-3 23b
SINT-1 23b
YAN-19 23b
YAN-20 23b
APBF-1 20a
APBF-2 20a
M53 20a
GOLF-1 20a
LAND-1 20a
KOON-1 20a
KOON-2 20a
TWIN-7 21c
TWIN-8 21c
HYMUS04 21c
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
YULE-3 21c
TALB6 20c
TALB10 20c
TALB11 20c
TALB7 20c
TALB3 20c
TALB5 20c
TALB2 20c
TALB8 20c
TALB9 20c
CARD8 20b
CARD9 20b
BURNRD01 20b
YARL042 0b
CARD3 21a
BRICK2 20b
CARD1 20b
CARD2 20b
CARD5 20b
CARD6 20b
BURNRD02 3b
YARL03 3b
CARD12 3b
CARD13 3b
WARO 01 3b
WARO 02 3b
DUNS-1 3b
KOOLJ-5 3b
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
TWIN-16
Q13NORTH ELLENBROOK
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-55
PAGA-35
PAGA-15
LOWD8 5
LOWD9A 5
LOWD9B 5
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWED2 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-45
AUSTB-65
GUTHR-2 5
GUTHR-45
HARRY-3 5
MILT-1 5
ELLEN-7 6
PEARCE-16
TWIN-46
BAMBUN-1 7
TWIN-2 6
TWIN-3 6
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8

Samples


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
25
30
35
40
Samples
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWED1 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUSD5 11
HYMUSD6 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUSD1 11
HYMUSD2 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRONO1 10b
IRONO2 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK49
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
POSSUM1 16
NAYB-1 16
POSSUM2 16
SANDON-1 16
TWIN-5 15
TWIN-10 15
R14NORTH ELLENBROOK
AUSTB-1 7
BAMBUN-2 15
CARAB-1 15
POSSUM5 17
COOLD4 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOLD1 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13
PAGA-2 13
ELLIS-2 18
ELLIS-3 18
COOL09 19
PB-1 19
PB-6 19
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1A 13
CAPEL-4 13
RUAB-3 13

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

15
20
25
30

HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWED1 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUSD5 11
HYMUSD6 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUSD1 11
HYMUSD2 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRONO1 10b
IRONO2 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
R15NORTH ELLENBROOK
POSSUM5 17
COOLD4 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOL01 17
COOL11 17
PAGA-5 17
MILT-2 13
MCLART-1 13
PAGA-2 13
ELLIS-2 18
ELLIS-3 18
COOL09 19
PB-1 19
PB-6 19
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1A 13
CAPEL-4 13
RUAB-3 13

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

25

30

35

HYMUS04 21c
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
YULE-3 21c
TALB6 20c
TALB10 20c
TALB11 20c
TALB7 20c
TALB3 20c
TALB5 20c
TALB2 20c
TALB8 20c
TALB9 20c
CARD8 20b
CARD9 20b
BURNRD01 20b
YARL04 20b
CARD3 21a
BRICK2 20b
CARD1 20b
CARD2 20b
CARD5 20b
CARD6 20b
BURNRD02 3b
YARL03 3b
CARD12 3b
CARD13 3b
WARO 01 3b
WARO 02 3b
DUNS-1 3b
KOOLJ-5 3b
CARD10 6
R16NORTH ELLENBROOK
CARD11 6
CARD4 6
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOW08 5
LOW09A 5
LOW09B 5
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

20

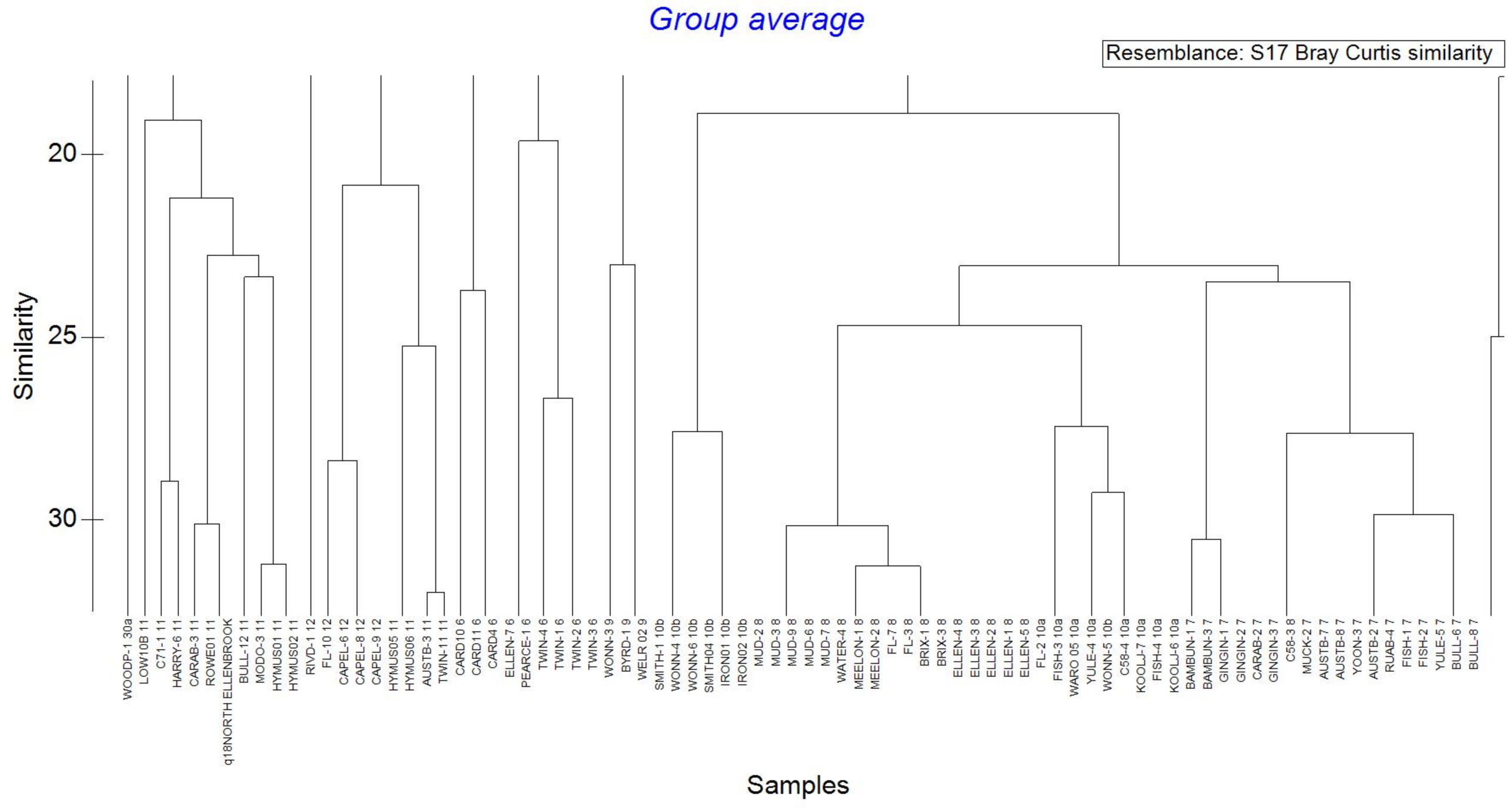
25

30

35

WOODP-1 30a
C71-1 11
HARRY-6 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
LOW10B 11
q17NORTH ELLENBROOK
CARAB-3 11
ROWED1 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-16
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR02 9
SMITH-1 10b
WONN-4 10b
WONN-5 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO03 8
WARO04 8
C58-2 13
WATER-1 13
PAGA-6 25
NAVB-4 24
MTB-2 24
MTB-3 24
MTB-4 24
COOL08 24
COOL02 24
COOL03 24
NAVB-3 24
PTWALT-1 24
BOLD-3 24
BOLD-4 24
TRIG-5 24
BOLD-1 24
BOLD-2 24
TRIG-1 29b
WHILL-2 29b
PB-5 29b
PB-3 29b
PB-2 29b
PB-4 29b
SEAB-4 29a
SEAB-5 29a
SEAB-7 29b
SEAB-2 29b
SEAB-3 29b
NWIL-1 29b
NWIL-3 29b
NPRES-1 29b

Samples


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
20
25
30
Samples
WOODP-1 30a
LOW10B 11
C71-1 11
HARRY-6 11
CARAB-3 11
ROWE01 11
q18NORTH ELLENBROOK
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

35

40

45

BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
LOW10B 11
PAGA-6 25
CARAB-3 11
ROWE01 11
r19NORTH ELLENBROOK
C71-1 11
HARRY-6 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

25

30

35

KOON-2 20a
TWIN-7 21c
TWIN-8 21c
HYMUS04 21c
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
YULE-3 21c
TALB6 20c
TALB10 20c
TALB11 20c
TALB7 20c
TALB3 20c
TALB5 20c
TALB2 20c
TALB8 20c
TALB9 20c
CARD8 20b
CARD9 20b
BURNRD01 20b
YARL04 20b
CARD3 21a
BRICK2 20b
CARD1 20b
CARD2 20b
CARD5 20b
CARD6 20b
BURNRD02 3b
YARL03 3b
CARD12 3b
CARD13 3b
WARO 01 3b
WARO 02 3b
DUNS-1 3b
KOOLJ-5 3b
r20NORTH ELLENBROOK
PLINE-4 4
WHITE-2 4
CARD10 6
CARD11 6
CARD4 6
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

15
20
25
30

LOW09B 5
PLINE-4 4
WHITE-2 4
KOOLJ-1 4
MELA-1 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWE02 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUSD5 11
HYMUSD6 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUSD1 11
HYMUSD2 11
q21NORTH ELLENBROOK
LOW10B 11
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
POSSUM1 16
NAVB-1 16

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

25

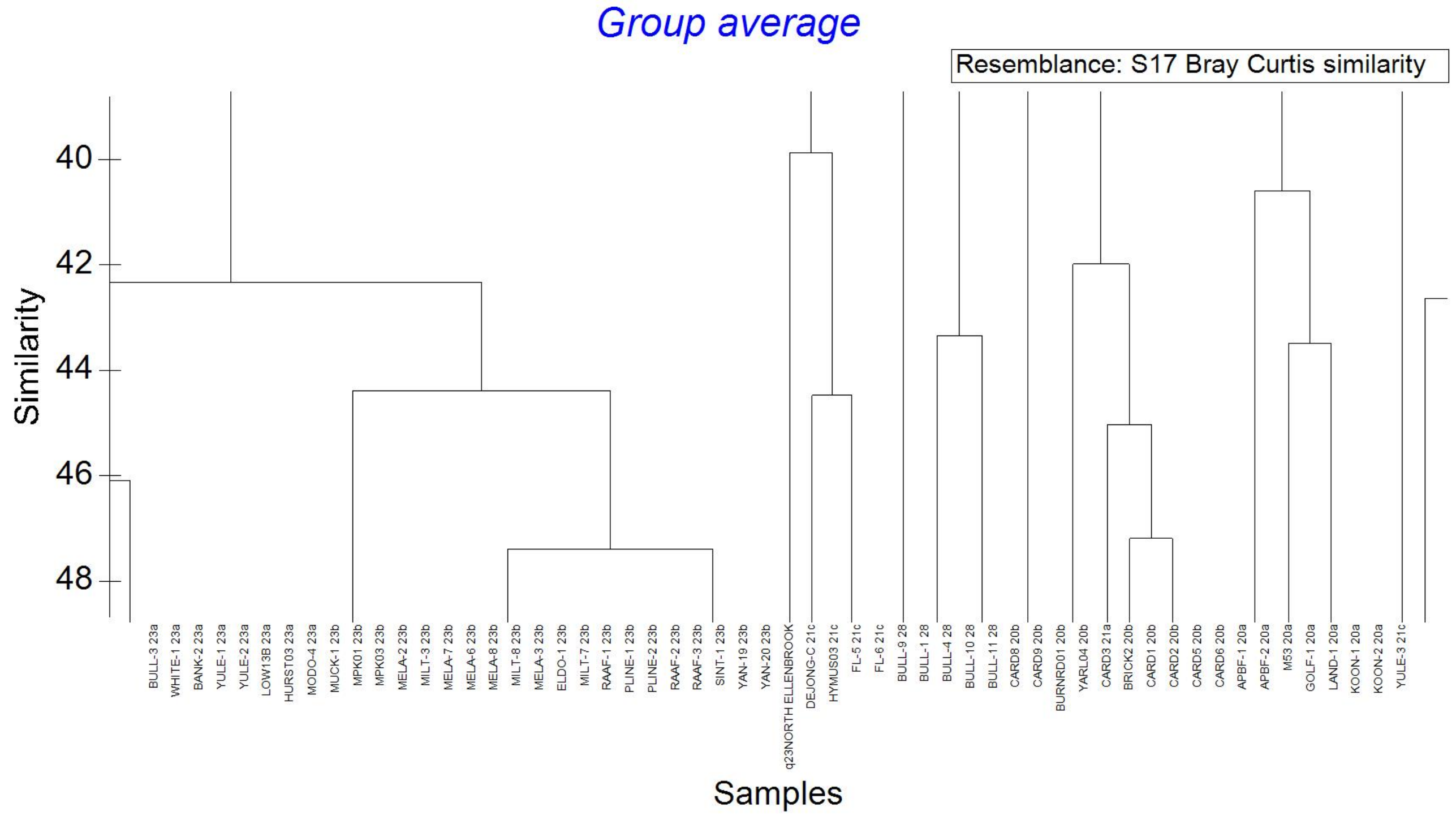
30

35

40

CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
WONN-3 9
BYRD-1 9
WELR 02 9
SMITH-1 10b
WONN-4 10b
WONN-6 10b
SMITH04 10b
IRON01 10b
IRON02 10b
MUD-2 8
MUD-3 8
MUD-9 8
MUD-6 8
MUD-7 8
WATER-4 8
MEELON-1 8
MEELON-2 8
FL-7 8
FL-3 8
BRIX-1 8
BRIX-3 8
ELLEN-4 8
ELLEN-3 8
ELLEN-2 8
ELLEN-1 8
ELLEN-5 8
FL-2 10a
FISH-3 10a
WARO 05 10a
YULE-4 10a
WONN-5 10b
C58-4 10a
KOOLJ-7 10a
FISH-4 10a
KOOLJ-6 10a
BAMBUN-1 7
BAMBUN-3 7
GINGIN-1 7
GINGIN-2 7
CARAB-2 7
GINGIN-3 7
C58-3 8
MUCK-2 7
AUSTB-7 7
AUSTB-8 7
YOON-3 7
AUSTB-2 7
RUAB-4 7
FISH-1 7
FISH-2 7
YULE-5 7
BULL-6 7
BULL-8 7
BRICK4 9
DUCK-3 9
BRIX-4 8
WARO 03 8
WARO 04 8
C58-2 13
WATER-1 13
LOWI0B 11
MILT-2 13
I22NORTH ELLENBROOK
C71-1 11
HARRY-6 11
PAGA-6 25
CARAB-3 11
ROWE01 11
RIVD-1 12
FL-10 12
CAPEL-6 12
CAPEL-8 12
CAPEL-9 12
HYMUS05 11
HYMUS06 11
AUSTB-3 11
TWIN-11 11
BULL-12 11
MODO-3 11
HYMUS01 11
HYMUS02 11
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
ELLIS-2 18
ELLIS-3 18
COOL09 19
PB-1 19
PB-6 19
POSSUM5 17
MCLART-1 13
PAGA-2 13
COOL04 17
ELLIS-1 17
MTB-5 17
LESCH-6 17
COOL01 17
COOL11 17
PAGA-5 17
MILT-5 14
YAN-21 14
WATER-2 13
BANK-1A 13
CAPEL-4 13
RUAB-3 13

Samples


Group average
Resemblance: S17 Bray Curtis similarity
Similarity
40
42
44
46
48
BULL-3 23a
WHITE-1 23a
BANK-2 23a
YULE-1 23a
YULE-2 23a
LOW13B 23a
HURST03 23a
MODO-4 23a
MUCK-1 23b
MPK01 23b
MPK03 23b
MELA-2 23b
MILT-3 23b
MELA-7 23b
MELA-6 23b
MELA-8 23b
MILT-8 23b
MELA-3 23b
ELDO-1 23b
MILT-7 23b
RAAF-1 23b
PLINE-1 23b
PLINE-2 23b
RAAF-2 23b
RAAF-3 23b
SINT-1 23b
YAN-19 23b
YAN-20 23b
q23NORTH ELLENBROOK
DEJONG-C 21c
HYMUS03 21c
FL-5 21c
FL-6 21c
BULL-9 28
BULL-1 28
BULL-4 28
BULL-10 28
BULL-11 28
CARD8 20b
CARD9 20b
BURNRD01 20b
YARL04 20b
CARD3 21a
BRICK2 20b
CARD1 20b
CARD2 20b
CARD5 20b
CARD6 20b
APBF-1 20a
APBF-2 20a
M53 20a
GOLF-1 20a
LAND-1 20a
KOON-1 20a
KOON-2 20a
YULE-3 21c
Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

15
20
25
30
35

SEAB-8 29a
PLINE-6 22
YAN-18 22
YAN-17 22
YAN-22 22
YOON-2 2
CARB-2 1b
YOON-1 1b
OATES-1 21b
CAPEL-5 1b
WONN02 1b
WILL02 1a
BOYAN02 1a
KELLY01 1a
DARD01 1a
DARD03 1a
KEMP01 1a
WICHER01 1a
ACTON-1 1a
SMITH02 1a
SMITH03 1a
WONN01 1a
CARB-1 1b
CARB-4 1b
YALLIN-1 1b
AMBR-6 1b
AMBR-9 1b
AMBR-4 1b
AMBR-1 1b
AMBRAL-1 1b
GIBSON02 1a
WILL04 1a
WATER-3 3c
YARL01 3c
ELLEN-6 3c
DUCK-1 3c
DUCK-2 3c
LAMB1 3a
LAMB2 3a
BRICK5 3a
WARO 06 3a
BRICK1 3a
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
r24NORTH ELLENBROOK
YAN-6 28
NEER-8 28
YAN-4 28
WABL-4 28
MILT-4 28
SHE-2 28
WATERRD1 28
YAN-25 28
SEAB-6 28
YAN-8 28
YAN-9 28
KERO-1 24
THOM-2 24
KERO-2 24
MTB-1 24
HARRY-1 28
HARRY-2 28
TAM-1 21a
WELL-1 21a
PAGA-4 21a
PAGA-7 21a
HARRY-5 21a
WELL-2 21a
NEER-23 28
NEER-22 28
NEER-20 28
NEER-21 28
NEER-2 28
NEER-6 28
WOODV-1 28
WOODV-2 28
DEPOT-1 28
NEER-5 28
YAN-3 28
NEER-3 28
NEER-4 28
TRIG-4 28
KING-1 28
KING-2 28
WARI-1 28
WARI-2 28
SHENT-1 28
TRIG-3 28
TRIG-6 24
NEER-1 24
NEER-11 24
PEPB-1 30b
C71-4 25
MINN-1 25
MINN-2 25
MEAL-2 26b
YALG-2 26b
YALG-6 26b
YALG-7 26b
WHILL-5 26b
YALG-1 26b
PAGA-8 25
MEAL-1 25
MYALUP-2 25
CORON-2 25
KEME-1 25
LYONS-2 25
MINN-3 25
FL-4 21a
BULLER-3 21c
KEME-3 21c
LOW01 21c
LOW06A 21c
LOW04 21a
LOW06B 21c
LOW07 21c
LOW13A 21a

Samples

Group average

Resemblance: S17 Bray Curtis similarity

Similarity

25
30
35
40
45

BOYAND2 1a
KELLY01 1a
DARD01 1a
DARD03 1a
KEMP01 1a
WICHERD1 1a
ACTON-1 1a
SMITH02 1a
SMITH03 1a
WONND1 1a
CARB-1 1b
CARB-4 1b
YALLIN-1 1b
AMBR-6 1b
AMBR-9 1b
AMBR-4 1b
AMBR-1 1b
AMBRAL-1 1b
GIBSOND2 1a
WILL04 1a
WATER-3 3c
YARL01 3c
ELLEN-6 3c
DUCK-1 3c
DUCK-2 3c
LAMB1 3a
LAMB2 3a
BRICK5 3a
WARO 06 3a
BRICK1 3a
BRICK3 3a
BRICK8 3a
BRICK6 3a
BRICK7 3a
BRIX-2 3a
BRIX-5 3a
MUD-4 3a
MUD-5 3a
TALB1 3c
TALB12 3c
TALB13 3c
PEARCE-2 3c
TALB4 3c
LOW10B 11
CARAB-3 11
PAGA-6 25
ROWED1 11
HYMUS01 11
i25NORTH ELLENBROOK
HARRY-6 11
C71-1 11
MODO-3 11
CARD10 6
CARD11 6
CARD4 6
ELLEN-7 6
PEARCE-1 6
TWIN-4 6
TWIN-1 6
TWIN-2 6
TWIN-3 6
PAYNE-1 4
WILL03 10b
WILL-1 10b
FISH-5 2
AMBR-5 2
AMBR-2 2
AMBR-7 2
BULL-5 5
BULL-7 5
PLINE-5 5
MODO-2 21c
PLINE-7 21c
AUSTB-4 5
AUSTB-6 5
GUTHR-2 5
GUTHR-4 5
HARRY-3 5
MILT-1 5
RIVD-1 12
TWIN-11 11
KOOLJ-1 4
MELA-1 4
YARL02 9
MANEA-1 9
WELR 01 9
AUSTB-5 5
PAGA-3 5
PAGA-1 5
LOWD8 5
LOWD9B 5
LOWD9A 5
PLINE-4 4
WHITE-2 4
AMBR-3 4
CAPEL-3 4
FL-1 4
LYONS-1 4
LOW14A 4
ROWED2 4
GUTHR-1 4
FL-9 4
C58-1 4
MODO-1 4
MODO-6 4
POSSUM1 16
NAVB-1 16
POSSUM2 16
SANDON-1 16
AUSTB-1 7
TWIN-10 15
TWIN-5 15
BAMBUN-2 15
CARAB-1 15
POSSUM5 17
COOL04 17
ELLIS-1 17
MTB-5 17

Samples

Appendix C

Fauna Assessment (BCE 2019)

Prepared by Bamford Consulting Ecologists (BCE) (2019)

Fauna Assessment
Various Lots, Bullsbrook

Remnant Marri woodland in grassed paddock in the Survey Area (photo: Barry Shepherd)

Prepared for: Emerge Associates
24 Railway Road
Subiaco WA 6008
On behalf of Lendlease

Prepared by: Barry Shepherd, Andrew Moore and Mike Bamford
M.J. & A.R. Bamford Consulting Ecologists
23 Plover Way
Kingsley, WA 6026

23rd April 2019

Executive Summary

Overview

Bamford Consulting Ecologists (BCE) was commissioned by Emerge Associates on behalf of Lendlease to conduct a level 1 fauna and targeted black-cockatoo assessment on several lots lying between Maralla and Warbrook roads in Bullsbrook.

A level 1 assessment involves a Survey Area inspection and desktop review, and can be a powerful approach for impact assessment where there is abundant information available on the fauna assemblage of the local area and general region, and where the consultant is familiar with the area, which is the case at Ellenbrook. Available databases contain extensive information on fauna in the region, and BCE has undertaken several level 1 and more intensive sampling assessments in the area (see Section 2.2.2).

Survey Area Description

The Survey Area is located approximately 26 kilometres (km) north-north-east of Perth, between the suburbs of Ellenbrook and Bullsbrook in the City of Swan. The Survey Area is located across Lots 2-5, 10-15, 29-33 and 101, 104, 106, 116 and 8247, and covers an area of approximately 500 hectares (ha).

The Survey Area is situated on low density, semi-rural land that is designated General Rural in the City of Swan's Local Planning Scheme 17 (LPS17) (City of Swan, 2018). The Survey Area is bounded by Railway Parade to the east, Maralla Road in the south, the new NorthLink Road to the west (under construction at the time of survey) and Warbrook Road to the north. Occupied dwellings and agricultural type buildings and structures were present on most lots.

The Survey Area is a brownfield site having been mostly cleared of native vegetation and sits on the eastern side of the Swan Coastal Plain. Underlying soils are formed on the Bassendean Sands over the Guildford Formation. This area is low-lying and situated within the Ellen Brook Floodplain. It is frequently inundated and as such, the majority of the Survey Area is classified a "multiple use" wetland that has a marked influence on the fauna assemblage likely to be present. Vegetation on the Survey Area is a mixture of improved grasslands cleared of native vegetation, and remnant patches of native vegetation.

Vegetation and Substrate Associations (VSAs)

Seven broad VSAs as defined by BCE were identified within the Survey Area from aerial images and during the field investigation (Figure 4):

VSA 1: Melaleuca shrubland of varying condition with fairly intact vegetation along the watercourse

VSA 2: Marri woodland in varying condition with smaller stands generally not very intact and larger stand being more intact, with the best representation on Lot 5.

VSA 3: Banksia woodland generally in poor condition and not very intact

VSA 4: Cleared areas almost devoid of native vegetation but which contains isolated trees, a few weed species, fallen trees and other features of use to fauna

VSA 5: Melaleuca and Astartea shrubland with dense understorey in places and occasional large trees in relatively intact condition
VSA 6: Jacksonia over Dasypogon herbland offering little structure and not very intact
VSA 7: Surface water in ponds and seasonal creeks of varying condition with ponds showing signs of nutrient enrichment.

The vegetation in poor condition may have little structure or botanical diversity, but can still offer important resources across the landscape for certain fauna including common and Threatened species alike. Open paddocks cleared of native vegetation offer foraging opportunities to insectivorous and granivorous birds, reptiles and mammals. Therefore, while most vegetation across the Survey Area has little to no inherent botanical interest and doesn't form a defined native ecological community, it has value to native fauna.

Fauna assemblage and significant species

The desktop study identified 235 vertebrate fauna species as potentially occurring in the Survey Area (see Table 3 and Appendix 3): seven fish, nine frogs, 35 reptiles, 162 birds, and 22 mammals. Of these, three fish, nine birds and five mammals are introduced species. Based primarily upon databases, 75 vertebrate species of conservation significance may occur in the study area, with the majority of these being birds classed as Conservation Significant 3 (Locally significant; see Table 5). Through the course of the desktop study, four invertebrates of conservation significance were identified as being potentially present in the Survey Area.

Two bird species of high conservation significance (Conservation Significance 1; listed under legislation) were either recorded or are known to occur or thought likely to occur regularly in the Survey Area:

- Carnaby's Black-Cockatoo - *Calyptorhynchus latirostris*
- Forest Red-tailed Black-Cockatoo - *Calyptorhynchus banksii naso*

Baudin's is a third species of Black-Cockatoo endemic to Western Australia but is unlikely to occur in the Survey Area, and if it does, it is likely to be fleeting. The study area was assessed for its foraging value for the two Black-Cockatoo species that are expected to occur in the area on a regular basis using the criteria outlined in Appendix 7. The patches of woodland over the Survey Area are in poor to moderate condition. Based on the condition and extent of the native vegetation, signs of foraging of both Carnaby's and Forest Red-tailed Black-Cockatoo, and the presence of a range of primary plant foraging species, the Survey Area has scored between 3 and 7 out of 10 for Carnaby's Black-Cockatoo and between 2 and 8 out of 10 for Forest Red-tailed Black-Cockatoo, depending on the quality of the habitat types. Four trees were found to have hollows potentially suited to nesting Black-Cockatoos; the openings or hollows had been chewed or scratched, or egg fragments potentially from black-Cockatoo were found inside suggesting that cockatoos had inspected or potentially occupied them. A further nine trees may have hollows suitable for black-Cockatoos.

Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations, but it is possible to draw some general conclusions based upon the size of the study area and the patterns of soils and vegetation across the landscape. Cleared areas (VSA 4) will be low in biodiversity but when such areas flood, they can support waterbirds. The remnant patches of Marri and Melaleuca woodland (VSA 1 and VSA 2) are reasonably intact and offer shelter and foraging opportunities for a range of vertebrate species and were the habitats in which Quenda diggings were found. The water courses provide connectivity to other stands and by crossing roads allow fauna to move between the Survey Area and surrounding bush. Therefore, the woodland that lies adjacent to the creeks and ponds is of value for fauna. Bushland of the northern Swan Coastal Plain is well recognised as having high biodiversity values. There is likely to be a high level of vertebrate fauna biodiversity, particularly birds and frogs, and to a lesser degree for reptiles and mammals; reptiles will have reduced diversity due to the regular inundation across the wetland. At the micro-landscape scale, individual large Jarrah and Marri trees may be important for hollow-nesting and roosting species, while the mixed Astartea and Jacksonia shrubland will be significant for nectarivorous birds and for Carnaby's Black-Cockatoo.

Key ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function. These include:

Fire. With the exception of some older dead trees scattered across the Survey Area, there are few indications that fire has affected any of the Survey Area in recent years and fuel loading is not high on any of the lots. Therefore, fire does not seem to have played a role in shaping the fauna assemblage.

Feral species and interactions with over-abundant native species. Feral species occur throughout Western Australia, with the Rabbit, Fox and Cat having been recorded during the Survey Area inspection. Additional species are expected to be resident. Honey Bees were commonly spotted in tree hollows; some of which appeared to be large enough for the larger cockatoo species. The Long-billed Corella and Galah were also recorded and these two species are introduced and over-abundant respectively.

Hydrology. Vegetation along the creeklines is clearly influenced by a relatively high water table and water is likely to be present in some of the ponds throughout most years. Remaining vegetation across the Survey Area is also likely to depend on groundwater that is relatively close to the surface, with the exception of the banksia woodland in the south west on higher ground. Changes to the groundwater regime would likely have the single largest and most widespread impact on the native wildlife on and adjacent to the Survey Area.

Connectivity and landscape permeability. The Survey Area is surrounded on all sides and dissected by roads. This will limit the movement of ground-dwelling animals. While no direct connectivity to surrounding vegetation remains, birds and larger fauna will be able to cross the

relatively narrow roads to the south, east and west. On completion of the Northlink Highway lying along the western boundary, a fauna overpass will offer connectivity for smaller birds and ground fauna. Important lines of connectivity exist along the creeklines that feed the Ellen Brook and Swan River. These corridors will be particularly important during flood for aquatic animals or those that take readily to water. In dryer periods, they will be of use to most ground dwelling animals including feral species.

Recommended Additional Survey

- Conduct Level 1 survey and black-cockatoo foraging habitat assessment on the remaining Lots within the Survey Area
- Inspect other potential tree hollows for actual or signs of Black-Cockatoo nesting.

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1 Introduction

Bamford Consulting Ecologists (BCE) was commissioned by Emerge Associates on behalf of Lendlease to conduct a level 1 fauna and Black-Cockatoo assessment on several lots lying between Maralla and Warbrook roads in Bullsbrook.

A level 1 assessment involves an inspection and desktop review to describe the fauna assemblage of the local area and general region, and to provide a baseline assessment of the fauna values likely to be present. It is often the most appropriate way to describe the fauna assemblage where the consultant is familiar with the area, which is the case at Bullsbrook; a field sampling programme to describe the general fauna assemblage would be a major undertaking and is unlikely to ever define all species present. Available databases contain extensive information on fauna in the region, and BCE has undertaken several level 1 assessments in the area (see Section 2.2.2). A Black-Cockatoo foraging habitat assessment involves the inspection of habitats and potential for tree hollows and is required for the Survey Area due to the presence of suitable foraging habitat and the presence of eucalypts that may be suited to nesting Black-Cockatoos.

1.1 Description of Survey Area

The Survey Area is located in the suburb of Bullsbrook approximately 26 kilometres (km) north of the Perth CBD and directly north of Ellenbrook (Figure 1) in the City of Swan. The Survey Area is located across Lots 2-5, 10-15, 29-33 and 101, 104, 106, 116 and 8247 (see Figure 2), and covers an area of approximately 500 hectares (ha).

According to the Local Planning Scheme No. 17 (City of Swan, 2008 as amended 2018), the Survey Area is situated on land that has been designated “General Rural” in the City of Swan’s Local Planning Scheme 17 (LPS17) (City of Swan, 2018). The Survey Area is bounded by Railway Parade to the east, Maralla Road in the south, the new NorthLink Road to the west (under construction at the time of survey) and Warbrook Road to the north (Figure 1). A dwelling with associated gardens was located within most lots and occasional large sheds or other structures were also present.

The land is generally very flat being formed on alluvial soils on the eastern edge of the Swan Coastal Plain, with elevations between 24 and 56 m AHD (Australian height datum) (DPIRD, 2019). The foot of the Darling Scarp lies approximately 1.5 km to the east. The underlying soil formation across the majority of the Survey Area is thin Bassendean Sand over Guildford Formation, with possibly some overlap to the extreme south-east with Guildford Clay (Davidson, 1995). Geomorphological soil types in the Survey Area that correspond with Bassendean Sands are comprised of Yanga soils (CSIRO, 2000; DAF, 2003). Beermullah soil types possibly exist in the south-east where the Survey Area encroaches the Guildford Clays. Both these soil types are poorly drained alluvial soils of plain and sandplain (CSIRO, 2000; DAF, 2003).

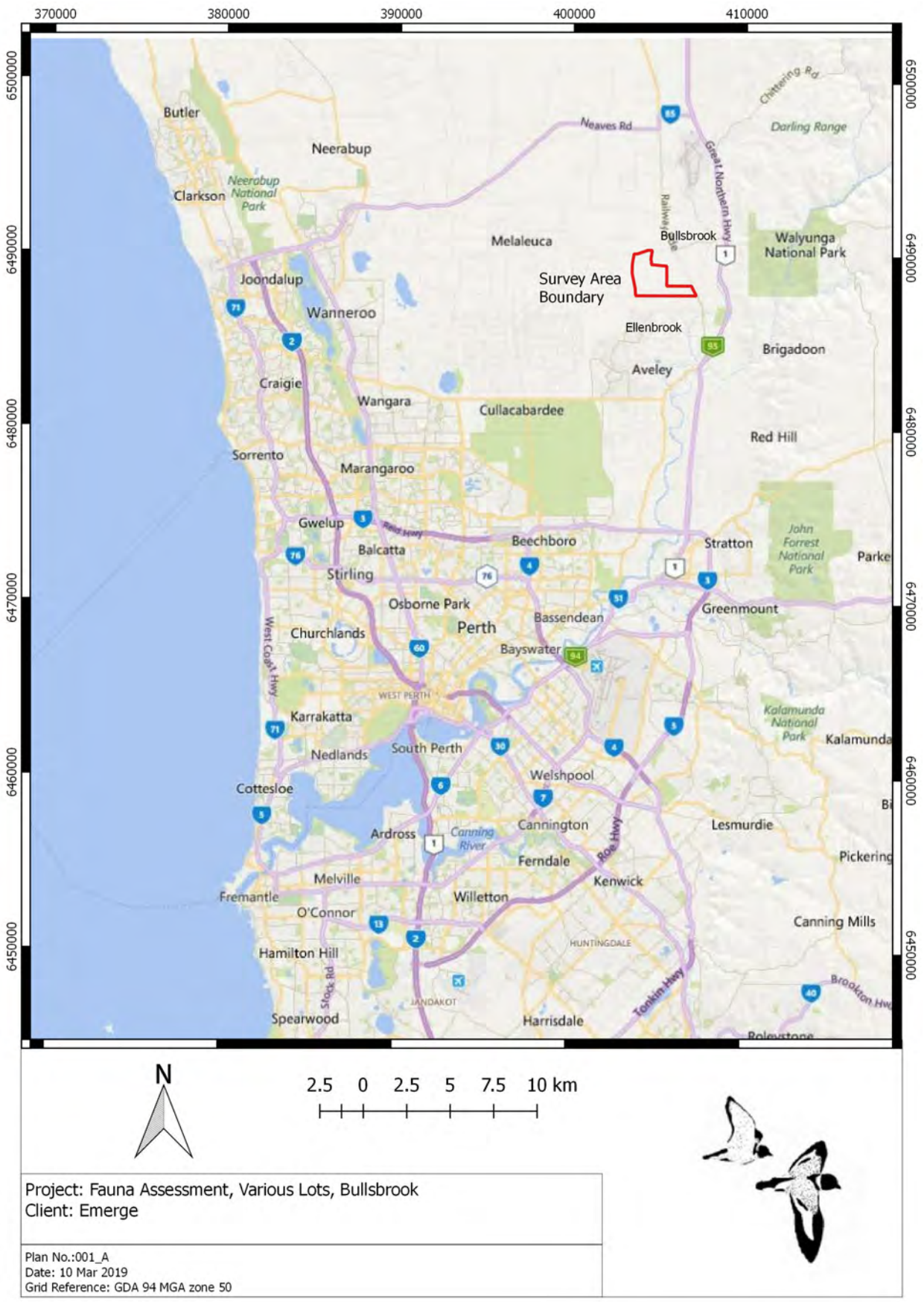

Figure 1. Location of the Survey Area

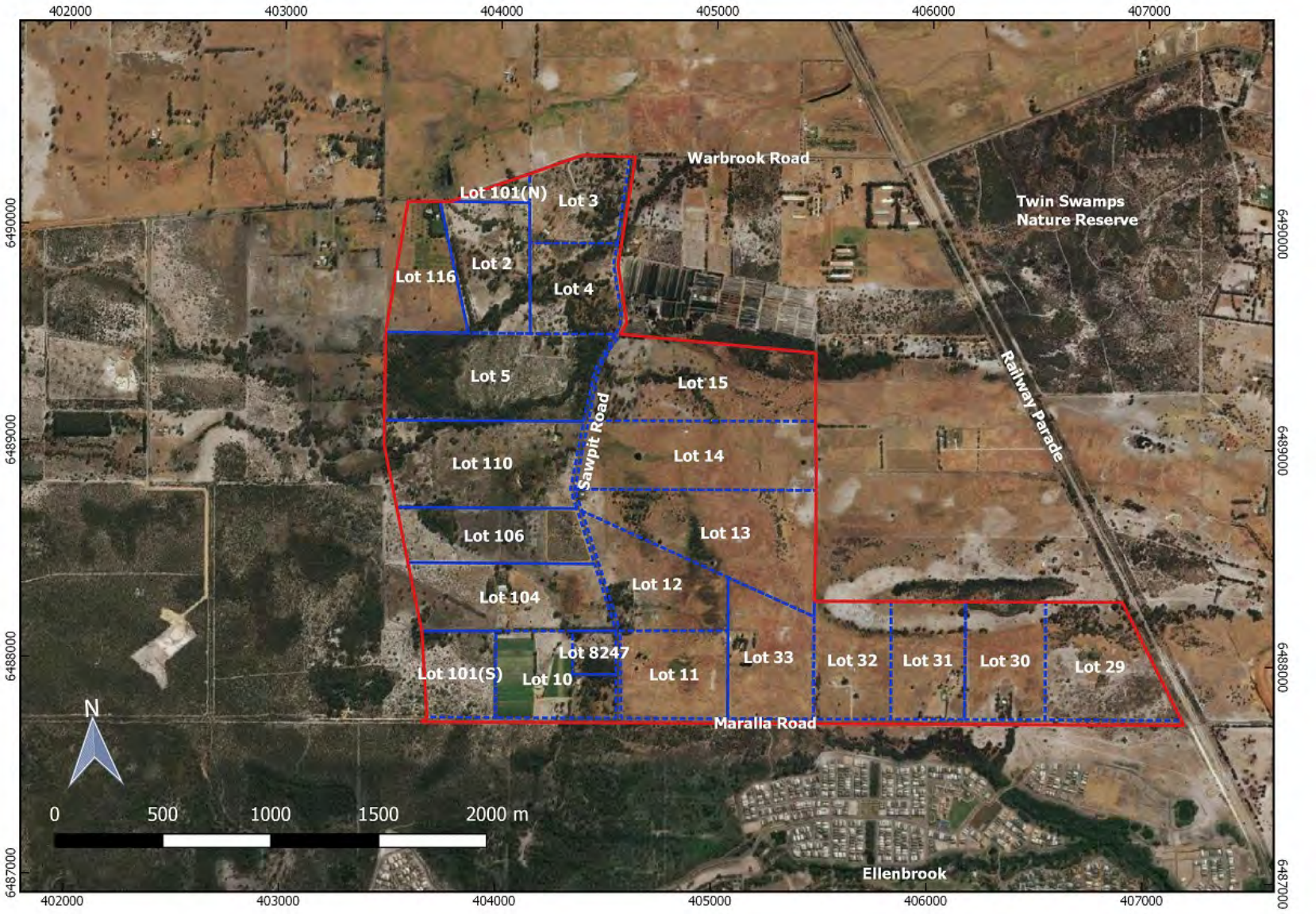

Figure 2. Site Plan showing Lot numbers, surrounding roads and features.

According to the Swan Coastal Plain Geomorphic Wetlands database, the majority of the Survey Area is evaluated as a "multiple use" wetland being located on the Ellen Brook Floodplain (ufi: 15732) and forms a palusplain being seasonally waterlogged. Several small areas have also been evaluated as either "resource enhancement" wetland or "conservation" wetland, with the latter having more of the natural features remaining and thus being able to sustain wetland functions and species. The multiple use designation identifies that most of the important natural features of the wetland have been lost (EPA 2008). The well-drained sandy soils covering the south-west corner of the Survey Area fall outside of the wetland classification.

Several key features exist in the surrounding area that will influence the fauna assemblage in the area by acting as a source of animals that may visit the Survey Area, in addition to those that are resident. A large stand of relatively intact remnant vegetation on Lot 5 has been designated as a Bush Forever Site (BFS) 13 (Sawpit Road Bushland) for the plant communities representative of the eastern side of the Swan Coastal Plain it contains, and relatively intact sample of Yanga vegetation complex and wetland creek. BFS 400 forms part of the Twin Swamps Nature Reserve (Identifier No.: R27621) which lies immediately to the north-east of the Survey Area on the eastern side of Railway Parade. The eastern part of BFS 298 (Della Road South Bushland) lies to the south of Maralla Road; note that this BFS lies along the location of the Northlink Road. Ellen Brook Nature Reserve (Identifier No.: R27620) lies some 1.78 km to the south-east; this and Twin Swamps Nature Reserve were gazetted for the protection of the last two known wild populations of the Western Swamp Tortoise *Pseudemydura umbrina*.

Immediately south of Maralla Road is a section of Marri and Banksia woodland designated as a nature reserve which also follows a tributary of Ellen Brook flowing from the west. The new Northlink Road has cut through this reserve on its westernmost boundary. To help maintain ecological linkages between each side of the Northlink Road, it is understood a fauna overpass will be built at the junction with this nature reserve (A. Biddiscombe, pers. comm.).

A large portion of the Gnangara-Moore River State Forest lies approximately 2.7 km west of the Survey Area and contains native vegetation typical of the Swan Coastal Plain, although large parts of this State Forest are heavily degraded and has been cleared and planted with pines for forestry. At the top of the Darling Scarp and 3.5 km east lies Walyunga National Park (identifier No.: R2065), which is designated for Jarrah and Marri forest and contains rocky outcrops. The fauna assemblage within the National Park will be reflective of those species that live in the environments of the escarpment and contain species that don't ordinarily reside on the Swan Coastal Plain. Despite that, it may be a source of species visiting the Survey Area. The Swan River and Ellen Brook lie to the east of the Survey Area of which the former forms the Swan River Trust Development Control Area. The majority of the surrounding area is of semi-urban development with Ellenbrook suburb lying just 200 m south of Maralla Road at its nearest.

The Interim Biogeographic Regionalisation of Australia (IBRA) has identified 26 bioregions in Western Australia which are further divided into subregions (Environment Australia 2000). Bioregions are classified on the basis of climate, geology, landforms, vegetation and fauna (Thackway and Cresswell, 1995). IBRA Bioregions are affected by a range of different threatening processes and have varying levels of sensitivity to impact (EPA, 2004). The Survey Area lies in the Swan Coastal Plain Perth Subregion.

The subregion is characterised by 'low lying coastal plain covered with woodland dominated by Banksia or Tuart on sandy soils, *Casuarina obesa* on outwash plains, and paperbark in swampy areas. The subregion is composed of colluvial and aeolian sands, alluvial river flats, and coastal limestone' (Mitchell *et al*. 2003). The dominant land uses in this subregion are mainly cultivation, conservation, UCL and Crown reserves, urban, rural residential, plantations, forestry-plantations, roads and other easements and infrastructure, and grazing.

The Survey Area is mostly grazing pasture having been cleared of the majority of native vegetation some time ago. Cattle and horses at very low densities were the only livestock present during the survey and were absent from most lots. The pasture was heavily infested with weeds and Pig Face (*Carpobrotus* sp.) was the dominant ground cover across large patches. Remnant native vegetation comprised Marri woodland, Paperbark woodland in good condition along creek lines, and remnant Banksia woodland in very degraded condition in the south-west corner in Lot 101. Planted ornamental trees were frequently located within the paddocks and along driveways including Tuart (*Eucalyptus gomphocephala*) which occur naturally further west on the Swan Coastal Plain.

Many small ponds have been formed along Sawpit Gully and its tributaries that flow to the south across Maralla Road and to Ellen Brook to the south-east of the Survey Area. Ellen Brook is a main arterial tributary of the Swan River on the Swan Coastal Plain.

2 Methods

2.1 Overview

The methods used for this desktop study and fauna investigation are based upon the general approach to fauna investigations that support impact assessment and with reference to Appendices 1 to 4. This approach to fauna impact assessment has been developed with reference to guidelines and recommendations set out by the Western Australian Environmental Protection Authority (EPA) on fauna surveys and environmental protection, and Commonwealth biodiversity legislation (EPA 2002; EPA 2004). The EPA proposes two levels of investigation that differ in the approach to field investigations, Level 1 (this assessment) being a review of data and a site reconnaissance to place data into the perspective of the Survey Area, and Level 2 being a literature review and intensive field investigations (e.g. trapping and other intensive sampling). The level of assessment recommended by the EPA is determined by the size and location of the proposed disturbance, the sensitivity of the surrounding environment in which the disturbance is planned, and the availability of pre-existing data.

The level 1 fauna assessment is divided into two stages as follows:

Desktop assessment. The purpose of the desktop review is to produce a species list that can be considered to represent the vertebrate fauna assemblage of the Survey Area based on unpublished and published data using a precautionary approach. Conservation significant invertebrates are also identified where found.

Field investigations. The purpose of the field investigations is to gather information on this assemblage: confirm the presence of as many species as possible (with an emphasis on species of conservation significance), place the list generated by the desktop review into the context of the environment of the Survey Area, collect information on the distribution and abundance of this assemblage, and develop an understanding of the Survey Area's ecological processes that maintain the fauna. Note that field investigations cannot confirm the presence of an entire assemblage or confirm the absence of a species. This requires far more work than is possible in the EIA process. For example, in an intensive trapping survey, How and Dell (1990) recorded in any one year only about 70% of the vertebrate species found over three years. In a study spanning over two decades, Bamford *et al.* (2010) has found that the vertebrate assemblage varies over time and space, meaning that even complete sampling at a single location only defines the assemblage of that site at the time of sampling.

Due to access restrictions, not all lots in Figure 2 could be visited at the time of survey. Lots 4, 11, 12, 13, 14, 15, 29, 32, 33, 101(S) and 110 were fully accessed and full Level 1 fauna survey and black-Cockatoo foraging habitat survey was completed. Lots 2, 3, 5, 10, 30, 31, 101(N), 104, 106, 116 and 8247 were not accessed. These lots contained a similar range of habitats that were present in those that were fully inspected. As such, it was assumed that the general fauna assemblage and Black-Cockatoo foraging habitat within the unvisited lots were similar to those lots that were fully inspected. The exceptions to these assumptions and extrapolations include the large stand of native vegetation in Lot 5 which appeared to be more intact than habitats on other lots, and contained large eucalypt trees which could not

be inspected for nesting hollows. In addition, trees along Maralla Road, Sawpit Road and Railway Parade were inspected for nesting hollows.

Because the Survey Area lies within the known distribution areas of Carnaby's Black-Cockatoo *Calyptorhynchus latirostris* and the Forest Red-tailed Black-Cockatoo *Calytporhynchus banksii naso*, which are listed as Endangered and Vulnerable respectively under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), a survey of the foraging habitat and nesting potential for these two species on the Survey Area was conducted at the same time. In addition, tree-hollows that were potentially suitable for black-Cockatoo nesting on Lots 15, 29, 32 and along the road verges were inspected using a pole-camera in April 2019.

2.2 Desktop Assessment

2.2.1 Sources of information

Information on the fauna assemblage of the Survey Area was drawn from a range of sources. These included state and federal government databases and results of regional studies. Databases accessed were the Atlas of Living Australia (ALA), Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap (incorporating the Western Australian Museum's FaunaBase and the DBCA Threatened and Priority Fauna Database), BirdLife Australia's Atlas Database (BA) and the EPBC Protected Matters Search Tool of the Department of Energy and the Environment (DEE) as listed in Table 1. Information from the above sources was supplemented with species expected in the area based on general patterns of distribution. Sources of information used for these general patterns were:

Frogs: Tyler *et al.* (2009) and Anstis (2013);
Reptiles: Storr *et al.* (1983, 1990, 1999 and 2002) and Wilson and Swan (2017);
Birds: Johnstone and Storr (1998, 2005) and Barrett *et al.* (2003); and
Mammals: Menkhorst & Knight (2004); Armstrong (2011); Churchill (2008) and Van Dyck and Strahan (2008).

Table 1. Sources of information used for the desktop assessment.

Database	Type of records held on database	Area searched
Atlas of Living Australia.	Records of biodiversity data from multiple sources across Australia.	Point search: 31° 29' 55"S, 115° 53' 15"E plus 20 km buffer. Searched: Dec 2018.
NatureMap (DBCA)	Records in the WAM and DBCA databases. Includes historical data and records on Threatened and Priority species in WA.	Point search: 31° 29' 55"S, 115° 53' 15"E plus 20 km buffer. Searched: Dec 2018
BirdLife Australia Atlas Database (Birdlife Australia)	Records of bird observations in Australia, 1998-2014.	Point search: 31° 29' 55"S, 115° 53' 15"E plus 10 km buffer. Searched: Dec 2018.
EPBC Protected Matters (DEE)	Records on matters of national environmental significance protected under the EPBC Act.	Point search: 31° 29' 55"S, 115° 53' 15"E plus 10 km buffer. Searched: Dec 2018

2.2.2 Previous fauna surveys and studies

The Northern Swan Coastal Plain is known for its high biodiversity, and a number of studies have been carried out to better understand the regional and biodiversity values, especially terrestrial fauna at landscape scale, such as Valentine *et al*. (2009) and Reaveley & Bettink (2009). Several previous fauna surveys have been conducted in the northern Swan Coastal Plain and general area, both by BCE and other organisations, but none is known to have been conducted within the current Survey Area. References include: How *et al*. (2009b); Bancroft *et al.* (2018); and Bamford and Everard (2018).

2.2.3 Nomenclature and taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are based on the Western Australian Museum's (WAM) Checklist of the Fauna of Western Australia 2016. The authorities used for each vertebrate group were: amphibians (Doughty *et al*. 2016a), reptiles (Doughty *et al*. 2016b), birds (Johnstone and Darnell 2016), and mammals (Travouillon 2016). In some cases, more widely-recognised names and naming conventions have been followed, particularly for birds where there are national and international naming conventions in place (e.g. the BirdLife Australia working list of names for Australian Birds). English names of species where available are used throughout the text; binomial species names are presented with corresponding English names in tables in the appendices.

2.2.4 Interpretation of species lists

Species lists generated from the review of sources of information are generous as they include records drawn from a large region and possibly from habitats not represented in the Survey Area. Therefore, some species that were returned by one or more of the data searches have been excluded because their ecology, or the habitats within the Survey Area, meant that it is highly unlikely that these species will be present. Such species can include, for example, seabirds that

might occur as extremely rare vagrants at a terrestrial, inland site, but for which the location is of no importance.

Species returned from the databases and not excluded on the basis of ecology or environment are therefore considered potentially present or expected to be present in the Survey Area at least occasionally, whether or not they were recorded during field surveys, and whether or not the Survey Area is likely to be important for them. This list of expected species is therefore subject to interpretation by assigning each a predicted status in the Survey Area.

The status categories used are:

> **Resident:** species with a population permanently present in the area;
> **Migrant or regular visitor**: species that occur within the area regularly in at least moderate numbers, such as part of annual cycle;
> **Irregular Visitor**: species that occur within the area irregularly such as nomadic and irruptive species. The length of time between visitations could be decades but when the species is present, it uses the area in at least moderate numbers and for some time;
> **Vagrant**: species that occur within the area unpredictably, in small numbers and/or for very brief periods. Therefore, the area is unlikely to be of importance for the species; and
> **Locally extinct**: species that would have been present but has not been recently recorded in the local area and therefore is almost certainly no longer present.

These status categories make it possible to distinguish between vagrant species, which may be recorded at any time but for which the Survey Area is not important in a conservation context, and species which use the Survey Area in other ways but for which the Survey Area is important at least occasionally. This is particularly useful for birds that may naturally be migratory or nomadic, and for some mammals that can also be mobile or irruptive, and further recognises that even the most detailed field survey can fail to record species which will be present at times or may have been previously confirmed as present. The status categories are assigned conservatively. For example, a lizard known from the general area is assumed to be a resident unless there is very good evidence that the Survey Area will not support it, and even then it may be classed as a vagrant rather than assumed to be absent if the Survey Area might support dispersing individuals. It must be stressed that these status categories are predictions only and that often very intensive sampling would be required to confirm a species' status.

2.3 Field Investigation and Personnel

The Survey Area was visited on 13th and 18th December 2018 by Mr Andrew Moore (B.Sc. Botany. and Geog., M.Sc. Ren. Energy) and Dr Barry Shepherd (B.Sc. Hons. Env. Biol., Ph.D. Ecol.). Further survey visits were carried out on 10th and 15th April 2019 and a black-cockatoo roost survey was conducted from 17:10 to 18:30 (Sunset was at 17:47) on 23 April 2019. The roost survey was conducted by sampling at various locations along Maralla Road, Sawpit Road and Warbrook Road and the surrounding area searched by eye and binoculars whilst constantly listening for black-cockatoos.

2.4 Vegetation and Substrate Associations

Vegetation and Substrate Associations (VSAs) in the Survey Area were assessed during the desktop review and as part of the field investigations. Within the Survey Area, all major VSAs were visited to develop an understanding of major fauna habitat types present and to assess the likelihood of conservation significant species being present in the area.

2.5 Assessment for Black-Cockatoo foraging values and nesting hollows

The survey for Black-Cockatoo tree nesting hollow methodology followed the recommendations of DotE (2017a, b, c). When encountered during the Survey Area inspection, trees that were considered potentially suitable for use by Black-Cockatoos for nesting were noted (e.g. Jarrah, Marri, Wandoo, Dwutta, Tuart and Flooded Gum) with a diameter at breast height (DBH) equal to or greater than 500 mm; or Wandoo with a DBH ≥ 300 mm. For each tree, the following was recorded:

- tree waypoint location
- tree species
- alive/dead status
- DBH (mm)
- Category rating of 1-5 depending on nesting hollows apparent from the ground
- Notes on the location of hollows and any foraging signs.

All trees which had large enough DBHs were assessed (from the ground) using binoculars for the presence of nest-hollows and allocated a nesting value score as described in Appendix 1. Trees on Lots 29, 33 and 110, and along Maralla Road and Sawpit Road, that appeared to contain suitable hollows from the ground (assigned values of 2 or 3), were subsequently inspected using a pole-camera and re-categorised to reflect the findings. Some trees could not be inspected for safety reasons as they contained bee hives.

The Survey Area was assessed for Black-Cockatoo foraging habitat value in terms of quality and quantity. The preferred foraging plants of Forest Red-tailed and Carnaby's Black-Cockatoos varies between the two species, however there is a degree of overlap in plant preference; i.e. both species feed on Marri and Jarrah seed (Commonwealth of Australia, 2017). Therefore, similarities and differences in foraging habitat values for both black-cockatoos will depend on the vegetation assemblage, and foraging values need to be assessed separately.

Areas of remnant trees and vegetation communities were inspected for presence and extent of known foraging plant species. Evidence of Black-Cockatoo foraging (chewed seed pods or cones) was noted and the species of Black-Cockatoo was identified based on the bill marks and chew pattern on Marri fruit and Banksia cones. Foraging value of remnant vegetation patches was assigned a foraging value score for each Black-Cockatoo species based on the BCE scoring system (see Appendix 4) which uses the following habitat characteristics:

- Vegetation composition, condition and structure
- Site context
- Presence of black-cockatoo feeding and foraging residue (chewed pods, fruit or cones).

For foraging value for Black-Cockatoos, the Survey Area was assessed by inspecting the vegetation and calculating a foraging score as outlined in Appendix 7. The foraging score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the sort of information needed by the Federal Department of the Environment and Energy (DEE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed in Appendix 6. These three components are drawn from the DEE offset calculator but with the scoring approach developed by BCE:

- A score out of six for the vegetation composition, condition and structure.
- A score out of three for the context of the Survey Area.
- A score out of one for species density.

Note that as outlined in Appendix 6, the context and species density scores are only used for vegetation scores of 3 or more. This is to avoid environments with little or no actual foraging value being given a moderate overall score (out of 10) if they occur in an area with high context and species density scores. In theory, a concrete carpark could get a score of 4 out of 10 in some situations.

2.6 Survey Limitations

The EPA *Guidance Statement 56* (EPA 2004) outlines a number of limitations that may arise during surveying. These survey limitations are discussed in the context of the BCE investigation of the Survey Area in Table 2.

Table 2. Survey limitations as outlined by EPA.

EPA Limitation	BCE Comment
Level of survey.	Level 1 (desktop study and site inspection). Survey intensity was deemed adequate due to the condition of the Survey Area with extensive past disturbance, and scale of the project and the amount of data records available in the region.
Competency/experience of the consultant(s) carrying out the survey.	The ecologists have had extensive experience in conducting fauna surveys and have conducted several fauna studies within the immediate region.
Scope. (What faunal groups were sampled and were some sampling methods not able to be employed because of constraints?)	The survey focussed on vertebrate fauna and fauna values.
Proportion of fauna identified, recorded and/or collected.	All vertebrate fauna observed were identified.
Sources of information e.g. previously available information (whether historic or recent) as distinct from new data.	Abundant information from databases and previous studies.

EPA Limitation	BCE Comment
The proportion of the task achieved and further work which might be needed.	The survey was completed according to access restrictions as outlined in Section 2, and the report provides fauna values for the Survey Area.
Timing/weather/season/cycle.	Timing is not of great importance for level 1 investigations and black-cockatoo foraging habitat assessment is not dependent on season though it is more efficient to conduct them in spring when nesting is more likely.
Disturbances (e.g. fire, flood, accidental human intervention etc.) that affected results of survey.	None
Intensity. (In retrospect, was the intensity adequate?)	The Survey Area covers approximately 500 ha and was traversed by vehicle and on foot and thus was adequately comprehensive to assess fauna and fauna values.
Completeness (e.g. was relevant area fully surveyed).	No - see Figure 3. Several lots (2, 3, 5, 10, 30, 31, 101(N), 104, 106, 116 and 8247) within the Survey Area were not inspected as access permissions were unavailable at the time of the survey. However, the surveyors have extrapolated where feasible to indicate the likely fauna assemblages in the lots that were not accessed.
Resources (e.g. degree of expertise available in animal identification to taxon level).	Field personnel have extensive experience with fauna and habitat in the region.
Remoteness and/or access problems.	There were no remoteness problems encountered but access was restricted to some lots and not others as described above.
Availability of contextual (e.g. bio-geographic) information on the region.	Extensive regional information was available and was consulted.

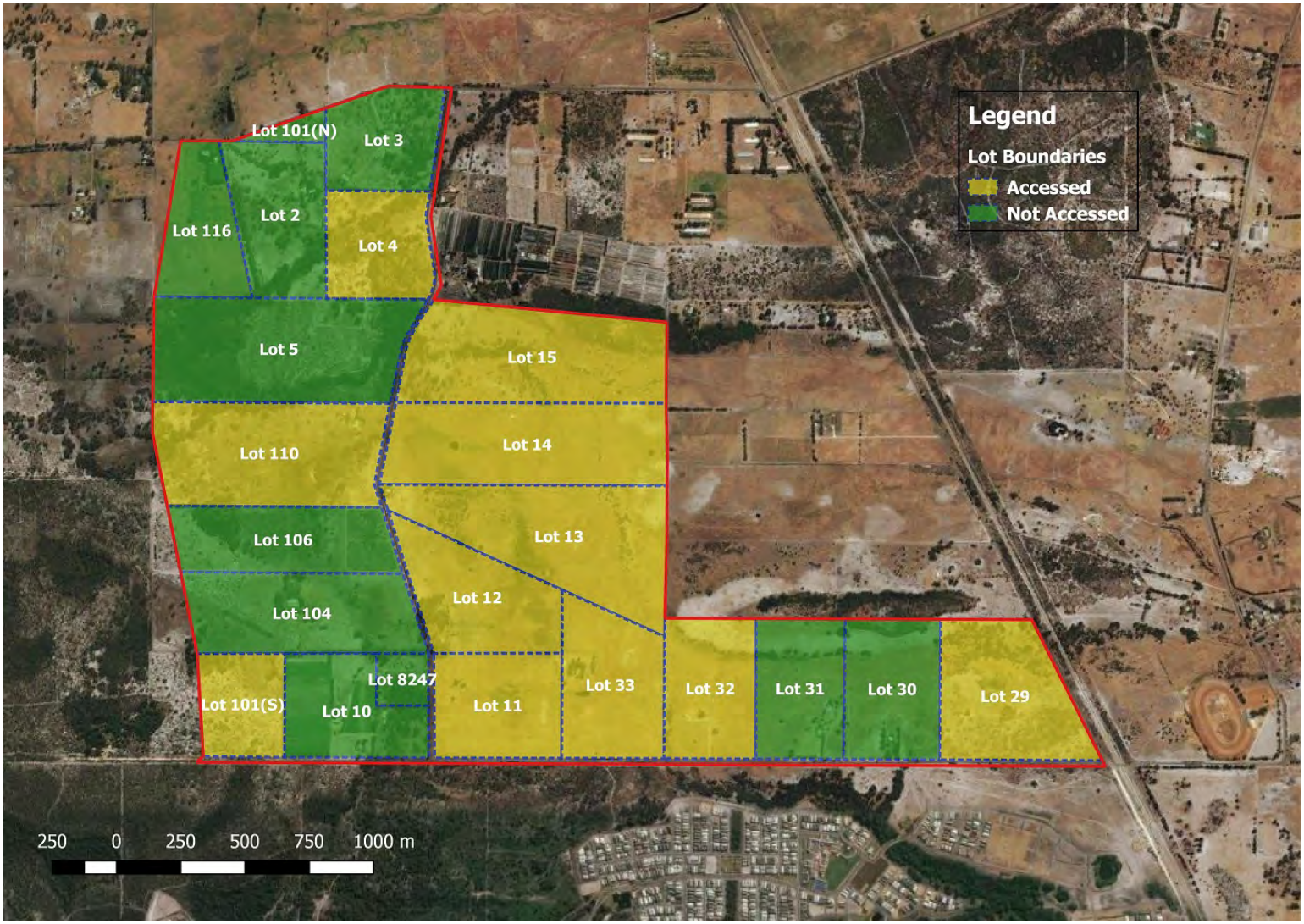

Figure 3. Lots accessed and surveyed within the study area. Lots hatched yellow were available for Level 1 fauna survey and black-Cockatoo foraging habitat survey. Only trees with hollows on Lots 15, 29 and 32, and along road verges were inspected with the pole-camera. Lots 11-14, 33 and 101(S) did not contain suitable trees with hollows that warranted pole-camera inspections.

3 Results

3.1 Vegetation and Substrate Associations

The following broad VSAs were identified within the Survey Area using information supplied by Emerge Associates from botanical survey and from field investigation, and these are shown in Figure 4. Representative views of these are shown in Plates 1 to 4.

VSA 1: Melaleuca Woodland. Vegetation along water courses, surrounding ponds and in damp soils; Modong or Stout Paperbark (*Melaleuca prieissiana*) woodland with occasional Flooded Gum (*Eucalyptus rudis*) and Marri (*Corymbia calophylla*) on dark grey clay/peaty sands. This includes small patches of ephemeral swamp subject to shallow and temporary seasonal inundation.

VSA 2: Marri woodland. Small pockets of intact open Marri woodland over Balga (*Xanthorrhea* spp.) and occasional Slender Banksia (*Banksia attenuata*) and Firewood Banksia (*Banksia menziesii*) and she-oak (*Allocasuarina* spp.) on pale grey sandy soil. This VSA occurs in very small localised patches in low elevation areas including occasional swales.

VSA 3: Banksia woodland. Degraded mixed woodlands of *B. attenuata* and *B. menziesii*, with scattered Prickly-bark (*Eucalyptus todtiana*) over Woolybush (*Adenanthos cygnorum*) on pale grey deep sand.

VSA 4: Cleared Areas. Open cleared areas of pasture grasses and occasional Marri, Tuart (*Eucalyptus gomphocephala*) (potentially planted), planted ornamental eucalypts and occasional extensive beds of Pigface (*Carpobrotus* spp.). Some areas subject to seasonal waterlogging and even inundation. This VSA is the most extensive across the Survey Area.

VSA 5: Melaleuca and Astartea shrubland. Stands of *Astartea scoparia* with *Melaleuca preissiana* and occasional *C. calophylla* and planted ornamental eucalypts. Some areas subject to seasonal waterlogging and even inundation. This VSA occurs on or near the eastern and north-eastern boundaries of the Survey Area.

VSA 6: Jacksonia over Dasypogon herbland. Degraded habitat of scattered *Jacksonia furcellata* over *Dasypogon brolmeliifolius* and extensive beds of Pigface.

VSA 7: Surface Water in semi-permanent ponds and seasonal creeks with some small patches of emergent *Typha* sp. on two ponds.

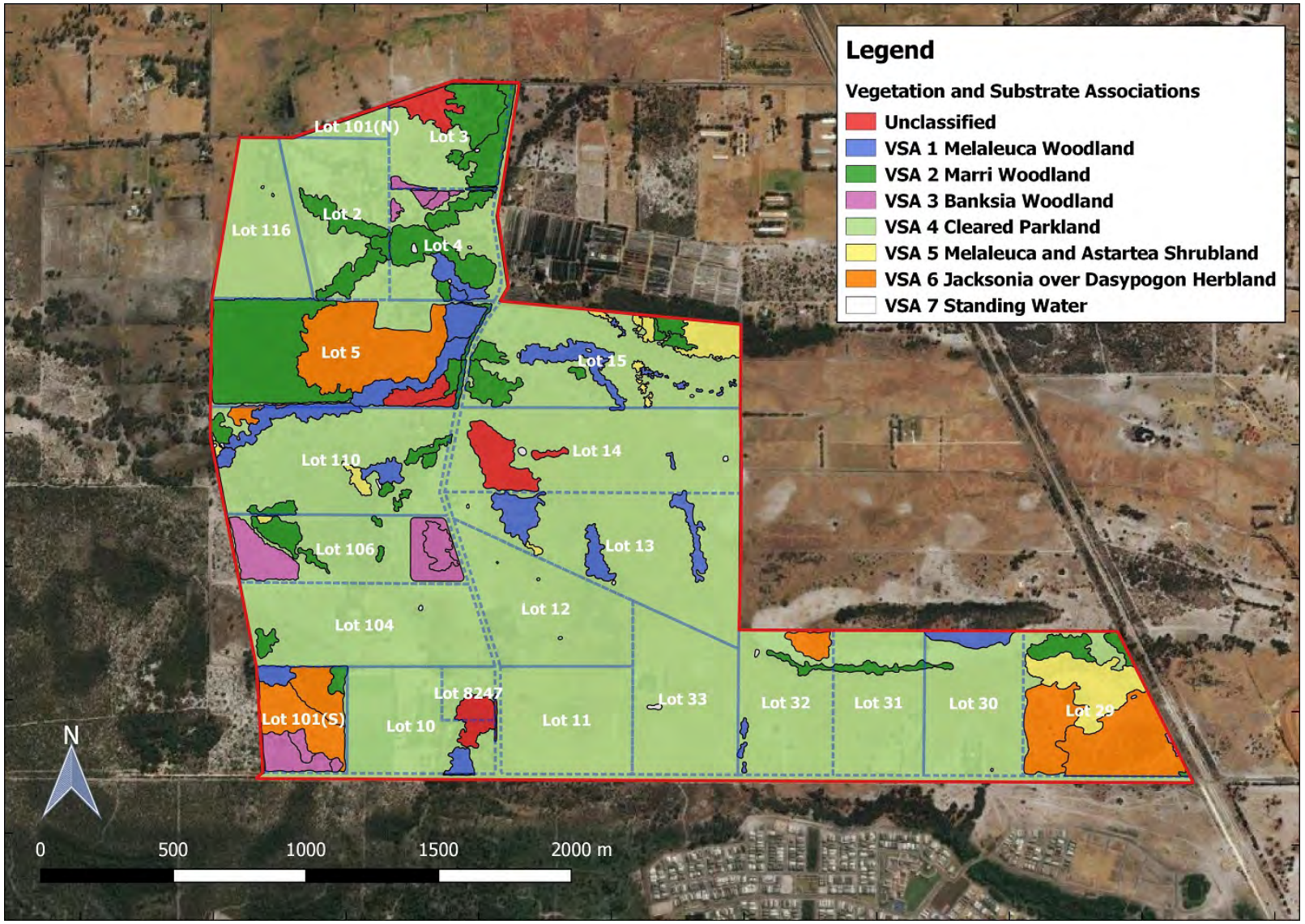

Figure 4. Site Plan showing vegetation and substrate associations (VSAs).

Plate 1. VSA 1: Melaleuca shrubland with pond (VSA 7) in Lot 15.

Plate 2. VSA 2: Remnant Marri woodland on Lot 15.

Plate 3. VSA 6: Jacksonia over Dasypogon herbland with *Carpobrotus* spp in foreground on Lot 101. Degraded Banksia woodland (VSA 3) can be seen at top of image on Lot 101.

Plate 4. VSA 4: Example of partially cleared pasture on Lot 15 with Acacia scrub, Marri and *Carpobrotus* spp forming ground cover in foreground.

3.2 Fauna

3.2.1 Overview of fauna assemblage

The desktop study identified 235 vertebrate fauna species as potentially occurring in the Survey Area (see Table 4 and Appendix 4). This does not include locally extinct species which are listed in Appendix 5, or livestock on the properties such as cattle and horses. Species returned from databases but excluded from species lists due to lack of suitable habitat are presented in Appendix 3 and summarised in Table 3.

Table 3. Composition of vertebrate fauna assemblage of the Survey Area. The number of species potentially present does not include locally extinct species.

Taxon	Number of species potentially present	Number of species in each status category				
		Resident	Migrant or regular visitor	Irregular visitor	Vagrant	Locally extinct
Fish	7 (3 introduced)	3	3	-	1	-
Frogs	9	9	-	-	-	-
Reptiles	35	34	-	-	1	2
Birds	162 (9 introduced)	38	48	61	15	3
Native Mammals	22 (5 introduced)	11	6	3	2	11
Total	235	99	54	64	18	16

Of those expected to occur in the area as identified from database searches and prior local knowledge, 47 were recorded during the two days of survey including one frog, five reptiles, 36 birds and five mammal species; of these, one bird and three mammal species were introduced.

Fish

Four native and three introduced fish species are known from the general area and may seasonally move into wetlands in the Survey Area. There may be additional native species that disperse along Ellen Brook occasionally. The three introduced species may be resident in permanent ponds as they are tolerant of poor water quality and may outcompete native species (Morgan *et al*. 2004), but the native species are expected only as seasonal visitors due to connectivity with Ellen Brook or, in the case of the Black-stripe Minnow, vagrant. This small fish is of conservation significance and occurs in a single wetland c. 5km to the north-west, but individuals may disperse during flood periods. Other native species are widespread in the South-West. No fish were recorded during the site inspection.

Frogs

The nine frog species are all expected to be resident and include eight that depend upon water bodies to some degree. The frog assemblage in the area is well-known due to extensive studies

at wetlands in the Lexia and Gnangara area (Bamford and Everard 2018). The Turtle Frog can live independently of water bodies and may occur in woodland across the Survey Area, although this species was not recorded. All of the frog species can be found in the terrestrial environment outside of the breeding season and several such as the Moaning Frog, Pobblebonk and Banjo Frogs can disperse up to 3-4 km from water bodies (Bamford 1986). Frogs can therefore be expected to occur throughout the Survey Area. All of the frog species are relatively common and widespread across the Swan Coastal Plain but the Moaning, Frog, Turtle Frog and Crawling Toadlet are known to be sensitive to disturbance and have declined (see notes on Conservation Significant species below). Only the Pobblebonk was recorded in the site inspection and was heard along creeklines on lots 4, 15 and 110.

Reptiles

Since a large portion of the Survey Area is classified as a wetland and is prone to inundation, the reptile fauna is comparatively depauperate compared with surrounding native bush on higher ground or on well-drained sand. With the exception of the Western Swamp Tortoise (see notes on Conservation Significant species below), the reptile species are all considered resident. Some such as the Western Heath Dragon and Dwarf Bearded Dragon will be limited to areas of Banksia woodland to the south-west and north-central parts of the Survey Area. Most of the others will be primarily restricted to the non-paddock areas, whereas the two goanna species and the more common reptiles such as the Two-toed Earless Skink and Buchanan's Snake-eyed Skink (also known as the Fence Skink) will be found throughout the Survey Area. With the exception of the Western Swamp Tortoise, the reptiles are considered widespread and relatively common though 15 are known to be vulnerable to common impacts such as fragmentation and habitat degradation (see notes on Conservation Significant species below). The reptile species observed during the site inspection were all common and widespread species.

Birds

The potential 162 bird species include a diverse array due to the mixture of habitat types that include water bodies, open woodland and scrub. However, the majority of the birds (76%) are considered to be visitors with only 38 being considered as potential residents. Nine of these are established introduced species, so the actual number of resident native species is small, reflecting the extent of clearing and seasonal variability of the Survey Area. The resident species include a suite of small bushbirds that are of local conservation significance as they decline in urban areas, some of which were recorded during the survey (e.g. Grey Shrike-thrush, Splendid Fairy-wren, Western Thornbill). Foraging evidence of the conservation significant Forest Red-tailed Black-Cockatoo and possibly Carnaby's Black-Cockatoo was also found; conservation significant species are discussed below. The low-lying location on the Ellen Brook Floodplain also gives rise to frequent flooding and thus many waders and water birds are likely to visit after high rainfall, however temporarily that may be. This was supported during the survey by a number of records of birds associated with standing water and wetlands including Pacific Black Duck, Australian Wood Duck and White-faced Heron. These and some other wetland species may be resident where water is permanent. The Australasian Darter recorded is likely to have been passing over between more extensive water bodies than those found in the Survey Area.

Mammals

The mammal assemblage of 17 native species is moderately depauperate in comparison to areas on the northern Swan Coastal Plain with vegetation more extensive and in better condition. Up to 11 mammal species (39% of the original mammalian fauna) may have been lost from the Survey Area since European settlement, due primarily to habitat loss, degradation and competition or predation from introduced species. Five species of introduced mammal species are known to be present and are likely to continue to impact native species (reptiles, birds and mammals) with the exception perhaps of the Western Grey Kangaroo and several species of bats. Eleven of the native mammals are likely to be resident but the only species confirmed were the Western Grey Kangaroo and the Quenda; the latter is of conservation significance (and is discussed below). The remaining six native species are thought likely to visit the area through natural transiting movements e.g. Rakali, Brush Wallaby and White-striped Freetail Bat, while others may occur through dispersal but are unlikely to be resident or even regular visitors due to poor environmental condition (e.g. Chuditch and Brush-tailed Phascogale). Of the native mammals that are regular visitors or resident and may rely on the Survey Area, all are vulnerable to habitat fragmentation and urbanisation and have been lost in large numbers with the exception perhaps of the Western Grey Kangaroo and the more common bat species. All introduced mammals are tolerant of fragmentation and urbanisation.

Invertebrates

Documenting the invertebrate assemblage is beyond the scope of a Level 1 investigation, but several species of conservation significance have been documented in the general area (Appendix 3) and are considered in Section 3.2.2. Carter's Freshwater Mussel has been recorded in the area in the past but it is thought likely to have become locally extinct in the Ellen Brook (Threatened Species Scientific Committee, 2018).

3.2.2 Fauna of conservation significance

Based primarily upon database searches, 75 vertebrate species of conservation significance may occur in the study area, with almost half of these being birds classed as CS3 (Locally significant). A summary of the fauna groups is given in Table 4 and a full list of the conservation species and their expected status in the Survey Area is provided in Table 5. Conservation significant species or groups of species which are resident, regular visitors or irregular visitors are discussed below (Section 3.4).

Table 4. Composition of extant conservation significant fauna of the Survey Area.

Taxon	Conservation Significant fauna		
	CS1	CS2	CS3
Fish	1	-	-
Frogs	-	-	3
Reptiles	1	-	15
Birds	13	4	31
Native Mammals	2	3	2
Invertebrates	2	2	-

(CS – Conservation Significant: CS1 = listed under WA State and/or Commonwealth legislation; CS2 = listed as Priority by DBCA; CS3 = considered locally significant (including species listed by DEP 2000).

Table 5. List of conservation significant species

Species	Common Name	Conservation significance	Status in Survey Area	Recorded
FISH				
Galaxiella nigrostriata	Black-striped Minnow	CS1 (E, S3[v])	Vagrant	
FROGS				
Heleioporus eyrei	Moaning Frog	CS3	Resident	
Myobatrachus gouldii	Turtle Frog	CS3	Resident	
Pseudophryne guentheri	Crawling Toadlet	CS3	Resident	
REPTILES				
Pseudemydura umbrina	Western Swamp Tortoise	CS1 (C, S1[c])	Vagrant	
Ctenophorus adelaidensis	Western Heath Dragon	CS3	Resident	
Pogona minor	Dwarf Bearded Dragon	CS3	Resident	
Delma fraseri	Fraser's Legless Lizard	CS3	Resident	
Lialis burtonis	Burton's Legless Lizard	CS3	Resident	
Pygopus lepidopodus	Common Scaly-foot	CS3	Resident	
Ctenotus fallens	West Coast Ctenotus	CS3	Resident	
Egernia kingii	King's Skink	CS3	Resident	
Tiliqua occipitalis	Western Blue-tongue	CS3	Resident	
Tiliqua rugosa	Bobtail	CS3	Resident	X
Varanus gouldii	Gould's Monitor	CS3	Resident	X
Varanus tristis	Black-headed Monitor	CS3	Resident	X
Brachyurophis semifasciatus	Southern Shovel-Nosed Snake	CS3	Resident	
Demansia reticulata	Yellow-faced Whip Snake	CS3	Resident	
Parasuta gouldii	Gould's Snake	CS3	Resident	
Simoselaps bertholdi	Jan's Banded Snake	CS3	Resident	

Species	Common Name	Conservation significance	Status in Survey Area	Recorded
BIRDS				
Rostratula australis	Australian Painted-snipe	CS1 (E,S2[e])	Vagrant	
Oxyura Australis	Blue-billed Duck	CS2 (P4)	Vagrant	
Phaps chalcoptera	Common Bronzewing	CS3 (HS)	Resident	X
Apus pacificus	Fork-tailed Swift	CS1 (M, S5)	Migratory Visitor	
Ixobrychus dubius	Australian Little Bittern	CS2 (P4)	Vagrant	
Threskiornis falcinellus	Glossy Ibis	CS1 (IA)	Vagrant	
Accipiter fasciatus	Brown Goshawk	CS3 (WR)	Regular Visitor	
Accipiter cirrocephalus	Collared Sparrowhawk	CS3 (WR)	Resident	
Aquila audax	Wedge-tailed Eagle	CS3 (WR)	Regular Visitor	
Haliastur sphenurus	Whistling Kite	CS3 (WR)	Regular Visitor	
Hieraaetus morphnoides	Little Eagle	CS3 (WR)	Regular Visitor	
Lophoictinia isura	Square-tailed Kite	CS3 (WR)	Regular Visitor	
Falco berigora	Brown Falcon	CS3 (WR)	Regular Visitor	
Falco peregrinus	Peregrine Falcon	CS1 (S7)	Regular Visitor	
Turnix varius	Painted Button-quail	CS3 (WR)	Resident	
Actitis hypoleucos	Common Sandpiper[W]	CS1 (Mig, S5)	Irregular Visitor	
Calidris acuminata	Sharp-tailed Sandpiper[W]	CS1 (Mig, S5)	Irregular Visitor	
Tringa glareola	Wood Sandpiper[W]	CS1 (Mig, S5)	Irregular Visitor	
Tringa stagnatilis	Marsh Sandpiper[W]	CS1 (Mig, S5)	Irregular Visitor	
Calidris ruficollis	Red-necked Stint[W]	CS1 (Mig, S5)	Irregular Visitor	
Tringa nebularia	Common Greenshank[W]	CS1 (Mig, S5)	Irregular Visitor	
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	CS1 (V, S3[v])	Regular Visitor	X
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	CS1 (V, S2[e])	Irregular Visitor	
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	CS1 (E, S2[e])	Regular Visitor	X
Platycercus icterotis	Western Rosella	CS3 (WR)	Irregular Visitor	
Ninox connivens	Barking Owl (SW pop'n)	CS2 (P2, WR)	Irregular Visitor	X
Tyto novaehollandeae	Masked Owl	CS2 (P3, WR)	Irregular Visitor	
Malurus lamberti	Variegated Fairy-wren	CS3 (HS)	Resident	
Malurus splendens	Splendid Fairy-wren	CS3 (HS)	Resident	X
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	CS3 (HS)	Resident	X
Acanthiza inornata	Western Thornbill	CS3 (HS)	Vagrant	X
Acanthiza apicalis	Inland Thornbill	CS3 (HS)	Irregular Visitor	
Sericornis frontalis	White-browed Scrubwren	CS3 (HS)	Regular Visitor	
Smicrornis brevirostris	Weebill	CS3 (HS)	Resident	
Anthochaera lunulata	Western Wattlebird	CS3 (WR)	Regular Visitor	
Glyciphila melanops	Tawny-crowned Honeyeater	CS3 (WR)	Irregular Visitor	
Phylidonyris niger	White-cheeked Honeyeater	CS3 (WR)	Resident	
Phylidonyris novaehollandiae	New Holland Honeyeater	CS3 (WR)	Resident	
Daphoenositta chrysoptera	Varied Sittella	CS3 (HS)	Regular Visitor	

Species	Common Name	Conservation significance	Status in Survey Area	Recorded
Colluricincla harmonica	Grey Shrike-thrush	CS3 (HS)	Resident	
Pachycephala pectoralis fuliginosa	Western Whistler	CS3 (HS)	Irregular Visitor	
Artamus cinereus	Black-faced Woodswallow	CS3 (WR)	Regular Visitor	X
Artamus cyanopterus	Dusky Woodswallow	CS3 (WR)	Irregular Visitor	
Strepera versicolor	Grey Currawong	CS3 (WR)	Vagrant	
Myiagra inquieta	Restless Flycatcher	CS3 (HS)	Irregular Visitor	
Melanodryas cucullata	Hooded Robin	CS3 (HS)	Vagrant	
Petroica boodang	Scarlet Robin	CS3 (HS)	Irregular Visitor	
Petroica goodenovii	Red-capped Robin	CS3 (HS)	Vagrant	
MAMMALS				
Dasyurus geoffroii	Chuditch	CS1 (V,S3[v])	Vagrant	
Phascogale tapoatafa wambenger	Brush-tailed Phascogale	CS1 (V,S3[v])	Vagrant	
Isoodon fusciventer	Quenda	CS2 (P4)	Resident	X
Notamacropus irma	Brush Wallaby	CS2 (P4)	Irregular Visitor	
Cercartetus concinnus	Western Pygmy-possum	CS3 (LS)	Irregular Visitor	
Ozimops kitcheneri	Western Freetail-Bat	CS3 (LS)	Regular Visitor	
Hydromys chrysogaster	Rakali (water-rat)	CS2 (P4)	Regular Visitor	
SIGNIFICANT INVERTEBRATES				
Westralunio carteri	Carter's Freshwater Mussel	CS1 (V,S3[v])	Possibly Extinct	
Leioproctus contrarius	Short-tongued Bee	CS2 (P3)	Irregular Visitor	
Leioproctus douglasiellus	Short-tongued Bee	CS1 (C,S3[e])	Irregular Visitor	
Synemon gratiosa	Graceful Sun-Moth	CS2 (P4)	Irregular Visitor	

3.3 Local context

The key features of the fauna assemblage expected in the Survey Area are:

- Uniqueness: The assemblage is likely to be typical of Marri woodland and Banksia woodland, wet Paperbark woodland and scrub typical of the Perth Swan Coastal Plain, and this assemblage can be expected to be represented in intact areas of the coastal plain nearby. However, the small size and degraded condition of the remaining native vegetation means that it is unlikely to support many of the species found in the surrounding bushland. Furthermore, the water course and ponds that have been created at various points appear eutrophic and have heavily trampled banks; riparian vegetation is degraded or absent in many locations. While the ponds, water courses and paddocks (when flooded) may offer foraging opportunities for a range of waterbirds and wader, conditions are likely to be far from pristine and unlikely to support a diverse and productive system that will support a wide range or large number of visiting species. Positive aspects remaining in the Survey Area are that good connectivity remains across the northern half through the Paperbarks and Marri that lie along or adjacent to the creek respectively, or the remaining scrub. It is expected that several reptiles, small birds and mammals will have disappeared from the Survey Area through lack of native vegetation and remaining pressures from feral Foxes and Cats compared with sizable

stands of native vegetation in good condition. Some significant species are present or expected (Section 3.2.2).

- Completeness: The assemblage is likely to be mostly intact in terms of fish and frogs, but several reptiles, birds and mammals associated with the natural habitats of the area are unlikely to be represented and some will be visitors or irregular visitors instead of resident or regular visitors respectively. This is likely due to a range of factors including large areas cleared of native vegetation and predation by feral species (discussed further in Section 3.2.3).
- Richness: The assemblage is moderately rich in the local context, due to the remaining vegetation and range of habitat types including bodies of water. The potential for the Survey Area to become waterlogged and flood will also raise the number of species using it over time compared with dryer soils and more arid conditions elsewhere on the Swan Coastal Plain.

3.4 Species of Conservation Significance

Species that have been identified as being conservation significant and resident, regular visitors or irregular visitors are discussed here. The Western Swamp Tortoise is included due to the proximity with Twin Swamps Reserve where it is known to occur, and the presence of water bodies across the Survey Area.

3.4.1 Black-Cockatoos

A pair or a small group of Carnaby's Black-Cockatoos was heard calling during the survey on the 13th December. A pair or Carnaby's Black-Cockatoo was observed in trees on Lot 5 on the morning of 15th April 2019 and a group of six Carnaby's joined the pair a short while afterwards. The black-Cockatoos appeared to be foraging in Marri trees. A number of feeding remains of Carnaby's Black-Cockatoo and many signs of foraging by the Forest Red-tailed Black-Cockatoo were found during the survey in numerous locations across the Survey Area where Marri and Banksias were present (see Figure 5). No foraging signs of Baudin's Black-Cockatoo were found but this species has been recorded in this area of the Coastal Plain more often in recent years, including a flock along Neaves Road in 2015 (M. Bamford pers. obs.). The Baudin's Black-Cockatoo is not dealt with in this section because it is considered as a vagrant at best within the Survey Area, whereas the other two Black-Cockatoos are prevalent and therefore considered in detail.

Both Black-Cockatoo species are known to roost communally and often at Survey Areas that are used regularly (Peck *et al*. 2017). No roosting sites have been previously recorded within the Survey Area based on Great Cocky Count database (Peck *et al*. 2017) but several are found in the broader area. The nearest known Forest Red-tailed Black-Cockatoo roost is located in Ellenbrook approximately 3 km south and another is located to the east of Bullsbrook approximately 10 km to the north-east of the Survey Area. The nearest Carnaby's roost lies about 7 km south in the suburb of Baskerville and another lies approximately 14 km south-west. The nearest roost used by both species is located approximately 10 km due west. A number of disused roost sites are located across the broader area with the nearest being located just to the west of the Survey area and another in Ellenbrook.

During the roost survey, held 30 minutes either side of sunset on the 23rd April 2019, no black-Cockatoos were recorded visually or aurally either within the study area or outside.

Patches of Marri (VSAs 1, 3 and 6) and other stands of Tuart, Jarrah or other large eucalypts are potential roost sites and all Eucalypts, Melaleuca and Casuarina and Banksia may be useful foodplants. Both species roam widely across the landscape and although it is likely that they can feed, mate, roost and nest, individuals will only be present for a couple of months at a time and cannot be considered resident.

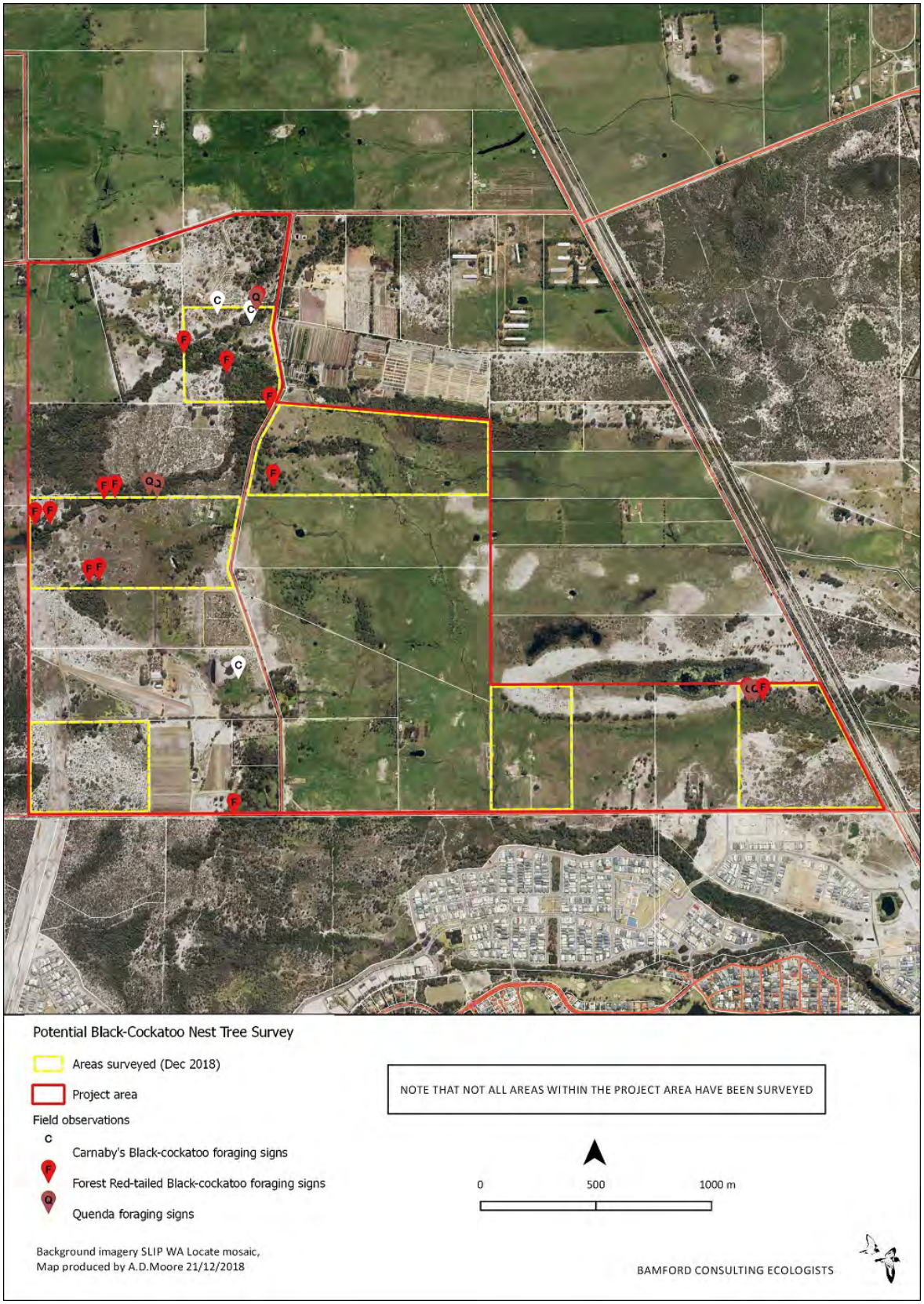

Figure 5. Locations where feeding remains of Black-Cockatoo and diggings of Quenda were recorded.

Black-Cockatoo Breeding Habitat

Across the Survey Area, 414 trees were recorded which qualified as potential hollow-bearing trees due to their Diameter at Breast Height (DBH) being greater than 500 mm and these are plotted in Figure 6. The majority of these were Marri (346), with 26 Tuart, 12 Paperbarks, seven Jarrah, four River Red Gum, one Dwutta (Prickly Bark) and 18 unidentified ornamental eucalypts. While paperbarks, River Red Gum and ornamental eucalypts are not known to be used by black-cockatoos for breeding, they were recorded as potential roost trees and it is possible any of the black-cockatoos may use a hollow in any tree if it is of suitable size (DEE 2017). Locations of all trees are plotted in Figure 6. These results were updated after the tree-hollow inspection and are shown in Figure 7 and parameters of all trees initially categorised as having potential hollows in Appendix 8. No black-cockatoo breeding activity or behaviour was observed during the survey. Feral bees were noted in several of the tree hollows observed. Out of the 414 trees, 34 were observed to contain or possibly contain hollows that met the size and position expectations for black-cockatoos. Most of these were subsequently inspected with a pole-camera and the results updated as provided in Appendix 8. These are divided as follows:

- Four Category 2 trees with hollows whereby the openings were considered large enough (approximately >100 mm) and in a position of the tree suited to black-cockatoo entrance (e.g. in a chimney type opening or on the side of a large enough vertical limb), chew marks around the opening or inside, or egg remains inside the hollow. The chew marks or egg fragments could not always be attributable to a species of cockatoo (black-Cockatoo or otherwise). All these have been confirmed as potentially suitable with the pole camera.
- Nine Category 3 trees with hollows which met the size and position expectations for nesting Black-Cockatoos but with no obvious chew marks were visible from the ground. Hollows in four of these trees were seen to be occupied by feral honey bees. None of these trees have been inspected with the pole camera due to access restrictions or bee nests, and their category may change on inspection.
- 29 Category 4 trees that either had hollows but not of an angle preferred by black cockatoos, or had hidden parts of the tree that could not be guaranteed devoid of hollows. Hollows in five of these trees were occupied by feral honeybees.
- 372 Category 5 trees that were large enough to be recorded but had no sign of any hollows big enough for Black-Cockatoos.

Some mature trees were present within lots that could not be accessed and were of a size that could contain hollows. In particular, Lots 2, 3 and 5 appeared to have a number of large native eucalypts with the potential for hollows suited to nesting Black-Cockatoos.

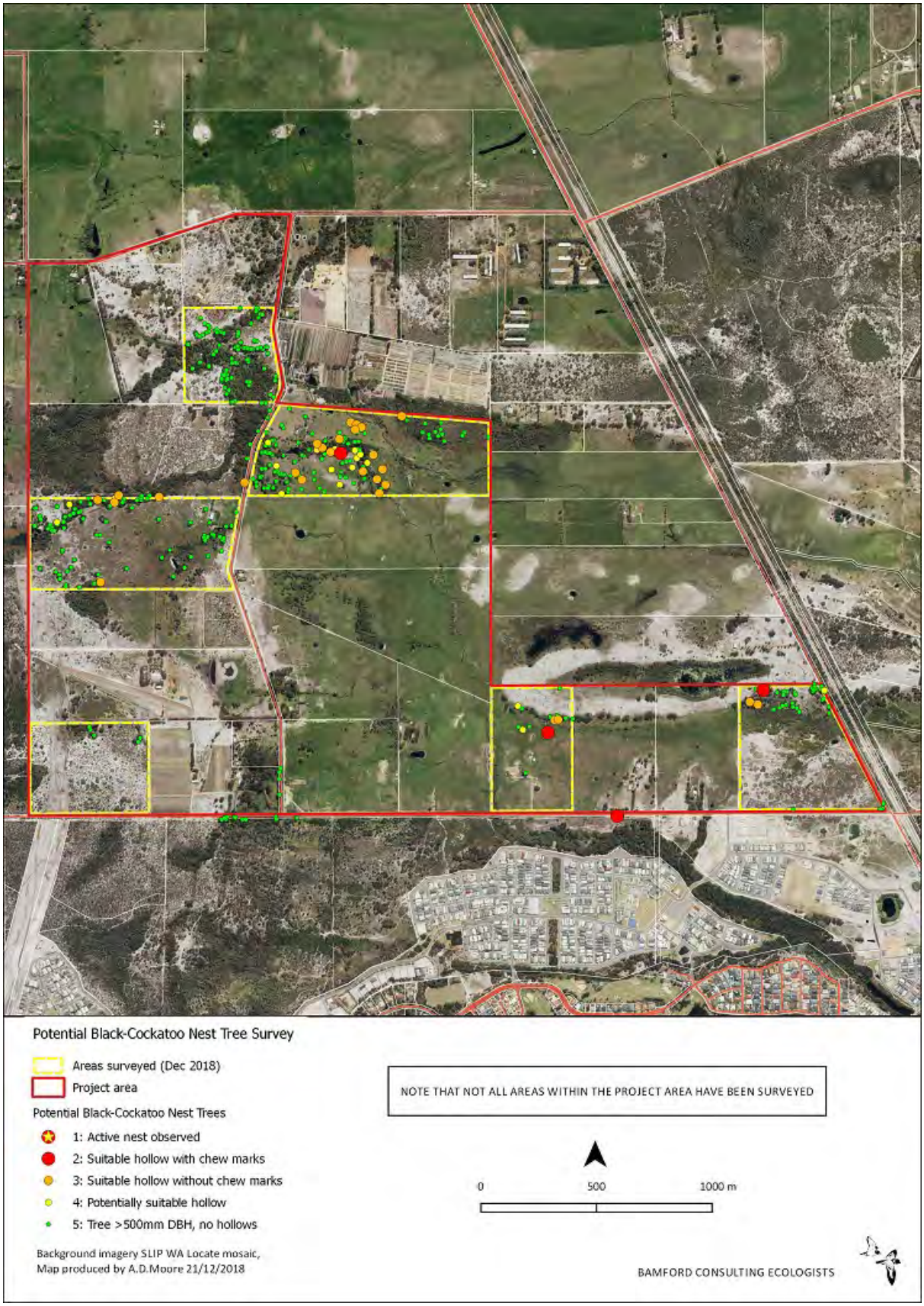

Figure 6. Results of the initial Black-Cockatoo Nesting Tree Survey. All trees shown are greater than 500 mm diameter at breast height (DBH).

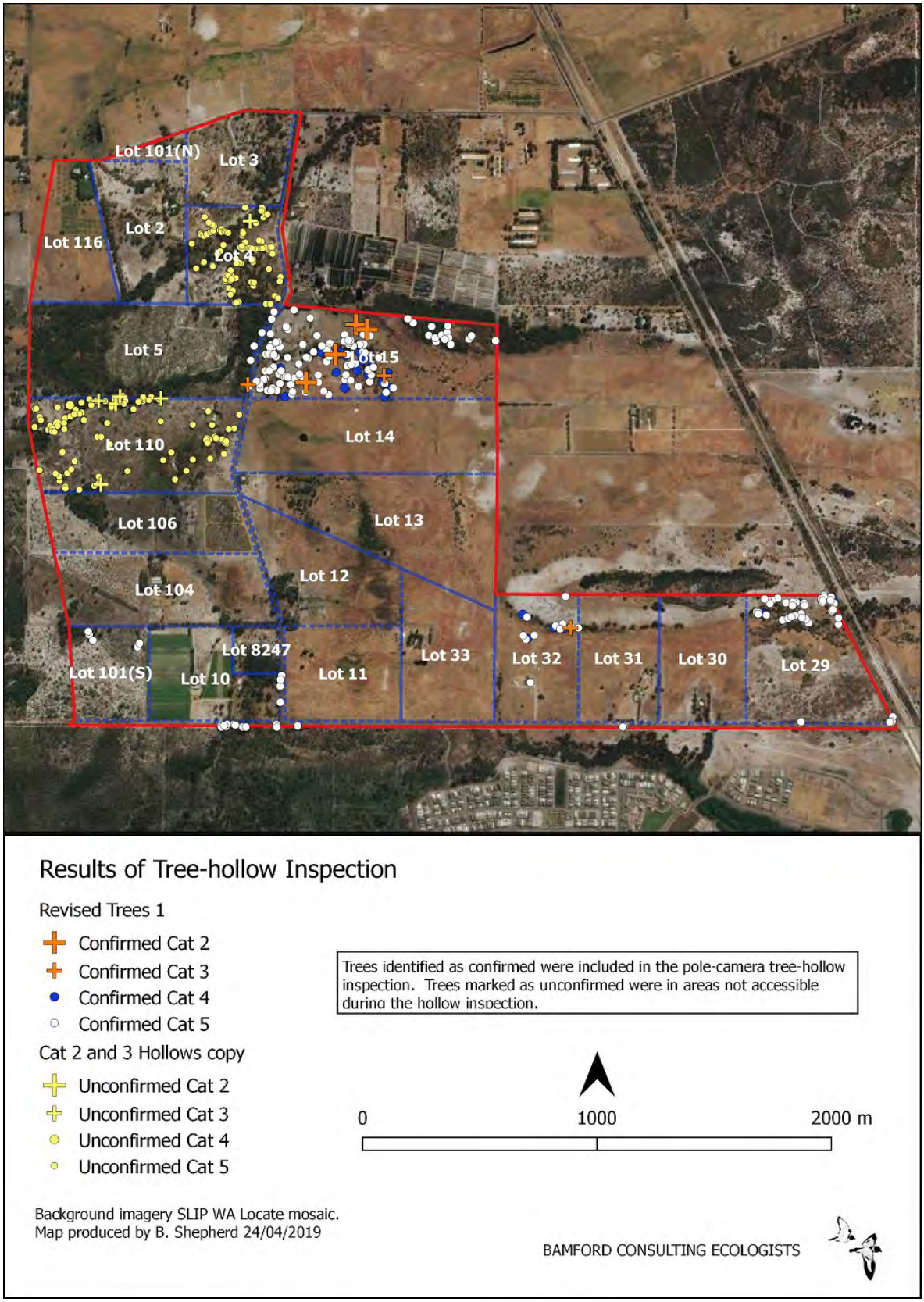

Figure 7. Modified results of the black-Cockatoo Nesting Tree Survey after category 2 and 3 trees on Lots 15, 29 and 32 were subjected to pole-cam inspections. Trees in areas not accessible at time of tree-hollow inspection retain categories from initial nesting survey. Category 3 trees on Sawpit Lane and on Lots 15 and 32 were not inspected due to bee hive within the trees.

Black-Cockatoo foraging habitat

The area of native vegetation remaining within the Survey Area that isn't either cleared parkland or completely degraded is 109.3 ha. Remnant vegetation mapping published by the Department of Primary Industries and Regional Development (2018), shows that the remaining native vegetation within 15 km of the Survey Area boundary is approximately 30,995 ha. The native vegetation within the Survey Area therefore comprises approximately 0.35% of the total remaining native vegetation within a 15 km range of the boundary. This does not include isolated native trees in grassed paddocks.

From the field assessment, several types of potential foraging habitat of varying quality were identified within the Survey Area for Forest Red-tailed and Carnaby's Black-Cockatoos. Based on the BCE foraging habitat scoring system (Appendix 7), each of the observed foraging habitat types were assigned a foraging value score (out of 6) based on vegetation composition, quality and condition as well as site context and species density (combined score out of 10). The foraging habitat value scores for Carnaby's Black-Cockatoo (CBC) are outlined in Table 6 and shown in Figure 8. The foraging habitat value scores for Forest Red-tailed Black-Cockatoo are outlined in Table 7 and shown in Figure 9.

Table 6. Carnaby's Black-Cockatoo foraging habitat type, quality and extent within Survey Area. Extent of foraging habitat categories is plotted in Figure 8.

Survey Area Score/ Foraging Value	Foraging Plants Present	VSAs	Foraging Signs Present	Extent (ha)
1 Negligible - Low	Isolated Marri, Banksia, *Jacksonia furcelata*, *Xanthorrhoea preissii,* occasional patches of *Pelargonium* spp.	VSA4 VSA5 VSA6	None	402.83
3 Low - Moderate	Isolated and patchy Marri, Jarrah, Tuart, Slender Banksia and Menzie's Banksia. Occasional patches of *Pelargonium* spp. Standing water.	VSA3 VSA4	None	37.2
4 Moderate	Common Marri and occasional Jarrah and Tuart, with some Banksia, *Acacia saligna.* Standing water.	VSA1 VSA2	Infrequent	59.37
5 Moderate - High	*Banksia attenuata, B. menziesii*, *B. ilicifolia*) with *Eucalyptus todtiana* and *X. preissii*	VSA3	Infrequent	4.65

Based on the area of native vegetation that the Survey Area contains compared with that remaining in the surrounding area (0.35%), the Site Context Score for Carnaby's Black-Cockatoo is 1.

Given foraging evidence of Carnaby's Black-Cockatoo was found during the field assessment, the Species Density score for the Survey Area is 1/1, based on the BCE scoring system provided in Appendix 4. As such, the Total Score for Carnaby's Black-Cockatoo using the BCE scoring system

provided in Appendix 4 is between 3 and 7 out of 10 depending on the Site Score for foraging value of the various habitat types, plus the context and species density.

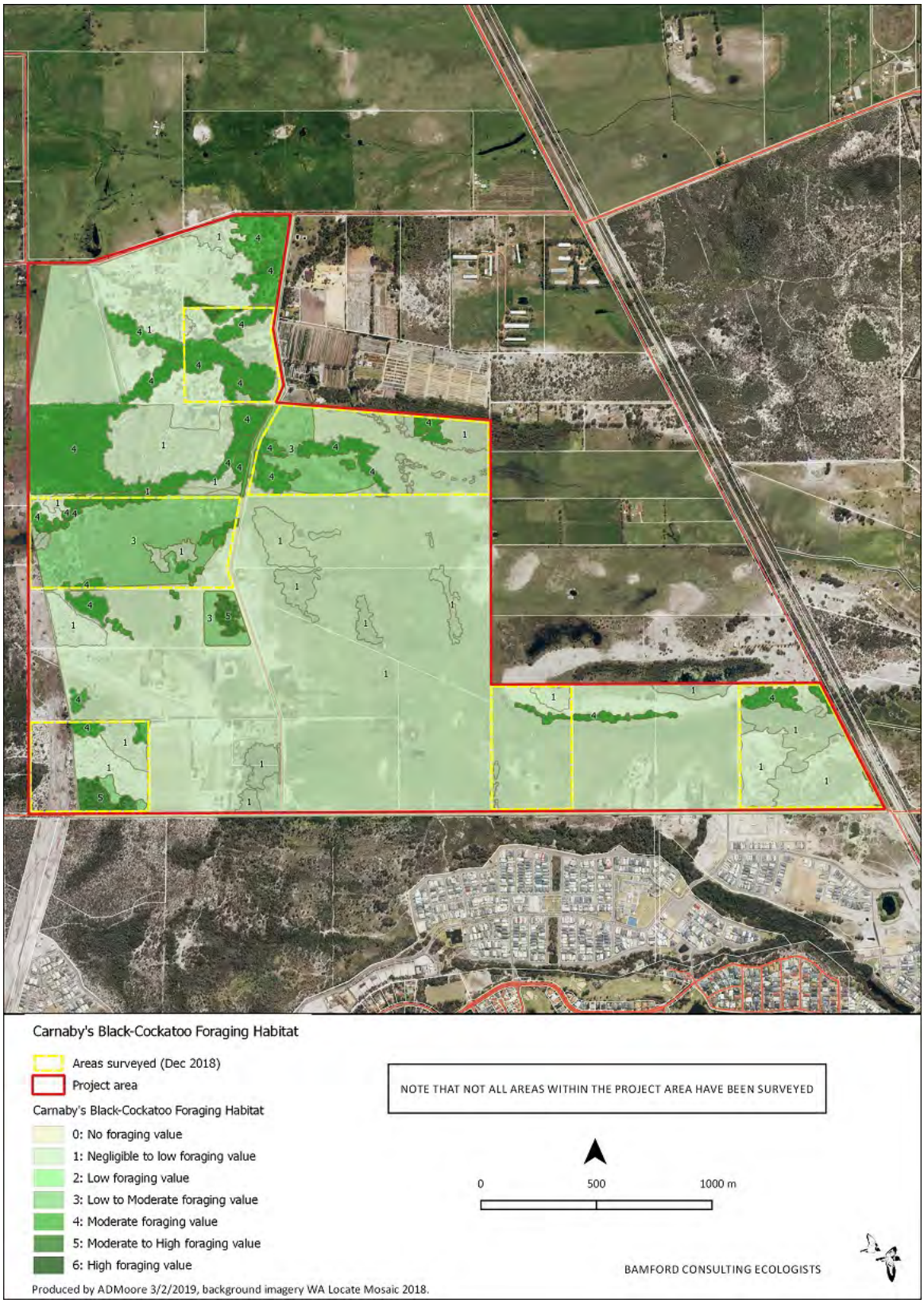

Figure 8. Foraging Habitat Value for Carnaby's Black-Cockatoo.

Table 7. Forest Red-tailed Black-Cockatoo foraging habitat type, quality and extent within Survey Area. Extent of foraging habitat categories is plotted in Figure 8.

Foraging Value	Foraging Plants Present	VSAs	Foraging Signs Present	Extent (ha)
0 None		VSA3 VSA4 VSA5 VSA6	None	148.47
1 Negligible - Low	Occasional Marri, Jarrah	VSA4	Infrequent	296.58
4 Moderate	Marri.	VSA2	Occasional	2.01
5 Moderate - High	Frequent Marri and occasional Jarrah. Standing water.	VSA1 VSA2	Occasional	20.65
6 High	Common Marri with occasional Jarrah, Standing water.	VSA1 VSA2	Occasional	36.34

Based on the area of native vegetation that the Survey Area contains compared with that remaining in the surrounding area (0.35%), the Survey Area Context Score for Forest Red-tailed Black-Cockatoo is 1.

Given foraging evidence of Forest Red-tailed Black-Cockatoo was found during the field assessment, the Species Density score for the Survey Area is 1/1, based on the BCE scoring system provided in Appendix 4. As such, the Total Score for Forest Red-tailed Black-Cockatoo using the BCE scoring system provided in Appendix 4 is between 0 and 8 out of 10 depending on the Survey Area Score for foraging value of individual habitat types, plus the context and species density.

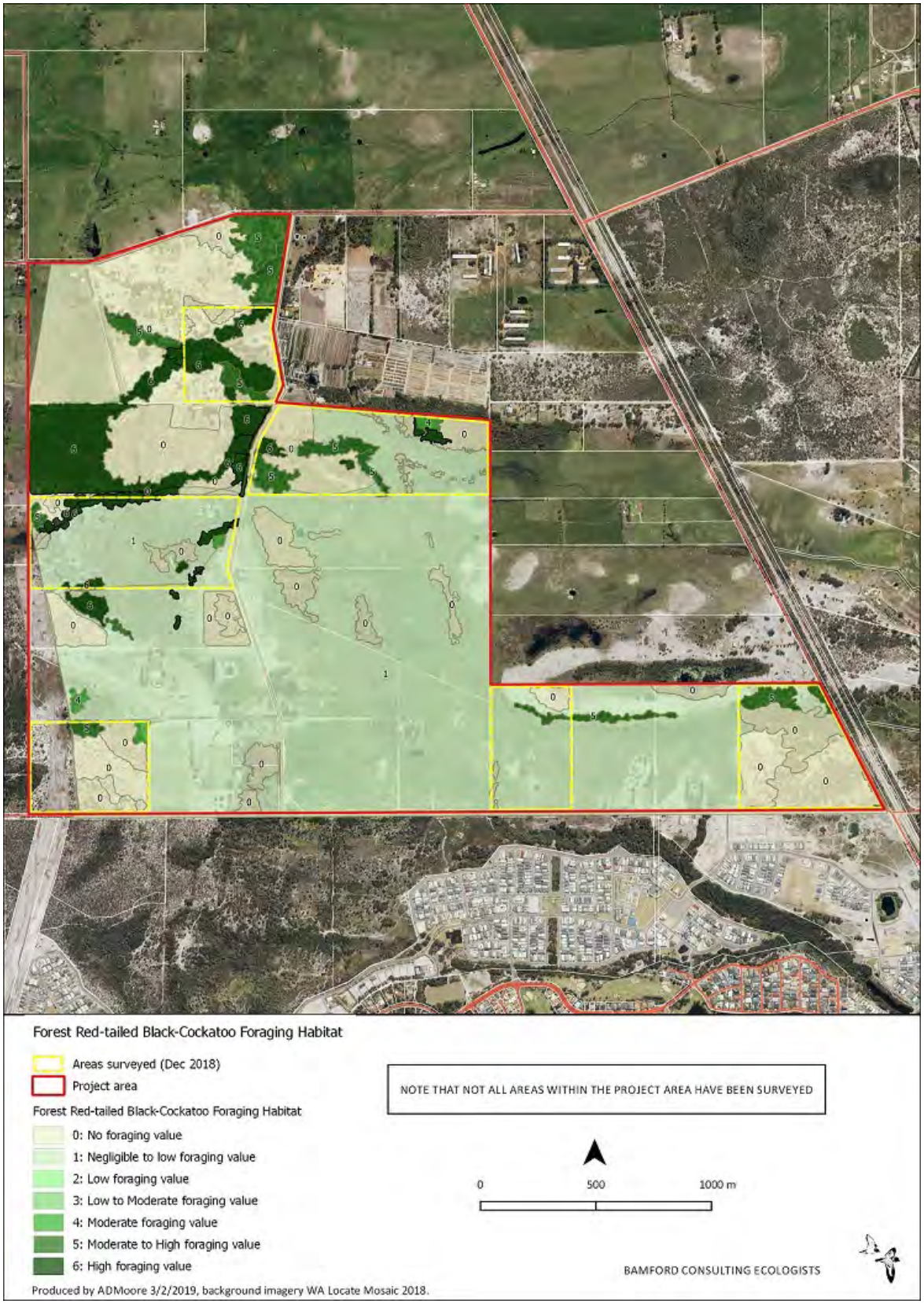

Figure 9. FRTBC Foraging Habitat Value

3.4.2 Conservation Significance Level 1

Black-striped Minnow

This species is endemic to WA and restricted to seasonal wetlands within the south west of WA between Albany and Augusta, and at three northern outlying populations on the Swan Coastal Plain between Moore River and Bunbury (Galeotti *et al*. 2009) including a population at Melaleuca Park which is a defined wetland (EPP173) and lies approximately 5 km north of the Survey Area. The ecology and habitat requirements of the Black-striped Minnow are not fully understood, although Knott *et al*. (2002) describe aquatic conditions at Melaleuca Park as very acidic (as low as pH3.3) and in spring and summer the water becomes extremely dark and helps form temperature stratification in the water column. Melaleuca Park lies approximately 5 km north-west of the Survey Area and is fed by permanent spring seepage which maintains a very small and localised area of water during summer (Smith *et al*. 2002). This wetland lies within native Banksia woodland and is surrounded by Paperbarks and fringing *Baumea* sp rushes. While it is unlikely that conditions in the ponds across Survey Area will support this highly specialised minnow, it cannot be excluded as at least a vagrant as many wetlands in the region may be connected during winter floods. A brief survey of potentially suitable wetlands in late summer could confirm presence/absence.

Western Swamp Tortoise

There has been a considerable amount of effort applied to finding this freshwater tortoise (Burbidge *et al.* 2010) and it is considered unlikely that it will be resident in the Survey Area. However, Twin Swamps Reserve has a relatively static population of this species and lies just 800 m outside the north-east boundary. There are many ponds across the Survey Area, some of which are artificial field dams whereas the origins of those along watercourses are less certain. While these could harbour Western Swamp Tortoises venturing outside of Twin Swamps, few are surrounded by suitable vegetation in which the tortoises would aestivate during the warmer, dry periods in summer and autumn. While they are known to travel up to 1.5 km from their aquatic habitat in search of suitable habitat (DBCA, 2017), a railway and road lie between the Survey Area and Twin Swamps Reserve which reduces the chances of tortoises moving between the two locations; the reserve around the swamp is now also fenced. Ponds surrounded by native vegetation that lie west of Sawpit Road may be more suitable for this species, but they are more than 1.5 km from the reserve. For this reason, the Western Swamp Tortoise has been identified as potentially present but is considered a vagrant because of its choice of habitat and low likelihood of successfully transiting onto the Survey Area.

Fork tailed Swift

This is a non-breeding migrant from Asia but is a largely aerial species of unpredictable occurrence in southern Western Australia. It does not rely closely on small areas of native vegetation.

Migratory shorebirds

Several migratory shorebird species (See Table 5 and Appendix 3) may occur as occasional, non-breeding visitor in small numbers, but the amount of available habitat is limited.

3.4.3 Conservation Significance Level 2

Barking Owl and Masked Owl

The proximity to other large stands of woodland in the Northern Swan Coastal Plain suggests that the two CS2 owl species may occur in the Survey Area as irregular visitors in their movement across the landscape. A call consistent with the Barking Owl was heard during the black-Cockatoo roost survey on the evening of 23rd April 2019. The call came from within bushland on Lot 5. Both species would hunt for small mammals, invertebrates and reptiles across the more open ground, and small birds and bats from the air, and could also roost in trees across the area during the day.

Little Bittern

Occasional visitor to wetlands where there are rushes and sedges to provide cover.

Quenda

This species was detected through records of foraging holes (see Figure 5) on lots 4, 15, 29, 110 and just to the south of Maralla Road, generally associated with dense scrub and understorey where it can take refuge from predators. It is known to occur on the Northern Swan Coastal Plain in a range of habitats where low vegetation affords cover from predators. VSAs 2, 3, 4 and 6 provide habitat which offer the shelter it would normally need to survive. Banksia woodlands to the south and west are likely to support Quenda and provide resilience in the locale, but the new highway immediately to the west of the Survey Area will possibly sever any movement to and from the west. An overpass is being constructed to link the east and west sides of the highway, with the intent of maintaining the connectivity for this and other species. It is considered a resident but with a tenuous chance of surviving any further widespread impact or urbanisation of the surrounding area.

Brush Wallaby

This species is known to occur within larger stands of native woodland and scrub vegetation across the Northern Swan Coastal Plain, and may occasionally venture into the Survey Area where it is likely to keep hidden within the denser vegetation of VSAs 1, 2, 3 and 6.

Rakali

The Rakali is a semi-aquatic species which follows water courses where it hunts invertebrates, fish and other vertebrate species. It will also roam widely across the landscape and not necessarily keep to water courses or VSAs 1 and 8. The creeks that traverse the Survey Area are unlikely to provide the deeper water this species needs to be considered resident, but since the Survey Area is relatively close to the larger Swan River and Ellen Brook which are likely to have Rakali year-round, this species may regularly visit especially after rain or when water is flowing in the creeks.

3.4.4 Conservation Significance Level 3

There are 43 species of CS3 listed in Table 5 and they are discussed in species groups below.

CS3 Frogs

Moaning Frog, Turtle Frog and Crawling Toadlet

These three frog species are recognised as CS3 because they decline from urban environments and when surrounded by development. The Moaning Frog and Crawling Toadlet are also sensitive to more arid conditions brought about by hydrological changes or falling rainfall. Whilst the Turtle Frog can complete its life cycle independent of water bodies, it may still depend on damp soil in which to reproduce and therefore may be also sensitive to changes in hydrology.

CS3 Reptiles

There are 15 CS3 reptiles of which two, the Western Heath Dragon and Dwarf Bearded Dragon, are likely to be restricted to VSA 4 Banksia dominated habitats. The two monitor lizards, Gould's Monitor and Black-headed Monitor, may occur anywhere across the Survey Area including paddocks with scattered trees. The remaining seven CS3 lizards and four snakes are more likely to be restricted to native vegetation of VSAs 1, 2, 3, 4 and 6.

CS3 Birds

Appendix 3 lists 31 birds of CS3, with the majority of these being small species of woodlands and open woodland that are listed by DEC (2000) as declining in urban landscapes. They are therefore at risk through highly developed areas where native vegetation is heavily fragmented, reduced to small areas, increased abundance of feral predators or competitors such as cats and foxes, or through human disturbance including dog walking. Nine of these species were recorded during the field investigation.

CS3 mammals

The two CS3 mammals, Western Pygmy-possum and Western Freetail Bat, have declined on the Swan Coastal Plain, and appear to be absent even from large reserves such as Melaleuca Park and Yeal Nature Reserve. There is one record of the Western Pygmy-possum from Melaleuca Park about 5 km to the west (2006; BCE records). If populations persist in the Survey Area, they would be the closest such populations to Perth.

3.4.5 Conservation significant invertebrates

Information on the invertebrate assemblage of the Survey Area is limited, but four invertebrate species of conservation significance were returned from databases and may be present (Table 4). There is too little information available on their biology to predict their status on the Survey Area, but all could be resident. They include Carter's Freshwater Mussel which is likely only to be present in fairly pristine aquatic conditions and is listed here as a precaution; aquatic conditions within the Survey Area are likely to be impacted by agriculture, horticulture and other

anthropogenic effects. There are two short-tongued bees (one CS2 and one CS3) and the Graceful Sun-Moth, all of which are expected to be at most irregular visitors due to the small areas of remnant vegetation left remaining.

3.5 Patterns of biodiversity

Investigating patterns of biodiversity can be complex and are often beyond the scope even of level 2 investigations, but it is possible to draw some general conclusions based upon the size of the study area and the patterns of soils and vegetation across the landscape. Cleared areas (VSA 5) will be low in biodiversity but may be used seasonally by waterbirds in small numbers especially when these areas are inundated. The small area of banksia woodland (VSA 4), is in poor condition but a larger, more intact area of Banksia woodland lies just outside the Survey Area boundary to the south offering some resilience in the area for the species that occupy this habitat. Connectivity to other larger stands of similar habitat such as Marri woodland is present but often severed by roads and rail lines which act as a barrier to many of the non-flying species that occur in the area. There is likely to be a moderate level of vertebrate fauna biodiversity, particularly frogs and reptiles, but a lesser degree for birds and mammals. At the micro-landscape scale, individual large Jarrah and Marri trees may be important for hollow-nesting and roosting species, while the mixed banksia woodland will be significant for nectarivorous birds and for Carnaby's Black-Cockatoo and increasingly Forest Red-tailed Black-Cockatoo.

3.5.1 Ecological processes

The nature of the landscape and the fauna assemblage indicate some of the ecological processes that may be important for ecosystem function (see Appendices 2 and 4 for descriptions and other ecological processes). These include:

Fire. As is the case throughout most of Western Australia, the vegetation of the region is fire-adapted to some degree, but the flora and fauna assemblages can be altered by too-frequent fires; and even by fire exclusion. Some species are particularly sensitive to wildfires and altered fire regimes. Fire season may also be important in seed germination. Fauna in small and isolated reserves can be vulnerable to local extinction due to an inappropriate fire regime, and this may be a concern for the study area. There was scant evidence of past fires from the field investigation or from aerial imagery, but some species loss may have occurred as a result of the past fire regime.

Hydrology. Much of the area is low-lying and there are distinctive VSAs such as Melaleuca and Marri woodland located on damper soils, where strong interaction between vegetation and near-surface (unconfined) groundwater is likely to occur.

Feral and pest species and interactions with over-abundant native species. Feral species occur throughout Western Australia, with the Cat, Rabbit, Fox and Laughing Kookaburra recorded during the Survey Area inspection. Additional species are expected to be resident. Honey Bees

were also frequently recorded occupying tree hollows. In a recent study in a small bushland reserve in Bullsbrook, BCE (unpub. data) found several domestic Cats were regularly visiting the reserve from nearby private property, and the same is likely to be happening within the Survey Area. This can lead to local extinction of sedentary birds such as fairy-wrens (Bamford 2008) which were already showing signs of low abundance (one record).

The habitat immediately north of the Banksia woodland in Lot 101(S) has clear signs of heavily degraded vegetation which may have been a result of dieback caused by the fungal plant pathogen *Phytophthora cinnamomi*.

Connectivity and landscape permeability. The land use and habitat characteristics of the Survey Area are fairly typical of the eastern strip of the northern Swan Coastal Plain, and connectivity is frequently severed by roads and other linear infrastructure. This will impact fossorial fauna and species that do not readily transit across hard surfaces or are slow to do so. Species that can move across hard surfaces or fly will more readily across this semi-urban landscape and move between similar patches of vegetation. Aquatic connectivity to the nearby Ellen Brook and Swan River is likely to be intact for most species expected in the area with the possible exception of the Western Swamp Tortoise.

4 Summary and Conclusion

4.1 Summary of fauna values

The desktop study identified 235 vertebrate fauna species as potentially occurring in the survey area including seven fishes, nine frogs, 35 reptiles, 162 birds and 22 mammals. This assemblage includes nine introduced birds and five introduced mammals, not including livestock or domestic animals. This does not include 16 locally extinct species which have been lost over the last 150 years through habitat clearance, habitat degradation and/or impacts from feral species and disease. The assemblage includes 68 species of conservation significance including two species of Black-Cockatoo which are endemic to Western Australia and classified as Threatened under Commonwealth and State legislation.

The most intact natural features of the Survey Area are the creeklines that feed into the Ellen Brook and the habitat surrounding the creeks and ponds. The most intact parcel of native vegetation appears to be located on Lot 5 and is designated a Bush Forever Site (BSF 13) for this reason. Linkages of the Bush Forever Site on Lot 5 and the watercourse running from Lot 110 through lots 5, 3 and 4 and further north-east where it joins with the Ellen Brook is important for a number of fauna species.

Though the ponds are likely to have been constructed to offer drinking water for livestock, they also offer valuable water through most of the year to native fauna including Black-Cockatoos. These features offer intact connectivity across roads and dense vegetation offering shelter and foraging opportunities to many of the conservation significant species.

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Appendices

Appendix 1. Explanation of fauna values.

Fauna values are the features of a Survey Area and its fauna that contribute to biodiversity, and it is these values that are potentially at threat from a development proposal. Fauna values can be examined under the five headings outlined below. It must be stressed that these values are interdependent and should not be considered equal, but contribute to an understanding of the biodiversity of a Survey Area. Understanding fauna values provides opportunities to predict and therefore mitigate impacts.

Assemblage characteristics

Uniqueness. This refers to the combination of species present at a Survey Area. For example, a Survey Area may support an unusual assemblage that has elements from adjacent biogeographic zones, it may have species present or absent that might be otherwise expected, or it may have an assemblage that is typical of a very large region. For the purposes of impact assessment, an unusual assemblage has greater value for biodiversity than a typical assemblage.

Completeness. An assemblage may be complete (i.e. has all the species that would have been present at the time of European settlement), or it may have lost species due to a variety of factors. Note that a complete assemblage, such as on an island, may have fewer species than an incomplete assemblage (such as in a species-rich but degraded Survey Area on the mainland).

Richness. This is a measure of the number of species at a Survey Area. At a simple level, a species rich Survey Area is more valuable than a species poor Survey Area, but value is also determined, for example, by the sorts of species present.

Vegetation/substrate associations (VSAs)

VSAs combine broad vegetation types, the soils or other substrate with which they are associated, and the landform. In the context of fauna assessment, VSAs are the environments that provide habitats for fauna. The term habitat is widely used in this context, but by definition an animal's habitat is the environment that it utilises (Calver *et al*. 2009), not the environment as a whole. Habitat is a function of the animal and its ecology, rather than being a function of the environment. For example, a species may occur in eucalypt canopy or in leaf-litter on sand, and that habitat may be found in only one or in several VSAs. VSAs are not the same as vegetation types since these may not incorporate soil and landform, and recognise floristics to a degree that VSAs do not. Vegetation types may also not recognise minor but often significant (for fauna) structural differences in the environment. VSAs also do not necessarily correspond with soil types, but may reflect some of these elements.

Because VSAs provide the habitat for fauna, they are important in determining assemblage characteristics. For the purposes of impact assessment, VSAs can also provide a surrogate for detailed information on the fauna assemblage. For example, rare, relict or restricted VSAs should automatically be considered a significant fauna value. Impacts may be significant if the VSA is rare, a large proportion of the VSA is affected and/or the VSA supports significant fauna. The

disturbance of even small amounts of habitat in a localised area can have significant impacts to fauna if rare or unusual habitats are disturbed.

Patterns of biodiversity across the landscape

This fauna value relates to how the assemblage is organised across the landscape. Generally, the fauna assemblage is not distributed evenly across the landscape or even within one VSA. There may be zones of high biodiversity such as particular environments or ecotones (transitions between VSAs). There may also be zones of low biodiversity. Impacts may be significant if a wide range of species is affected even if most of those species are not significant per se.

Species of conservation significance

Species of conservation significance are of special importance in impact assessment. The conservation status of fauna species in Australia is assessed under Commonwealth and State Acts such as the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Biodiversity Conservation Act 2016* (BC Act) (formerly the *Wildlife Conservation Act 1950*). In addition, the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA) recognises priority levels, while local populations of some species may be significant even if the species as a whole has no formal recognition. Therefore, three broad levels of conservation significance can be recognised and are used for the purposes of this report, and are outlined below. A full description of the conservation significance categories, schedules and priority levels mentioned below is provided in Appendix 2.

<u>Conservation Significance (CS) 1: Species listed under State or Commonwealth Acts.</u>

Species listed under the EPBC Act are assigned to categories recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994), or are listed as migratory. Migratory species are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of South Korea Australia Migratory Bird Agreement (ROKAMBA), and/or the Convention on the Conservation of Migratory Species of Wild Animals (CMS; also referred to as the Bonn Convention).

Species that are threatened (and generally follows the IUCN and EPBC Act listings) are also listed under Part 2, Division 1, Subdivision 2 of the Biodiversity Conservation Act 2016 (BC Act)(formerly the Wildlife Conservation Act 1950). Extinct species are recognised and listed under Part 2, Division 1, Subdivision 3 of the BC Act.

Native species that are not extinct or threatened but are considered specially protected, are listed under Part 2, Division 1, Subdivision 1 of the BC Act. These include migratory fauna, cetaceans, species of special conservation interest, are subject to international agreement or, are in need of special protection.

Threatened and extinct species are identified and reported through Ministerial Guidelines No. 2 and specially protected species are identified and reported through Ministerial Guidelines No 3 as prescribed under section 260(1) of the BC Act.

The DBCA lists threatened, extinct and specially protected species in a series of seven schedules listed in the Wildlife Conservation (Specially Protected Fauna) Notice 2018 and published through the Government Gazette. The first fauna notice under the BC Act is yet to be published.

Conservation Significance (CS) 2: Species listed as Priority by the DEC but not listed under State or Commonwealth Acts.

In Western Australia, the DBCA has produced a supplementary list of Priority Fauna, being species that are not considered threatened under the BC Act but for which the DBCA feels there is cause for concern. Some Priority species are also assigned to the Conservation Dependent category of the IUCN.

Conservation Significance (CS) 3: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution.

This level of significance has no legislative or published recognition and is based on interpretation of distribution information, but is used here as it may have links to preserving biodiversity at the genetic level (EPA 2002). If a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Conservation significance is applied to allow for the preservation of genetic richness at a population level, and not just at a species level. Populations on the edge of a species' range are often less abundant and more vulnerable to local extinction than populations at the centre of the range (Curnutt *et al*. 1996), and thus such populations can be considered significant. In addition, species that are sensitive to impacts such as habitat fragmentation may be classed as CS3, as may colonies of waterbirds. The Western Australian Department of Environmental Protection, now DPaW, used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of the Perth Bushplan (DEP 2000).

Invertebrate species considered to be short range endemics (SREs) also fall within the CS3 category, as they have no legislative or published recognition and their significance is based on interpretation of distribution information. Harvey (2002) notes that the majority of species that have been classified as short-range endemics have common life history characteristics such as poor powers of dispersal or confinement to discontinuous habitats. Several groups, therefore, have particularly high instances of short-range endemic species: Gastropoda (snails and slugs), Oligochaeta (earthworms), Onychophora (velvet worms), Araneae (mygalomorph spiders), Pseudoscorpionida (pseudoscorpions), Schizomida (schizomids), Diplopoda (millipedes), Phreatoicidea (phreatoicidean crustaceans), and Decapoda (freshwater crayfish). The poor understanding of the taxonomy of many of the short-range endemic species hinders their conservation (Harvey 2002).

Introduced species

In addition to these conservation levels, species that have been introduced (INT) are indicated throughout the report. Introduced species may be important to the native fauna assemblage through effects by predation and/or competition.

Ecological processes upon which the fauna depend

These are the processes that affect and maintain fauna populations in an area and as such are very complex; for example, populations are maintained through the dynamic of mortality, survival and recruitment being more or less in balance, and these are affected by a myriad of factors. The dynamics of fauna populations in a project may be affected by processes such as fire regime, landscape patterns (such as fragmentation and/or linkage), the presence of feral species and hydrology. Impacts may be significant if processes are altered such that fauna populations are adversely affected, resulting in declines and even localised loss of species. Threatening processes as outlined below are effectively the ecological processes that can be altered to result in impacts upon fauna.

Appendix 2. Categories used in the assessment of conservation status.

IUCN categories (based on review by Mace and Stuart 1994) as used for the *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *WA Biodiversity Conservation Act 2016* (formerly the *Wildlife Conservation Act 1950*). Conservation status is assigned as follows:

- Species listed as threatened, extinct, migratory or specially protected in state and commonwealth legislation can be grouped as Conservation Significance level 1 **(CS1)**
- Those listed a Priority as Conservation Significance 2 **(CS2)**
- Species listed by Dell and Banyard (2000) or assessed by BCE as locally significant are classed as Conservation Significance 3 **(CS3)**
- Least Concern are those species that are not considered rare or threatened by IUCN.

Category definitions are provided below and are taken from the Conservation Codes of the DBCA. Letter codes applied to each are used as abbreviations in Appendices 3, 4, 5 and 6.

Extinct	**Taxa listed as extinct or extinct in the wild**
• Extinct	Taxa not definitely located in the wild during the past 50 years.
• Extinct in the Wild	Taxa known to survive only in captivity.
Threatened (CS1)	**Taxa that are listed as critically endangered, endangered or vulnerable as defined below:**
• Critically Endangered (CR)	Taxa facing an extremely high risk of extinction in the wild in the immediate future.
• Endangered (E)	Taxa facing a very high risk of extinction in the wild in the near future.
• Vulnerable (V)	Taxa facing a high risk of extinction in the wild in the medium-term future.
Specially Protected Species (CS1)	**Taxa that are listed as one or more of the following:**
• Migratory (M):	Fauna that periodically or occasionally visit Australia or an external Territory or the exclusive economic zone; or the species is subject of an international agreement that relates to the protection of migratory species and that binds the Commonwealth.
• Species of special conservation interest:	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened.
• Other specially protected species:	Fauna otherwise in need of special protection to ensure their conservation
Priority Species (CS2)	**Possibly threatened species that are considered poorly known (data deficient), rare, near threatened, or in need of monitoring as defined below:**
• Rare	Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection but could be if present circumstances change
• Near Threatened	Species that are considered to have been adequately surveyed and that are close to qualifying for vulnerable but are not listed as Conservation Dependent.
• Data Deficient (Insufficiently Known)	Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Schedules used for specially protected species under the WA *Wildlife Conservation Act 1950* (replaced in January 2019 by the *Biodiversity Conservation Act 2016* but for which a Fauna Notice has not yet been issued).

Schedule 1 (S1)	Critically Endangered fauna.
Schedule 2 (S2)	Endangered fauna
Schedule 3 (S3)	Vulnerable Migratory species listed under international treaties.
Schedule 4 (S4)	Presumed extinct fauna
Schedule 5 (S5)	Migratory birds under international agreement
Schedule 6 (S6)	Conservation dependant fauna
Schedule 7 (S7)	Other specially protected fauna

WA Department of Environment and Conservation Priority species (species not listed under the Biodiversity Conservation Act 2018, but for which there is some concern).

Priority 1 (P1)	Taxa with few, poorly known populations on threatened lands.
Priority 2 (P2)	Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.
Priority 3 (P3)	Taxa with several, poorly known populations, some on conservation lands.
Priority 4 (P4)	Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.
Priority 5 (P5)	Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

Appendix 3. Vertebrate fauna expected to occur in the survey area.

Status in Survey Area is based on the categories described in Section 2.1.3. R = Resident; M = Migrant; RV = Regular Visitor; IV = Irregular Visitor; Va = Vagrant. Wholly marine species have been excluded.
Species marked with a superscript 'w' are generally dependent on wetlands, species marked with a superscript 'o' are generally oceanic species, species marked with a superscript 'a' are highly aerial species.

Conservation significance codes used in the tables (as defined in Appendix 2):

- CS1, CS2, CS3 = (summary) levels of conservation significance. See Appendix 1 for full explanation.
- EPBC Act listings: Ex = Presumed Extinct, CR = Critically Endangered, E = Endangered, V = Vulnerable, M = Migratory.
- Wildlife Conservation Act (replaced by the BC Act) listings in Schedules 1 to 7 shown in brackets as:
  S1(c) = Schedule 1: Critically Endangered
  S2(e) = Schedule 2: Endangered
  S3(v) = Schedule 3: Vulnerable
  S4(x) = Schedule 4: Extinct
  S5(m) = Schedule 5: Migratory
  S6 = Schedule 6: Fauna that is conservation dependent
  S7 = Schedule 7: Other specially protected fauna
- DBCA Priority species: P1 to P4 = Priority 1 to 4.
- Bush Forever (DEP 2000) status: HS = habitat specialists with a reduced distribution on the Swan Coastal Plain, LE = locally extinct, WR = wide ranging species with reduced populations on the Swan Coastal Plain.
- LS = considered to be of local significance by Bamford Consulting Ecologists.
- Int = introduced species.
- X = recorded during the field investigation.

Sources of information (see Section 2.1 for more details):

1 = Atlas of Living Australia database search.
2 = NatureMap database search.
3 = BirdLife Australia Atlas II database search.
4 = EPBC Protected Matters Search Tool
5 = Recorded by GHD (2018)
6 = Glauert 1948.
BCE = added by BCE through prior knowledge of the area.

Species		Conservation significance	status in Survey Area	Source	Recorded
FISH					
Cyprinidae (Carp)					
Carassius auratus	Goldfish	Int	R	2	
Carpinus carpio	European Carp	Int	R	2	
Galaxiidae (Minnows)					
Galaxias occidentalis	Western Minnow		RV	1,2	
Galaxiella nigrostriata	Black-striped Minnow	CS1 (E, S3[v])	Va	1,2,4	
Percichthyidae (Basses)					
Bostockia porosa	Nightfish		RV	2	

Species		Conservation significance	status in Survey Area	Source	Recorded
Nannoperca vittata	Western Pygmy-perch		RV	2	
Poecilidae (Gambusia)					
Gambusia holbrooki	Mosquitofish		R	2	
FROGS					
Hylidae (Tree frogs)					
Litoria adelaidensis	Slender Tree Frog		R	1	
Litoria moorei	Motorbike Frog		R	1	
Limnodynastidae (Burrowing frogs)					
Heleioporus eyrei	Moaning Frog	CS3	R	1	X
Limnodynastes dorsalis	Pobblebonk		R	1	X
Myobatrachidae (Australian frogs)					
Crinia georgiana	Quacking Froglet		R	1	
Crinia glauerti	Clicking Froglet		R	1	X
Crinia insignifera	Squelching Froglet		R	1	
Myobatrachus gouldii	Turtle Frog	CS3	R	BCE	
Pseudophryne guentheri	Crawling Toadlet	CS3	R	1	
REPTILES					
Chelidae (side-necked tortoises)					
Chelodina colliei	South-west Long-necked Tortoise[W]		R	1,2	
Pseudemydura umbrina	Western Swamp Tortoise[W]	CS1 (C, S1[c])	Va	1,2,4	
Agamidae (Dragons)					
Ctenophorus adelaidensis	Western Heath Dragon	CS3	R	1,2	
Pogona minor	Dwarf Bearded Dragon	CS3	R	1,2	
Diplodactylidae (Diplodactylids)					
Strophurus spinigerus	Soft Spiny-tailed Gecko		R	1,2	
Gekkonidae (Gekkonids)					
Christinus marmoratus	Marbled Gecko		R	2	
Pygopodidae (Legless lizards)					
Aprasia repens	Sand-plain Worm-lizard		R	1,2	
Delma fraseri	Fraser's Legless Lizard	CS3	R	2	
Lialis burtonis	Burton's Legless Lizard	CS3	R	1,2	
Pygopus lepidopodus	Common Scaly-foot	CS3	R	2	
Scincidae (Skinks)					
Acritoscincus trilineatum	Cool Skink		R	1,2	
Cryptoblepharus buchananii	Buchanan's Snake-eyed Skink		R	1,2	X
Ctenotus fallens	West Coast Ctenotus	CS3	R	2	
Egernia kingii	King's Skink	CS3	R	2	
Egernia napoleonis	Salmon-bellied Skink		R	2	
Hemiergis quadrilineata	Two-toed Earless Skink		R	1,2	
Lerista elegans	West Coast Four-toed Slider		R	1,2	
Lerista lineopunctulata	West Coast Line-spotted Slider		R	2	

Species		Conservation significance	status in Survey Area	Source	Recorded
Lerista praepedita	West Coast Worm-slider		R	1,2	
Menetia greyii	Common Dwarf Skink		R	1,2	
Morethia lineoocellata	Western Pale-flecked Morethia		R	1,2	
Morethia obscura	Dusky Morethia		R	1,2	
Tiliqua occipitalis	Western Blue-tongue	CS3	R	1,2	
Tiliqua rugosa	Bobtail	CS3	R	1,2	X
Varanidae (Monitor lizards)					
Varanus gouldii	Gould's Monitor	CS3	R	BCE	X
Varanus tristis	Black-headed Monitor	CS3	R	1,2	X
Typhlopidae (Blind snakes)					
Anilios australis	Southern Blind Snake		R	1,2	
Anilios waitii	Southern Beaked Blind Snake		R	1	
Elapidae (Venomous land snakes)					
Brachyurophis semifasciatus	Southern Shovel-Nosed Snake	CS3	R	1,2	
Demansia reticulata	Yellow-faced Whip Snake	CS3	R		
Notechis scutatus	Tiger Snake		R	1,2	
Parasuta gouldii	Gould's Snake	CS3	R	1,2	
Pseudechis australis	Mulga Snake		R	1,2	
Pseudonaja affinis	Dugite		R	1,2	X
Simoselaps bertholdi	Jan's Banded Snake	CS3	R	1,2	
birds					
Phalacrocoracididae (Pelicans and Cormorants)					
Pelecanus conspicillatus	Australian Pelican[W]		Va	2,3	
Phalacrocorax carbo	Great Cormorant[W]		IV	2,3	
Phalacrocorax melanoleucos	Little Pied Cormorant[W]		IV	2,3	
Phalacrocorax sulcirostris	Little Black Cormorant[W]		IV	2,3	
Phalacrocorax varius	Pied Cormorant[W]		IV	2,3	
Anhingidae (Darters)					
Anhinga novaehollandiae	Australasian Darter[W]		IV	2,3	X
Recurvirostridae (Stilts and Avocets)					
Himantopus leucocephalus	Black-winged Stilt, White-headed Stilt[W]		IV	2,3	
Cladorhynchus leucocephalus	Banded Stilt[W]		IV	3	
Recurvirostra novaehollandiae	Red-necked Avocet[W]		IV	3	
Charadriidae (Plovers and Lapwings)					
Elseyornis melanops	Black-fronted Dotterel[W]		RV	2,3	
Erythrogonys cinctus	Red-kneed Dotterel[W]		IV	2,3	
Charadrius ruficapillus	Red-capped Plover[W]		RV	3	
Vanellus tricolor	Banded Lapwing[W]		RV	2,3	
Rostratulidae (Painted-snipe)					
Rostratula australis	Australian Painted-snipe	CS1 (E,S2[e])	Va	2,4	

Species		Conservation significance	status in Survey Area	Source	Recorded
Phasianidae (Pheasants and allies)					
Coturnix pectoralis	Stubble Quail		RV	3	
Anatidae (Ducks and allies)					
Cygnus atratus	Black Swan[W]		RV	1,2,3	
Anas castanea	Chestnut Teal[W]		IV	3	
Anas gracilis	Grey Teal[W]		RV	1,2,3	
Anas platyrhynchos	Domestic Mallard[W]	Int	IV	1,2,3	
Anas rhynchotis	Australasian Shoveler[W]		IV	1,2,3	
Anas superciliosa	Pacific Black Duck[W]		R	1,2,3	X
Aythya australis	Hardhead[W]		RV	2,3	
Biziura lobata	Musk Duck[W]		Va	2,3	
Chenonetta jubata	Australian Wood Duck[W]		RV	1,2,3	X
Malacorhynchus membranaeus	Pink-eared Duck[W]		IV	2,3	
Oxyura Australis	Blue-billed Duck[W]	CS2 (P4)	Va	2,3	
Stictonetta naevosa	Freckled Duck[W]		IV	3	
Tadorna tadornoides	Australian Shelduck[W]		RV	1,2,3	
Podicepedidae (Grebes)					
Podiceps cristatus	Great Crested Grebe[W]		IV	3	
Poliocephalus poliocephallus	Hoary-headed Grebe[W]		IV	2,3	
Tachybaptus novaehollandiae	Australasian Grebe[W]		RV	1,2,3	
Columbidae (Pigeons and doves)					
Columba livia	Rock Dove/Feral Pigeon	Int	R	1,2,3	
Phaps chalcoptera	Common Bronzewing	CS3 (HS)	R	1,2,3	X
Phaps elegans	Brush Bronzewing		IV	3	
Ocyphaps lophotes	Crested Pigeon		R	1,2,3	X
Streptopelia chinesensis	Spotted Dove	Int	R	1,2,3	
Streptopelia senegalensis	Laughing Dove	Int	R	1,2,3	
Podargidae (Australian frogmouth)					
Podargus strigoides	Tawny Frogmouth		R	2,3	
Caprimulgidae (Nightjars)					
Eurostopodus argus	Spotted Nightjar		IV	3	
Aegothelidae (Owlet-nightjars)					
Aegotheles cristatus	Australian Owlet-nightjar		IV	3	
Apodidae (Typical swifts)					
Apus pacificus	Fork-tailed Swift[a]	CS1 (M, S5)	M, V	3,4	
Ardeidae (Heron, bittern, egret)					
Ardea modesta	Eastern Great Egret[W]		IV	2	
Ardea novaehollandiae	White-faced Heron[W]		IV	2,3	X
Ardea pacifica	White-necked Heron[W]		IV	2,3	
Egretta garzetta	Little Egret[W]		IV	1,2,3	
Ixobrychus dubius	Australian Little Bittern[W]	CS2 (P4)	Va	3	

Species		Conservation significance	status in Survey Area	Source	Recorded
Nicticorax caledonicus	Nankeen Night-Heron[W]		RV	2,3	
Threskiornithidae (Ibis, Spoonbill)					
Platalea flavipes	Yellow-billed Spoonbill[W]		IV	2,3	
Threskiornis falcinellus	Glossy Ibis	CS1 (IA)	Va	2,3	
Threskiornis molucca	Australian White Ibis		RV	1,3	
Threskiornis spinicollis	Straw-necked Ibis		IV	1,2	X
Accipitridae (Osprey, hawk, eagle)					
Accipiter fasciatus	Brown Goshawk	CS3 (WR)	RV	2,3	
Accipiter cirrocephalus	Collared Sparrowhawk	CS3 (WR)	R	2,3	
Aquila audax	Wedge-tailed Eagle	CS3 (WR)	RV	1,2,3	
Circus assimilis	Spotted Harrier		IV		
Circus approximans	Swamp Harrier		IV	2,3	
Elanus caeruleus (axillaris)	Black-shouldered Kite		RV	2,3	
Haliastur sphenurus	Whistling Kite	CS3 (WR)	RV	2,3	
Hieraaetus morphnoides	Little Eagle	CS3 (WR)	RV	1,2,3	
Lophoictinia isura	Square-tailed Kite	CS3 (WR)	RV	1,2,3	
Milvus migrans	Black Kite		Va	3	
Falconidae (Falcons)					
Falco cenchroides	Nankeen Kestrel		RV	1,2,3	X
Falco berigora	Brown Falcon	CS3 (WR)	RV	2,3	
Falco longipennis	Australian Hobby		RV	3	
Falco peregrinus	Peregrine Falcon	CS1 (S7)	RV	2,3	
Rallidae (crakes and rails)					
Fulica atra	Eurasian Coot[W]		R	1,2,3	
Gallinula tenebrosa	Dusky Moorhen[W]		R	1,2,3	
Porphyrio melanotus	Australasian Swamphen[W]		RV	1,2,3	
Hypotaenidia philippensis	Buff-banded Rail[W]		IV	3	
Porzana fluminea	Australian Spotted Crake[W]		IV	3	
Zapornia pusilla	Baillon's Crake[W]		IV	3	
Zapornia tabuensis	Spotless Crake[W]		IV	3	
Tribonyx ventralis	Black-tailed Native-hen[W]		IV	3	
Turnicidae (Button-quails)					
Turnix varius	Painted Button-quail	CS3 (WR)	R	2,3	
Turnix velox	Little Button-quail		IV	2,3	
Scolopacidae (Sandpipers and Snipes)					
Actitis hypoleucos	Common Sandpiper[W]	CS1 (Mig, S5)	IV	3,4	
Calidris acuminata	Sharp-tailed Sandpiper[W]	CS1 (Mig, S5)	IV	3,4	
Tringa glareola	Wood Sandpiper[W]	CS1 (Mig, S5)	IV	3	
Tringa stagnatilis	Marsh Sandpiper[W]	CS1 (Mig, S5)	IV	3	
Calidris ruficollis	Red-necked Stint[W]	CS1 (Mig, S5)	IV	3	
Tringa nebularia	Common Greenshank[W]	CS1 (Mig, S5)	IV	3,4	

Species		Conservation significance	status in Survey Area	Source	Recorded
Cacatuidae (Cockatoos)					
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	CS1 (V, S3[v])	RV	1,2,3,4	X
Calyptorhynchus baudinii	Baudin's Black-Cockatoo	CS1 (V, S2[e])	IV	2,3,4	
Calyptorhynchus latirostris	Carnaby's Black-Cockatoo	CS1 (E, S2[e])	RV	1,3,4	X
Cacatua galerita	Sulphur-crested Cockatoo	Int	IV	3	
Cacatua pastinator	Western Long-billed Corella		RV	1,2,3	
Cacatua tenuirostris	Eastern Long-billed Corella	Int	RV	2,3	X
Cacatua sanguinea	Little Corella	Int	RV	1,2,3	
Eolophus roseicapillus	Galah		R	1,2,3	X
Psittacidae (Parrots)					
Glossopsitta porphyrocephala	Purple-crowned Lorikeet		IV	3	
Neophema elegans	Elegant Parrot		IV	2,3	
Platycercus icterotis	Western Rosella	CS3 (WR)	IV	2,3	
Platycercus zonarius	Australian Ringneck		R	1,2,3	X
Polytelis anthopeplus	Regent Parrot		IV	1,2,3	
Purpureicephalus spurius	Red-capped Parrot		R	1,2,3	X
Trichoglossus haematodus	Rainbow Lorikeet	Int	RV	1,2,3	
Cuculidae (Old world cuckoos)					
Chalcites basalis	Horsfield's Bronze-Cuckoo		RV	2,3	
Chalcites lucidus	Shining Bronze-Cuckoo		RV	1,2,3	
Cacomantis flabelliformis	Fan-tailed Cuckoo		RV	1,2,3	
Cacomantis pallidus	Pallid Cuckoo		RV	1,2,3	
Strigidae (Hawk owls)					
Ninox boobook	Southern Boobook		R	3	X
Ninox connivens	Barking Owl (South-west pop'n)	CS2 (P2, WR)	IV	3	X
Tytonidae (Barn owls)					
Tyto novaehollandeae	Masked Owl	CS2 (P3, WR)	IV	3	
Tyto javanica	Eastern Barn Owl		RV		
Alcedinidae (Tree kingfishers)					
Dacelo novaeguineae	Laughing Kookaburra	Int	R	1,2,3	X
Todiramphus sanctus	Sacred Kingfisher		RV	1,2,3	X
Meropidae (Bee-eaters)					
Merops ornatus	Rainbow Bee-eater		M, RV	1,2,3	X
Maluridae (Fairy-wrens and allies)					
Malurus lamberti	Variegated Fairy-wren	CS3 (HS)	R	2,3	
Malurus splendens	Splendid Fairy-wren	CS3 (HS)	R	1,2,3	X
Cisticolidae (Cisticolas and Warblers)					
Acrocephalus australis	Australian Reed-Warbler		RV	1,2,3	
Acanthizidae (thornbills and allies)					
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	CS3 (HS)	R	1,2,3	X
Acanthiza inornata	Western Thornbill	CS3 (HS)	Va	1,2,3	X

Species		Conservation significance	status in Survey Area	Source	Recorded
Acanthiza apicalis	Inland Thornbill	CS3 (HS)	IV	1,2,3	
Gerygone fusca	Western Gerygone		R	1,2,3	
Sericornis frontalis	White-browed Scrubwren	CS3 (HS)	RV	2,3	
Smicrornis brevirostris	Weebill	CS3 (HS)	R	1,2,3	
Pardalotidae (Pardalotes)					
Pardalotus punctatus	Spotted Pardalote		RV	2,3	X
Pardalotus striatus	Striated Pardalote		R	1,2,3	
Meliphagidae (Honeyeaters)					
Acanthorhynchus superciliosus	Western Spinebill		IV	1,2,3	
Anthochaera carunculata	Red Wattlebird		R	1,2,3	X
Anthochaera lunulata	Western Wattlebird	CS3 (WR)	RV	1,2,3	
Epthianura albifrons	White-fronted Chat		IV	2,3	
Gavicalis virescens	Singing Honeyeater		R	1,2,3	X
Glyciphila melanops	Tawny-crowned Honeyeater	CS3 (WR)	IV	2,3	
Lichmera indistincta	Brown Honeyeater		R	1,2,3	X
Melithreptus brevirostris	Brown-headed Honeyeater		IV	1,2,3	
Melithreptus lunatus	White-naped Honeyeater		IV	3	
Manorina flavigula	Yellow-throated Miner		RV	1,2,3	
Phylidonyris niger	White-cheeked Honeyeater	CS3 (WR)	R	1,2,3	
Phylidonyris novaehollandiae	New Holland Honeyeater	CS3 (WR)	R	1,2,3	
Neosittidae (Survey Areallas)					
Daphoenositta chrysoptera	Varied Sittella	CS3 (HS)	RV	1,2,3	
Campephagidae (Cuckoo-shrikes and trillers)					
Coracina novaehollandiae	Black-faced Cuckoo-shrike		R	1,2,3	X
Lalage sueurii	White-winged Triller		RV	3	
Pachycephalidae (Whistlers, shrike-thrushes)					
Colluricincla harmonica	Grey Shrike-thrush	CS3 (HS)	R	1,2,3	
Pachycephala pectoralis fuliginosa	Western Whistler	CS3 (HS)	IV	3	
Pachycephala rufiventris	Rufous Whistler		R	1,2,3	X
Artamidae (Woodswallows, butcherbirds, currawong)					
Artamus cinereus	Black-faced Woodswallow	CS3 (WR)	RV	1,2,3	X
Artamus cyanopterus	Dusky Woodswallow	CS3 (WR)	IV	2,3	
Artamus personatus	Masked Woodswallow		Va	3	
Cracticus tibicen	Australian Magpie		R	1,2,3	X
Cracticus torquatus	Grey Butcherbird		R	1,2,3	X
Strepera versicolor	Grey Currawong	CS3 (WR)	Va	2,3	
Corvidae (Ravens and Crows)					
Corvus coronoides	Australian Raven		R	1,2,3	X
Rhipiduridae (Fantails)					
Rhipidura albiscapa	Grey Fantail		R	1,2,3	X
Rhipidura leucophrys	Willie Wagtail		R	1,2,3	X

Species		Conservation significance	status in Survey Area	Source	Recorded
Monarchidae (Flycatchers and magpie-lark)					
Grallina cyanoleuca	Magpie-lark		R	1,2,3	X
Myiagra inquieta	Restless Flycatcher	CS3 (HS)	IV	2,3	
Petroicidae (Robins)					
Melanodryas cucullata	Hooded Robin	CS3 (HS)	Va	2,3	
Petroica boodang	Scarlet Robin	CS3 (HS)	IV	1,2,3	
Petroica goodenovii	Red-capped Robin	CS3 (HS)	Va	1,2,3	
Megaluridae (Grassbirds)					
Cincloramphus cruralis	Brown Songlark		IV	1,3	
Cincloramphus mathewsi	Rufous Songlark		RV	3	
Poodytes gramineus	Little Grassbird		IV	3	
Timaliidae (White-eyes)					
Zosterops lateralis	Silvereye		R	1,2,3	X
Hirundinidae (Swallows and martins)					
Cheramoeca leucosterna	White-backed Swallow[a]		IV	3	
Hirundo neoxena	Welcome Swallow[a]		R	1,2,3	
Petrochelidon ariel	Fairy Martin[a]		IV	1,3	
Petrochelidon nigricans	Tree Martin[a]		RV	1,2,3	X
Nectariniidae (Sunbirds and allies)					
Dicaeum hirundinaceum	Mistletoebird		RV	2,3	
Motacillidae (Old world wagtail, pipit)					
Anthus novaeseelandiae	Australasian Pipit		RV	2,3	X
Estrillidae (Grass Finches)					
Stagonopleura oculata	Red-eared Firetail		Va	2,3	
Taeniopygia guttata	Zebra Finch		Va	3	
MAMMALS					
Tachyglossidae (Echidnas)					
Tachyglossus aculeatus	Echidna		R	BCE	
Dasyuridae (Dasyurids)					
Dasyurus geoffroii	Chuditch	CS1 (V,S3[v])	Va	2,4	
Phascogale tapoatafa wambenger	Brush-tailed Phascogale	CS1 (V,S3[v])	Va	1	
Peremelidae (Bandicoots)					
Isoodon fusciventer	Quenda	CS2 (P4)	R	1,2	X
Macropodidae (Kangaroos, wallabies)					
Macropus fuliginosus	Western Grey Kangaroo		R	1,2	X
Notamacropus irma	Brush Wallaby	CS2 (P4)	IV	2	
Phalangeridae (Brushtail possums)					
Trichosurus vulpecula	Brushtail Possum		R	2	
Burramyidae (Pygmy possums)					
Cercartetus concinnus	Western Pygmy-possum	CS3 (LS)	IV	2	

Species		Conservation significance	status in Survey Area	Source	Recorded
Tarsipedidae (Honey Possum)					
Tarsipes rostratus	Honey Possum		IV	1,2	
Vespertilionidae (Vespertillionid bats)					
Chalinolobus gouldii	Gould's Wattled Bat		R	BCE	
Chalinolobus morio	Chocolate Wattled Bat		RV	BCE	
Nyctophilus geoffroyi	Lesser Long-eared Bat		R	BCE	
Nyctophilus major	Western long-eared Bat		RV	BCE	
Vespadelus regulus	Southern Forest Bat		RV	2	
Molossidae (Freetail bats)					
Austronomus (Tadarida) australis	White-striped Freetail Bat		RV	BCE	
Ozimops kitcheneri	Western Freetail-Bat	CS3 (LS)	RV	BCE	
Muridae (Rats and mice)					
Hydromys chrysogaster	Rakali (water-rat)	CS2 (P4)	RV	2	
Mus musculus	House Mouse	Int	R	2	
Rattus rattus	Black Rat	Int	R	1,2	
Leporidae (Rabbits and hares)					
Oryctolagus cuniculus	Rabbit	Int	R	2	X
Canidae (Dogs and foxes)					
Vulpes vulpes	Red Fox	Int	R	BCE	X
Felidae (Cats)					
Felis catus	Cat	Int	R	2	X
Significant invertebrates					
Westralunio carteri	Carter's Freshwater Mussel	CS1 (V,S3[v])	Possibly Extinct	2,4	
Leioproctus contrarius	Short-tongued Bee	CS2 (P3)	IV	2	
Leioproctus douglasiellus	Short-tongued Bee	CS1 (C,S3[e])	IV	2	
Synemon gratiosa	Graceful Sun-Moth	CS2 (P4)	IV	2	

Appendix 4. Species listed in databases or previously listed as recorded but unlikely to occur in the Survey Area.

For codes used in tables see Appendix 3.

Species have been placed on this list because there is no suitable habitat for them, the Survey Area is outside recognised range of the species or they are considered extremely unlikely to be present (but could occur as very rare vagrants). A few are the result of records of introduced species that are not established, and some are database errors.

Seabirds that were present in the data records and that do not generally move inland are not included.

Species		Conservation significance	Source
FROGS			
Limnodynastidae (Burrowing frogs)			
Heleioporus barycragus	Hooting Frog		1
Neobatrachus pelabatoides	Humming Frog		1
REPTILES			
Agamidae (Dragons)			
Ctenophorus ornatus	Ornate Crevice-Dragon		2
Intellagama lesuerii	Australian Water Dragon	Int	1
Carphodactylidae (Thick-tailed Geckos)			
Underwoodisaurus milii	Barking Gecko		2
Diplodactylidae (Diplodactylid geckoess)			
Crenadactylus occelatus	Clawless Gecko		1,2
Diplodactylus granariensis	Western Stone Gecko		1,2
Hesperoedura reticulata	Reticulated Velvet Gecko		2
Gekkonidae (Gekkonids)			
Gehyra variegata	Variegated Dtella		2
Pygopodidae (Legless lizards)			
Aprasia pulchella	Western Granite Worm Lizard		1,2
Delma concinna	Javelin Legless Lizard		2
Delma grayii	Gray's Legless Lizard	CS3	2
Pletholax gracilis	Keeled Legless Lizard	CS3	1,2
Scincidae (Skinks)			
Ctenotus australis	Western Limestone Ctenotus	CS3	2
Ctenotus gemmula	Jewelled Sand-plain Skink	CS2 (P3)	2
Ctenotus impar	Odd-striped Ctenotus		1,2
Ctenotus inornatus	Plain Ctenotus	Int	1
Hemiergis initialis subsp. initialis	Western Earless Skink		2
Hemiergis peronii	Peron's Earless Skink		2
Lampropholis guichenoti	Grass Skink	Int	1
Lerista christinae	Bold-striped Slider	CS3	1,2

Species		Conservation significance	Source
Elapidae (Venomous land snakes)			
Brachyurophis fasciolatus	Narrow-banded Burrowing Snake		1,2
Echiopsis curta	Bardick	CS3	2
Neelaps bimaculatus	Black-naped Snake	CS2 (P4)	1,2
Neelaps calonotos	Black-striped Snake	CS2 (P3)	2
Parasuta nigreceps	Black-backed Snake		
Pseudonaja mengdeni	Gwardar, Western Brown Snake		1,2
BIRDS			
Charadriidae (Plovers and Lapwings)			
Eolophus roseicephalus	Red-capped Dotterel[W]		2
Anatidae (Ducks and allies)			
Dendrocygna eytoni	Plumed Whistling-Duck[W]		3
Accipitridae (Osprey, hawk, eagle)			
Haliaeetus leucogaster	White-bellied Sea-Eagle[O]		3
Pandion cristatus	Eastern Osprey[O]	CS1 (IA)	3,4
Scolopacidae (Sandpipers and Snipes)			
Calidris ferruginea	Curlew Sandpiper[W]	CS1 (C,M,S[c])	3,4
Numenius madagascariensis	Eastern Curlew[W]	CS1 (C,M,S[c])	4
Calidris melanotos	Pectoral Sandpiper[W]		4
Calidris subminuta	Long-toed Stint[W]		3
Glareolidae (Pratincoles and Coursers)			
Glareola maldivarum	Oriental Pratincole		3
Cacatuidae (Cockatoos)			
Cacatua leadbeateri	Major Mitchell's Cockatoo		3
Psittacidae (Parrots)			
Nymphicus hollandicus	Cockatiel		3
Trichoglossus chlorolepidotus	Scaly-breasted Lorikeet	Int	2
Cuculidae (Old world cuckoos)			
Chrysococcyx osculans	Black-eared Cuckoo		1,3
Tytonidae (Barn owls)			
Tyto alba subsp. delicatula	Barn Owl		1,3
Maluridae (Fairy-wrens and allies)			
Malurus elegans	Red-winged Fairy-wren	CS3 (HS)	3
Malurus leucopterus	White-winged Fairy-wren	CS3 (HS)	2,3
Malurus pulcherrimus	Blue-breasted Fairy-wren		1,2,3
Cisticolidae (Cisticolas and Warblers)			
Calamanthus cautus	Shy Heathwren		3
Acanthizidae (thornbills and allies)			
Acanthiza uropygialis	Chestnut-rumped Thornbill		3

Species		Conservation significance	Source
Meliphagidae (Honeyeaters)			
Acanthagenys rufogularis	Spiny-cheeked Honeyeater		3
Ptilotula ornata	Yellow-plumed Honeyeater	CS3 (WR)	3
Purnella albifrons	White-fronted honeyeater		2,3
Pomatastomidae (Babblers)			
Pomatastomus superciliosus	White-browed Babbler	CS3 (HS)	2,3
Climacteridae (Treecreepers*)*			
Climacteris rufus	Rufous Treecreeper		1,3
Artamidae (Woodswallows, butcherbirds, currawong)			
Cracticus nigrogularis	Pied Butcherbird	CS3 (WR)	1,2,3
Petroicidae (Robins)			
Eopsaltria georgiana	White-breasted Robin	CS3 (HS)	3
Eopsaltria griseogularis	Western Yellow Robin	CS3 (HS)	3
Microeca fascinans	Jacky Winter	CS3 (HS)	2
Motacillidae (Wagtails)			
Motacilla cinerea	Grey Wagtail	CS1 (M)	4
Fringillidae (Finches)			
Carduelis carduelis	European Goldfinch	Int	3

Appendix 5. Species returned from database searches but that are locally extinct

For codes used in table see Appendix 3.

Species		Conservation significance	Source
REPTILES			
Boidae (Pythons)			
Antaresia stimsoni	Stimson's Python	CS3	
Morelia spilota imbricata	Carpet Python (south-west pop'n)	CS3	2
BIRDS			
Casuariidae (Cassowaries, emus)			
Dromaius novaehollandiae	Emu		1,2,3
Megapodiidae (Megapodes)			
Leipoa ocellata	Malleefowl	CS1 (V,S3[v])	4
Burhinidae (Stone Curlews)			
Burhinus grallarius	Bush Stone-curlew		3
MAMMALS			
Dasyuridae (Dasyurids)			
Sminthopsis gilberti	Gilbert's Dunnart	CS3 (LS)	BCE
Sminthopsis fuliginosus	Grey-bellied Dunnart	CS3 (LS)	BCE
Potoroidae (Potoroos)			
Bettongia lesueur graii	Boodie (inland), Burrowing Bettong	CS1 (Ex, S4[e])	BCE
Bettongia penicillata ogilbyi	Woylie, Brush-tailed Bettong	CS1 (E, S1[c])	4
Potorous gilbertii	Gilbert's Potoroo	CS1 (CR, S1[c])	BCE
Macropodidae (Kangaroos, wallabies)			
Notamacropus eugenii	Tammar Wallaby	CS2 (P4)	2
Petrogale lateralis subsp. lateralis	Black-flanked Rock Wallaby	CS1 (V,S2[e])	2,4
Onychogalea lunata	Tjawalpa, Crescent Nail-tail Wallaby	CS1 (Ex, S4[e])	BCE
Setonix brachyurus	Quokka	CS1 (V, S3[v])	BCE
Peramelidae (Bandicoots)			
Macrotis lagotis	Bilby, Dalgyte	CS1 (V,S3[v])	2
Muridae (Rats and mice)			
Pseudomys albocinereus	Noodji, Ash-grey Mouse	CS3 (LS)	BCE

Appendix 6. Opportunistic fauna observation recorded during the field assessment.

	Frog species	Notes
1	Pobblebonk (*Limnodynastes dorsalis*)	calling in ponds on Lots 15 and 101
	Reptile species	
2	Snake-eyed skink (*Cryptoblepharus buchananii*)	Several seen basking on logs
3	Bobtail Skink (*Tiliqua rugosa*)	One moving through ground cover
4	Gould's Monitor (*Varanus gouldii*)	Diggings throughout paddocks on Lot 15
5	Black-headed Monitor (*Varanus tristis*)	Juvenile spotted in tree hollow.
6	Dugite (*Pseudonaja affinis*)	One disturbed while basking
	Bird species	
7	Australasian Darter (*Anhinga novaehollandiae*)	Flying over Survey Area
8	Pacific Black Duck (*Anas superciliosa*)	Several on a pond on Lot 110
9	Wood Duck (*Chenonetta jubata*)	Pair on a pond on Lot 110 in December, small group on pond on Lot 110 in April and abandoned nest found in tree hollow on Lot 110.
10	Common Bronzewing (*Phaps chalcoptera*)	Several across the Survey Area
11	Crested Pigeon (*Ocyphaps lophotes*)	Several across the Survey Area
12	White-faced Heron (*Ardea novaehollandiae*)	Flushed from pond
13	Straw-necked Ibis (*Threskiornis spinicollis*)	Several observed in paddocks or in trees
14	Nankeen Kestrel (*Falco cenchroides*)	Nesting pair on Lot 15
15	Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*)	Foraging signs
16	Carnaby's Black-Cockatoo (*Calyptorhynchus latirostris*)	Pair or small group heard calling and foraging signs. Pair and group of six birds seen foraging in Marri trees on Lot 5.
17	Eastern Long-billed Corella (*Cacatua tenuirostris*)	Small group observed flying over eastern half of Survey Area
18	Galah (*Eolophus roseicapilla*)	Several observed across Survey Area
19	Australian Ringneck (*Barnardius zonarius*)	Many observed and heard calling throughout Survey Area
20	Red-capped Parrot (*Purpureicephalus spurius*)	Observed, heard calling and foraging signs
21	Southern Boobook (*Ninox boobook*)	One flushed from daytime roost on Lot 15
22	Laughing Kookaburra (*Dacelo novaeguineae*)	Heard calling from dense woodland
23	Sacred Kingfisher (*Todiramphus sanctus*)	Observed on overhead lines on Maralla Rd
24	Rainbow Bee-eater (*Merops ornatus*)	Pair hawking over several Lots.
25	Splendid Fairy-wren (*Malurus splendens*)	One observed on Lot 15
26	Yellow rumped Thornbill (*Acanthiza chrysorrhoa*)	Several groups observed and heard
27	Western Thornbill (*Acanthiza inornata*)	Several groups observed and heard
28	Striated Pardalote (*Pardalotus striatus*)	Heard calling
29	Red Wattlebird (*Anthochaera carunculata*)	Observed across Survey Area
30	Singing Honeyeater (*Gavicalis virescens*)	Observed and heard across Survey Area
31	Brown Honeyeater (*Lichmera indistincta*)	Observed and heard across Survey Area
32	Black-faced Cuckoo-shrike (*Coracina novaehollandiae*)	Several observed and heard across Survey Area
33	Rufous Whistler (*Pachycephala rufiventris*)	Observed and heard
34	Black-faced Woodswallow (*Artamus cinereus*)	Observed and heard in open paddocks
35	Australian Magpie (*Cracticus tibicen*)	Several across Survey Area
36	Grey Butcherbird (*Cracticus torquatus*)	One heard

37	Australian Raven (*Corvus coronoides*)	Several observed across Survey Area
38	Grey Fantail (*Rhipidura albiscapa*)	Observed and heard calling
39	Willie Wagtail (*Rhipidura leucophrys*)	Observed across Survey Area
40	Magpie-lark (*Grallina cyanoleuca*)	Several observed
41	Silvereye (*Zosterops lateralis*)	Observed and heard calling
42	Tree Martin (*Petrochelidon nigricans*)	Observed overhead
43	Australian Pipit (*Anthus novaeseelandiae*)	Family group observed on Lot 15
44	Barking Owl (*Ninox connivens*)	Probable call heard from within Lot 5 on evening of 23 April during black-Cockatoo roost survey.
Mammal species		
44	Quenda (*Isoodon fusciventer*)	Diggings
45	Western Grey Kangaroo (*Macropus fuliginosus*)	Several small groups
46	Rabbit (*Oryctolagus cuniculus*)	Frequent droppings and diggings
47	Red Fox (*Vulpes vulpes*)	Scats, tracks and one earth
48	Cat (*Felis catus*)	Tracks found

Appendix 7. Scoring system for the assessment of vegetation foraging value for black-cockatoos.

Total score (out of 10) comprises:

- A score out of six for the vegetation composition, condition and structure; plus
- A score out of three for the context of the Survey Area; plus
- A score out of one for species density.

These are described in detail below.

A. Vegetation composition, condition and structure scoring

Survey Area Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
0	No foraging value. No Proteaceae, eucalypts or other potential sources of food. Examples would be salt lakes and bare ground.	No foraging value. No eucalypts or other potential sources of food.	No foraging value. No eucalypts (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri) or other potential sources of food.
1	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <2%. Could include urban areas with scattered foraging trees. Blue Gum plantations are considered to have a score of 1 as foraging by Black-Cockatoos has been reported but appears to be unusual.	Negligible to low foraging value. Scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.	Negligible to low foraging value. Scattered specimens of known food plants but projected foliage cover of these <1%. Could include urban areas with scattered foraging trees.

Survey Area Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
2	Low foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with <10% projected foliage cover • Open eucalypt woodland/mallee of small-fruited species • Paddocks with melons or other weeds (a short-term, seasonal food source).	Low foraging value. Example: • Woodland or forest with scattered specimens of known food plants (e.g. Marri and Jarrah) but projected foliage cover of these 1-<5%. Could include urban areas with scattered foraging trees.	Low foraging value. Examples: • Open eucalypt woodland (i.e. Marri, Jarrah, Wandoo, Blackbutt or Karri). Projected foliage cover of these 1-<5% • Urban areas with scattered food plants such as Cape Lilac, *Eucalyptus caesia* and *Eucalyptus erythrocorys*.
3	Low to Moderate foraging value. Examples: • Shrubland in which species of foraging value, such as shrubby banksias, with 10-20% projected foliage cover • Woodland with tree banksias 2-10% projected foliage cover • Eucalypt woodland/mallee of small-fruited species; Marri, if present, <10% project foliage cover.	Low to Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 5-<10%. • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 10-<20% can be considered low-to-moderate because of poor long-term viability without management.	Low to Moderate foraging value. Examples: • Eucalypt woodland (i.e. Marri, Jarrah, Wandoo, and Blackbutt), if present, <10% project foliage cover.

Survey Area Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
4	Moderate foraging value. Examples: • Woodland with tree banksias 20-40% projected foliage cover. • Eucalypt woodland/forest with Marri 20-40% projected foliage cover.	Moderate foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 10-<20% • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of 20-<40% can be considered moderate because of poor long-term viability without management • Areas of orchards and especially those with apples can be considered of moderate value.	Moderate foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with 20-40% projected foliage cover.
5	Moderate to High foraging value. Examples: • Banksia Woodlands with tree banksias >40%. Vegetation condition moderate due to weed invasion and some tree deaths. • Pine plantations with trees more than 10 years old.	Moderate to High foraging value. Examples: • Eucalypt woodland with known food plants (and in particular Marri) with a projected foliage cover of 20-<40% • Parkland-cleared eucalypt woodland with projected foliage cover of known food plants of >40% can be considered moderate because of poor long-term viability without management.	Moderate to High foraging value. Examples: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >40% projected foliage cover. Vegetation condition moderate due to weed invasion and some tree deaths.

Survey Area Score	Description of Vegetation Values		
	Carnaby's Black-Cockatoo	**Baudin's Black-Cockatoo**	**Forest Red-tailed Black-Cockatoo**
6	High foraging value. Example: • Banksia Woodlands of key species (e.g. *B. attenuata, B. menziesii*) with projected foliage cover >60%. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest with a high proportion of Marri (>40% projected foliage cover). Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.	High foraging value. Example: • Eucalypt woodland/forest (i.e. Marri, Jarrah, Wandoo, and Blackbutt) with >60% projected foliage cover. Vegetation condition good with low weed invasion and low tree death to indicate it is robust and unlikely to decline in the medium term.

B. Survey Area context.

The maximum score is given in situations where foraging habitat is supporting breeding birds. It can also be given in fragmented landscapes where there is little foraging habitat remaining and thus what is left has a high contextual value. The Survey Area context score is species-specific as it depends upon factors such as the vegetation type and extent, and the presence of breeding birds. Criteria for the assignment of the context score are discussed below. 'Local area' is defined as within a 15 km radius of the centre point of the Survey Area.

A score of 3 applies to Survey Areas that support:

- 5% or more of that local area's total remaining foraging habitat, if it also supports breeding birds (breeding habitat within the Survey Area or within 10km of the Survey Area), or
- 10% or more of the local area's total remaining foraging habitat.

A score of 2 applies to Survey Areas that support:

- 1-5% of that local area's total remaining foraging habitat, if it also supports breeding birds (breeding habitat within the Survey Area or within 10km of the Survey Area), or
- foraging habitat (but not breeding habitat) which is less than 10% of that local area's total remaining foraging habitat.

A score of 1 applies to Survey Areas that support:

- 0.1-1% of that local area's total remaining foraging habitat, whether or not it also supports breeding birds (breeding habitat within the Survey Area or within 10km of the Survey Area).

A score of 0 applies to Survey Areas that support:

- less than 0.1% of that local area's total remaining foraging habitat, whether or not it also supports breeding birds (breeding habitat within the Survey Area or within 10km of the Survey Area).

C. Species density.

Assignation of the species density score (0 or 1) is based upon the black-cockatoo species being either abundant or not abundant, and is species specific. A score of 1 is used where the species is seen or reported regularly and/or there is abundant foraging evidence. Regularly is when the species is seen at intervals of every few days or weeks for at least several months of the year. A score of 0 is used when the species is recorded or reported very infrequently and there is little or no foraging evidence.

Note that context and species density scores are affected by the vegetation score and this is discussed below.

A. Moderation of scores for the calculation of a value out of 10.

The foraging value score provides a numerical value that reflects the significance of vegetation as foraging habitat for Black-Cockatoos, and this numerical value is designed to provide the information needed by the Federal Department of the Environment and Energy (DoEE) to assess impact significance and offset requirements. The foraging value of the vegetation depends upon the type, density and condition of trees and shrubs in an area, and can be influenced by the context such as the availability of foraging habitat nearby. The BCE scoring system for value of foraging habitat has three components as detailed above. These three components are drawn from the DoEE offsets guide but the scoring approach was developed by Bamford Consulting Ecologists.

A A score out of six for the vegetation composition, condition and structure; plus
B A score out of three for the context of the Survey Area; plus
C A score out of one for species density.

Foraging value can thus be assigned a score out of six, based upon Survey Area vegetation characteristics, or a score out of 10 if context and species density are considered. Assigning a score out of 10 represents step D and may require moderation rather than simple addition.
The score out of six for vegetation characteristics and value can be compared across a Survey Area, while a score out of 10 is the overall foraging value and is used for the purposes of aiding offset calculations. The calculation out of 10 requires the vegetation characteristics (out of 6) to be combined with the scores given for context and species density. It is considered that the context and density scores are not independent of vegetation characteristics; otherwise habitat of absolutely no value for black-cockatoo foraging (such as concrete or a wetland) could get a foraging score out of 10 as high as 4 if it occurred in an area where the species breed (context score of 3) and are abundant (species density score of 1). Similarly, vegetation of negligible or low characteristics which could not support black-cockatoos could be assigned a score as high as 6 out of 10. In that case, the score of 6 would be more a reflection of nearby vegetation of high characteristics than of the foraging value of the negligible to low scoring vegetation. The Black-Cockatoos would only be present because of vegetation of high characteristics, so applying the context and species density scores to vegetation of low characteristics would not give a true reflection of their foraging value. For this reason, the context and species density scores need to be moderated for the vegetation characteristic score to prevent vegetation of little or no foraging value receiving an excessive score out of 10. A simple approach is assign a context and species density score of zero to with a characteristic score of low (2), negligible (1) or none (0), on the basis that birds will not use such areas unless they are adjacent to at least low-moderate quality foraging habitat ($\geq$3). The approach to calculating a score out of 10 can be summarised as follows:

vegetation composition, condition and structure score	context score	Species density score
3-6 (low/moderate to high value)	Assessed as per B above	Assessed as per C above
0-2 (no to low value)	0	0

Appendix 8. Results of the Black-Cockatoo tree-hollow pole camera inspection. Only trees that appeared to have suitable hollows (categories 2 and 3) from the ground were inspected. Appendix 9 provides photographs of each tree.

Waypoint/ Tree Ref	Lot	Easting	Northing	Species	Status	DBH	Cat	Original Notes	Photo Nos	New Notes	Rev Cat
817	**4**	404410	6489865	Marri	Dead	800	**3**	Bees		No access at time of inspection	
106	**15**	404655	6489181	Marri	Dead	550	**3**	Hollow entrance but no signs of chew marks	GOPR5585-89	Hollow is deep enough and slightly narrow opening. One egg presumed abandoned in prepared base. Species thought to be Wood Duck. Chew marks visible inside showing it has been visited by large cockatoo in past and therefore Cat 2.	2
118	**15**	404627	6489211	Marri	Dead	950	**3**	One spout type opening	GOPR5580-84	#1 lower opening is ledge only and has no opening #2 Upper opening in fork in branch and is shallow with opening to outside of trunk at floor of hollow. Hollow only 200-300 deep.	4
684	**15**	404866	6489429	Marri	Dead	600	**3**	vertical spout	GOPR5456-58, DSC00085	Spout opening, adequate width and depth. Cracks through trunk to outside. Flat bottom with debris including possible white egg shell remains and therefore maybe old BC nest. No chew marks discernible because wood is very decayed.	2
685	**15**	404891	6489420	Marri	Dead	600	**3**	spout and hollow	GOPR5462	No depth to opening no hollow.	5
686	**15**	404913	6489408	Marri	Dead	600	**3**	spout and hollow, hollow on top of branch, bees in other branch	GOPR5467-5470 and GOPR5472-5474	Three hollows. #1 & #3 too shallow and open. #2 branch junction, wide and deep enough with insides worn smooth from occupation and flat base at bottom. Some cracks in trunk to outside letting light through. Possible remains of white eggshell and therefore possible BC nest. Four Ringnecks were perched in tree before inspection.	2
688	**15**	404885	6489398	Marri	Dead	700	**3**	hollow	GOPR5463-65	Too shallow for BC circa 200mm deep	4
691	**15**	405087	6489456	Marri	Dead	1100	**3**	hollow	GOPR5475-77	No hollow at branch base and other hollow too small and obstructed.	5
705	**15**	405004	6489226	Marri	Dead	800	**3**	hollow	GOPR5509-11	Opening too small and hollow is space between heartwood and sapwood.	4
706	**15**	404988	6489212	Marri	Dead	900	**3**	bees		Not inspected due to bees.	
707	**15**	404980	6489183	Marri	Dead	800	**3**	big hollow	GOPR5522 & 5526	No depth to hollow at end of horizontal branch and filled with	4

										termite concrete.	
709	**15**	405017	6489159	Marri	Live	700	**3**		GOPR5513 & 5521	Very low hollow - circa 3.5 m. Opening wide enough but hollow only 200 mm deep. Entrance covered in spider web	4
712	**15**	404990	6489123	Marri	Dead	1100	**3**		GOPR5527 & 5530	Opening possibly large enough but only 300 mm deep and floor maybe flush with opening.	4
714	**15**	404919	6489217	Marri	Dead	700	**3**	vertical spout (high)	GOPR5534-38	Broken branch but poor access to opening so couldn't get a good photo. Opening wide enough and some depth but appears to be wood blocking within 300 mm of opening.	4
719	**15**	404964	6489289	Marri	Dead	900	**3**		GOPR5482-93	Two possible hollows. #1 has no hollow has remains of a white eggshell on a shelf - possibly old Kestrel nest. #2 broken branch has no hollow.	5
720	**15**	404779	6489301	Marri	Dead	1000	**3**		GOPR5557-5564	Two possible hollows. #1 is wide and deep enough but has a crack in wood to side. Platform at bottom is lined with fresh eucalypt leaves and two Galahs were perched on tree before inspection suggesting currently occupied by Galahs. Chew marks visible inside. #2 is broken branch and no hollow.	2
722	**15**	404823	6489296	Marri	Live	800	**2**	Two hollows, bitten and red	GOPR5540-5555	Two hollows both at base of branch junction. Lower one has very shallow hollow and other is flush with outside.	4
730	**15**	404817	6489357	Marri	Dead	1100	**3**	spout	GOPR5478-81	Branch is heavily decayed on top surface with no hollow.	5
735	**15**	404743	6489319	Marri	Live	500	**3**		GOPR5566-5567	Shallow hollow in fork of tree limbs. Hollow is 300 mm deep and filled with debris.	5
736	**15**	404721	6489337	Marri	Dead	700	**3**	hollow	GOPR5573-79	Branch partially gone at fork but no hollow.	5
10	**29**	406652	6488272	Marri	Live	1050	**2**	One spout type opening	GOPR5662-67	No hollow present. Upper side of branch burnt and halved but no hollow	5
752	**29**	406593	6488220	Marri	Live	700	**3**	hollow	GOPR5668-71	Chewed indent to trunk at fork. No hollow	5
755	**29**	406628	6488209	Marri	Dead	600	**3**	Vertical spout	#1 5674-75, #2 5676, #3 5677-82	#1 burnt end of branch, no hollow #2 Burnt upper side to branch but no hollow #3 Burnt fork between trunk and branch but no hollow	5

744	**32**	405723	6488149	Marri	Live	700	**2**		GOPR5648-56	Revised Coordinates provided for this tree. Lower hollow is too shallow (150mm) but old chew marks evident.	4
747	**32**	405749	6488142	Marri	Live	1200	**3**	Vertical spout	GOPR5590-94	Very short stump remaining on tree with potential hollow only 2.5 m above GL. No hollows present in stump.	5
748	**32**	405764	6488144	Marri	Dead	700	**3**		GOPR 5646 - 47 GOPR5660	#1 Unusual hollow formed at the back end of the shelf formed at the base of a broken branch. Termite concretions form lip into hollow below. Too narrow for BCs being <70mm wide and too shallow of around 300mm deep but opens to wider hollow underneath and contains downy feather. #2 hollow in fork of branch and trunk but too shallow of 200mm.	4
749	**32**	405793	6488147	Marri	Live	500	**3**	bees in hollow		Not inspected due to bees.	
136	**110**	403784	6488738	Marri	Live	1150	**3**	One spout type opening with bees		No access at time of inspection	
758	**110**	404037	6489107	Marri	Dead	1000	**3**	Vertical spout		No access at time of inspection	
770	**110**	403844	6489083	Marri	Live	1000	**3**	Hollow on top edge of broken branch		No access at time of inspection	
772	**110**	403862	6489114	Marri	Dead	700	**3**	Vertical spout		No access at time of inspection	
777	**110**	403771	6489094	Marri	Live	800	**3**	Vertical spout		No access at time of inspection	
193	**Verge**	406020	6487727	Marri	Live	750	**2**	One opening in side of trunk with fresh chew marks	GOPR5683-91	Two galahs inspecting on first arrival. Returned and they had gone. Broken branch at fork but hollow filled with sand and has no hollow.	5
859	**Verge**	404407	6489169	Marri	Dead	700	**3**	Road verge, vertical spout but lots of bees in base would make camera inspection dangerous		Not inspected due to bees.	

Appendix 9. Sample photographs from the tree-hollow inspection.

Tree Ref 10 – No hollow

Tree Ref 106 – Suitable hollow

Tree Ref 118 One hollow too shallow and second not a hollow

Tree Ref 193 – No hollow

Tree Ref 684 – Suitable hollow

Tree Ref 685 – No hollow

Tree Ref 686 – Suitable hollow

Tree Ref 688 – Hollow too shallow

Tree Ref 691 – No hollow

Tree Ref 705 – Hollow too narrow

Tree Ref 707 – Unsuitable hollow

Tree Ref 709 – Hollow too shallow

Tree Ref 712 – Hollow too shallow

Tree Ref 714 – Hollow too narrow and shallow

Tree Ref 719

Tree Ref 720 – One suitable hollow but occupied by Galahs, and a second no hollow

Tree Ref 722 – Two hollows are too shallow

Tree Ref 730 – No hollow

Tree Ref 735 – Hollow too shallow

Tree Ref 736 – No hollow

Tree Ref 744 – No hollow

Tree Ref 747 – No hollow

Tree Ref 748 – One hollow too narrow and shallow and a second too shallow

Tree Ref 752 – No hollow

Tree Ref 755 – No hollows

Appendix D

Aquatic Fauna Assessment (IPE 2019)

Prepared by Indo Pacific Environmental (IPE) (2019)

PRELIMINARY ASSESSMENT OF LISTED AQUATIC FAUNA WITHIN VARIOUS LOTS, NORTH ELLENBROOK

Prepared for:

Emerge Associates

26 Railway Rd

Subiaco, WA, 6008

Prepared by:

Indo-Pacific Environmental Pty Ltd

PO BOX 191

Duncraig East, WA, 6023

Phone: (08) 9444 1422

Fax: (08) 9444 1466

ACN 120 114 365

Project ID: 18021

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B	Draft to Client	D. Thorburn	12-12-2018	T. Atkinson (Emerge) A. Biddiscombe (Emerge)	24-01-2019
0	J. Keleher D. Thorburn	27-02-2019			

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EXECUTIVE SUMMARY

Lendlease commissioned Emerge Associates for the purpose of undertaking an environmental assessment to document the existing environmental attributes and values of the North Ellenbrook Development (study area) approximately 30 kms north-north east of the Perth CBD. In light of the aquatic habitats present within the area, Indo-Pacific Environmental was engaged during September 2018 by Emerge to undertake a preliminary aquatic fauna assessment. A level 1 aquatic fauna survey was conducted with the aim of providing information on the aquatic fauna values of the area and determining the possibility and likelihood of conservation significant aquatic fauna being present within the study area.

Results from the desk top review initially indicated that three aquatic species of conservation significance may potentially exist within the study area, including *Pseudemydura umbrina* (Western Swamp Tortoise), *Galaxiella nigrostriata* (Black-stripe Minnow) and *Westralunio carteri* (Freshwater Mussel). An assessment of the habitats present in the study area was subsequently undertaken. While this assessment indicated that at a majority of sites were considered to be unsuitable for *P. umbrina* and *G. nigrostriata* and marginal for *W. carteri*, several sites containing suitable habitat for these species were considered to be present. The ability of these species to disperse, the presence of remnant aquatic habitats and current pressures were also taken into account to determine the likelihood of the species being present. As a result, it was subsequently considered possible that these species may occur at some sites where suitable or marginal aquatic habitat was present. It was however considered unlikely that *G. nigrostriata* or *W. carteri* would occur in isolated man made waterbodies as connectivity is needed for these species to disperse.

To determine whether *P. umbrina*, *G. nigrostriata* or *W. carteri* in fact do or do not occur within the study area at the limited number of sites that were considered to contain suitable or marginal habitat, further survey work would be required. Further survey work would require multiple sampling techniques including fyke nets, turtle traps, seine netting, sweep netting and hand searching to ensure that all species present are recorded, and that accurate quantification of fauna is achieved. Ideally, further survey work would be undertaken between September and November 2019 as this period is when *P. umbrina* is known to increase movements and *G. nigrostriata* is yet to aestivate whilst water remains present.

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Appendix 1. Qualitative data recorded from each site within the study area along with the ranking of each habitat component in comparison to the criteria developed in Section 3.3 (ranked as having met the criteria = Y, almost met the criteria = A or not met the criteria =N) for *Pseudemydura umbrina* (Pu), *Galaxiella nigrostriata* (Gn) and *Westralunio carteri* (WC) with the overall habitat suitability for each species displayed (ranked as suitable = S, marginal =M or unsuitable =U).

1.0 INTRODUCTION

1.1 Background

Lendlease commissioned Emerge Associates for the purpose of undertaking an environmental assessment to document the existing environmental attributes and values of the North Ellenbrook Development (study area) approximately 30 kms north-north east of the Perth CBD (Figure 1). In light of the aquatic habitats present within the area, populations of *Pseudemydura umbrina* (Western Swamp Tortoise) occurring within close proximity (2 km) at the Twin Swamps and Ellen Brook Nature Reserves, and that the study area adjoins the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* area (Figure 1), Indo-Pacific Environmental was engaged during September 2018 by Emerge to undertake a preliminary aquatic fauna assessment, with a focus on *P. umbrina*.

1.2 Aims of the study

The main aim of the assessment is to provide information on the aquatic fauna values of the area, particularly *P. umbrina,* by determining the:

- possibility of *P. umbrina* or other conservation significant aquatic fauna being present within the study area;
- suitability of habitat within the study area for *P. umbrina* and other conservation significant aquatic fauna; and
- likelihood of *P. umbrina* or other conservation significant aquatic fauna being present in areas of suitable habitat.

The scope of works was to conduct a level 1 aquatic fauna survey which included:

- a desktop study to gather relevant background information of conservation significant fauna that may be within the study area and biological information on habitat preferences;
- an inspection of sites within the study area to determine the suitability of habitats present; and
- preparation of a report that summarises the results and includes:
    - a discussion on the results and likelihood of conservation significant aquatic fauna being present
    - discussion on whether a targeted or comprehensive Level 2 survey is required; and
    - details for survey work that would confirm presence or absence of *P. umbrina* or other listed and conservation significant aquatic fauna if suspected to be present.

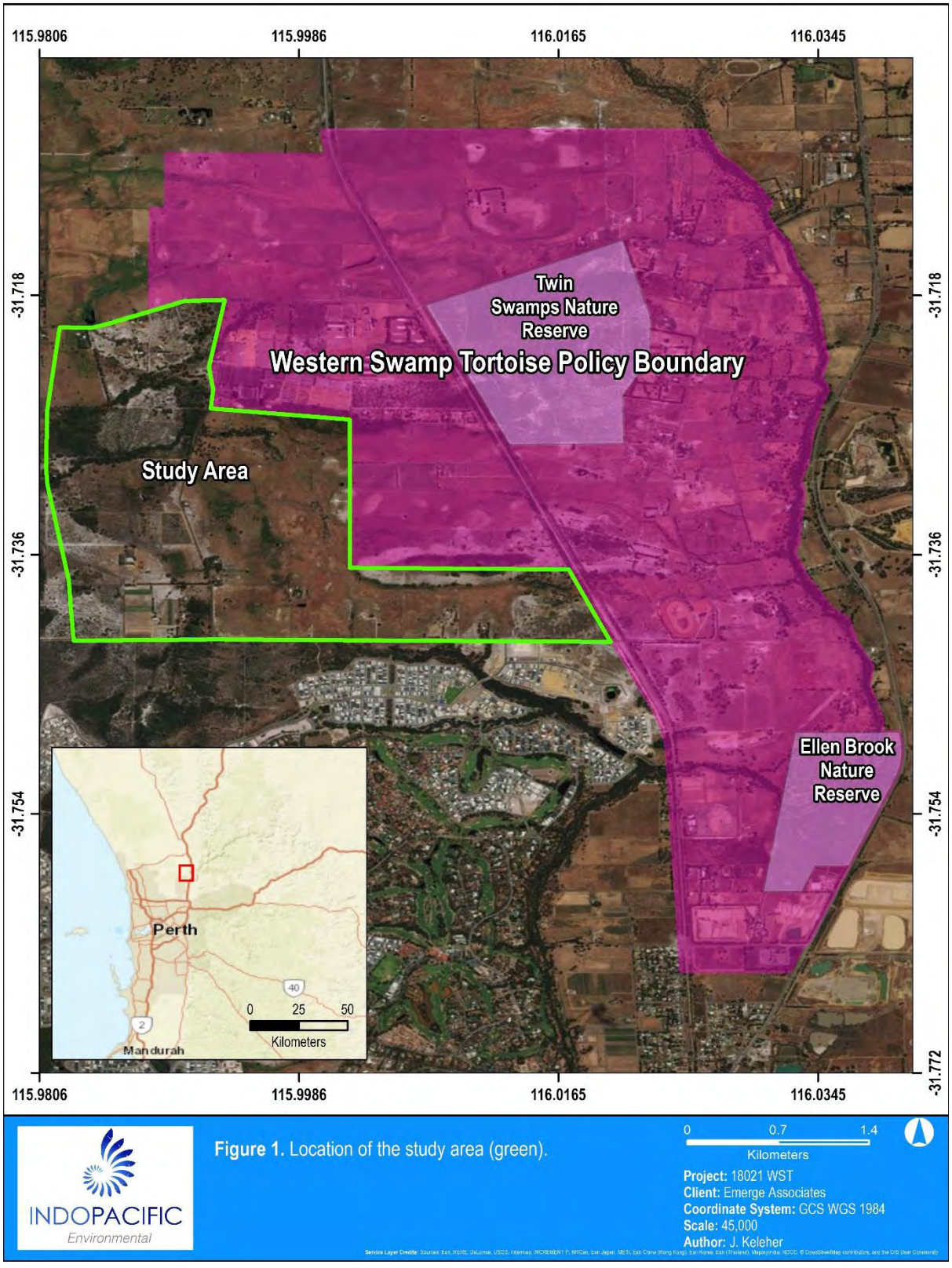


Figure 1. Location of the study area (green).

2.0 Methodology

The assessment was carried out in accordance with all relevant legislation, including EPA policies, guidance statements and regulations relating to fauna assessments in Western Australia, including:

- Environmental Protection Authority and Department of Environment and Conservation (2010), *Technical Guide – Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment*;
- Commonwealth of Australia (2011), *Survey guidelines for Australia's threatened fish - Guidelines for detecting fish listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*; and
- Commonwealth of Australia (2011), *Survey guidelines for Australia's threatened reptiles - Guidelines for detecting reptiles listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999*.
- *Environment Protection and Biodiversity Conservation Act 1999* (Cwth);
- *Biodiversity Conservation Act 2016* (WA);

2.1 Desktop Review

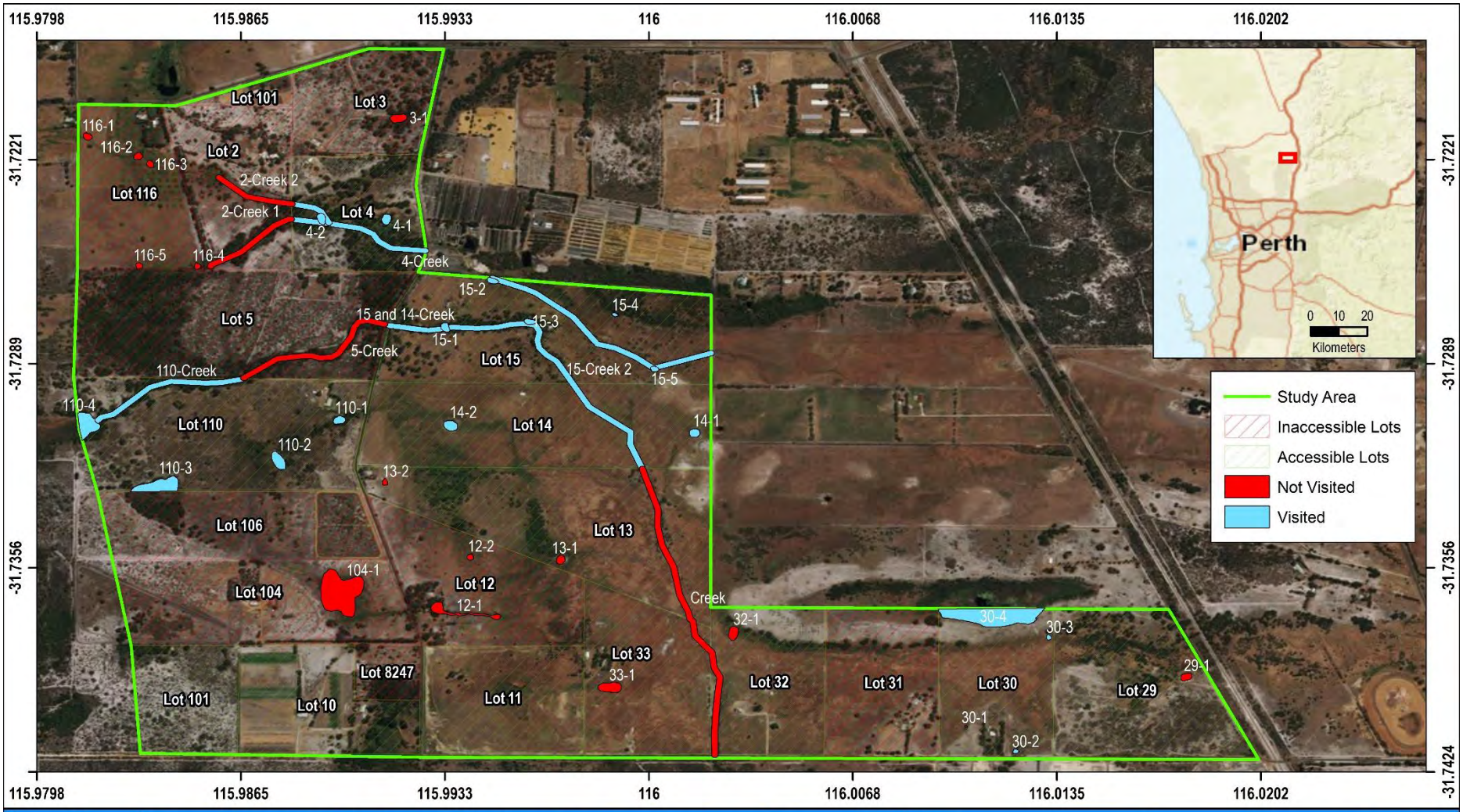
To compile a list of aquatic vertebrate fauna potentially occurring within the study area, searches of the Department of Biodiversity, Conservation and Attractions (DBCA) NatureMap database and the Department Primary Industries and Region Developments Freshwater Fish Distribution in Western Australia database were undertaken within a five kilometre radius. The conservation status of aquatic fauna identified was then examined and a list of conservation significant fauna compiled.

To determine whether conservation significant species may exist within the study area, distributions and topographic maps were examined along with published and grey literature. When it was considered possible that a conservation significant species may be present within the study area, the literature was further examined to determine the habitat requirements of each identified species. This information was then refined to develop criteria for which the suitability of aquatic habitat present could be assessed.

2.2 Aquatic Fauna Habitat Assessment

2.2.1 *Site Locations and Timing*

A visit to the study area for the single-phase Level 1 aquatic fauna habitat assessment was carried out by James Keleher and Joe Porter on 9 November 2018. Prior to the field survey, satellite imagery was examined to determine the location of aquatic habitats within the study area. Of the 12 lots that were accessible, nine were found to contain 22 potential separate waterbodies and two potential creek lines (Figure 2). During the survey 16 of these separate waterbodies and reaches of the two creek lines were inspected. As the priority was to inspect potential habitat sites, six sites and a reach of the creek line was not visited as they were considered comparable (based on satellite imagery) to a number of man-made dams in cleared fields that were visited.



INDOPACIFIC Environmental

Figure 2. Aquatic habitat sites identified prior to visiting the survey area and those inspected during the survey. The accessibility of each lot is also displayed.

Project: 18021 WST
Client: Emerge Associates
Coordinate System: GCS WGS 1984
Scale: 21,001
Author: J. Keleher

0 0.4 0.8
Kilometers

2.3 Data Collection and analysis

At each site, *in situ* measurements of dissolved oxygen (DO; % and mg/L), water temperature (°C), conductivity (mS), salinity (ppt) and pH were taken using a portable hand-held YSI field meter. A qualitative habitat assessment was also undertaken at each site documenting available instream habitat, riparian habitat, bank morphology and substrate composition.

To supplement this data and provide an indication as to whether the identified waterbodies were ephemeral or permanent without a consecutive visit, satellite imagery from a number of months and years was examined. As mentioned, a number of isolated artificial waterbodies on accessible lots were not visited as they were considered comparable to a number of sites visited. A number were also located on inaccessible lots (Figure 2). As such inferences were made from habitat data collected from visited waterbodies in conjunction with satellite imagery, particularly for those on the inaccessible lots.

To determine the likelihood of aquatic habitats within the study area being suitable for *P. umbrina* or other conservation significant aquatic fauna, the habitat information obtained was compared to the criteria developed during the desktop review. When suitable habitat was identified for an aquatic species of conservation significance, distribution and topographic maps were again examined along with published and grey literature to determine the likelihood of their presence at that particular location.

3.0 Desktop Review

3.1 Database search

Results from the database searches indicated that the conservation significant species *P. umbrina*, *Galaxiella nigrostriata* (Black-stripe Minnow) and *Westralunio carteri* (Freshwater Mussel) have been recorded within the search area as presented in Figure 3 with their conservation status.

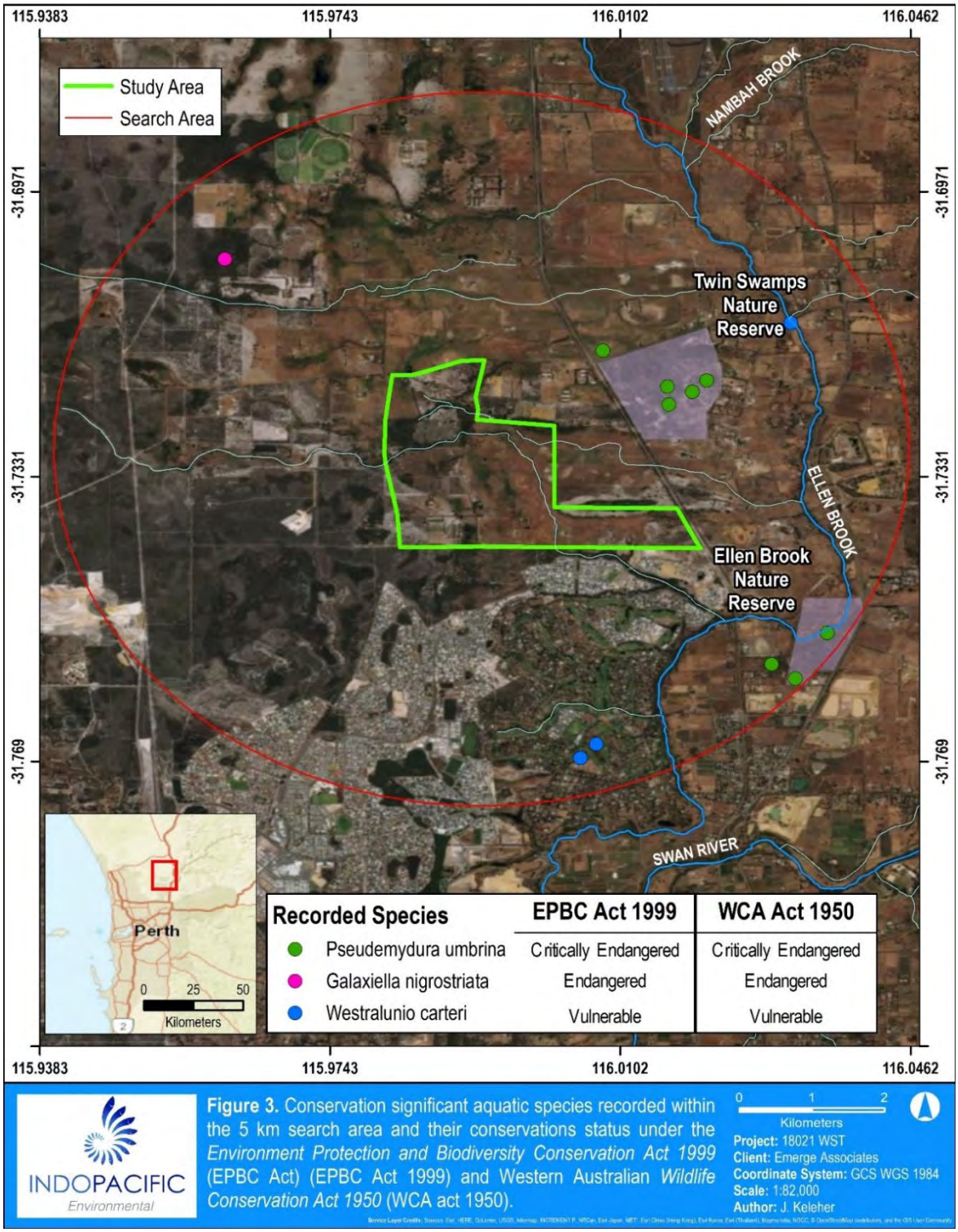


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Figure 3. Conservation significant aquatic species recorded within the 5 km search area and their conservations status under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (EPBC Act 1999) and Western Australian *Wildlife Conservation Act 1950* (WCA act 1950).

3.2 Potential for Conservation Significant Species to Exist Within the Study Area

3.2.1 *Pseudemydura umbrina*

The historic home range of *P. umbrina* is thought to have been a narrow strip of the Swan Coastal Plain running from Perth Airport at Guildford to near Pearce Royal Australian Air Force Base at Bullsbrook, of which almost all is now cleared and either urbanised, used for agriculture, or previously mined for clay. As a result, there are only two known and monitored wild populations at present, occurring in Ellen Brook (Class A Reserve 27620) and Twin Swamps (Class A Reserve No. 27621) Nature Reserves which are situated 950 m and 2.6 km from the study area, respectively (Burbidge *et al.* 2010). Furthermore, the study area lies within the historic range of *P. umbrina* and adjoins the *Environmental Protection (Western Swamp Tortoise Habitat) Policy 2011* area which encompasses the two reserves.

Studies on *P. umbrina* home ranges and movements suggests that they may potentially be larger than the Twin Swamps and Ellen Brook nature reserves as movements over land of up to 600 m have been recorded in two days, whilst Twin Swamps animals have been found up to one kilometre outside the reserve boundary (Burbidge *et al.* 2010). Considering that the study area lies within the historic range of *P. umbrina* and that individuals from Twin Swamps have been recorded at a distance equal to the study area, *P. umbrina* has the potential to occur within the study area as a relic or vagrant population.

3.2.2 *Galaxiella nigrostriata*

The three known populations of *G. nigrostriata* on the Swan Coastal Plain, one of which occurs within the 5 km search area (Figure 3), are believed to be remnants of a greater distribution prior to European colonisation (Galeotti *et al*. 2010). Considering that one of these remnant populations has only been recently discovered in 2009 (Galeotti *et al*. 2010) and that a number of remnant ephemeral habitats exist within the study area, it is possible that relic populations may still exist at these sites, however, isolated manmade dams are unlikely to contain this species.

3.2.3 *Westralunio carteri*

Despite recent declines in the distribution of *W. carteri*, this species has a relatively broad distribution throughout the South West Coast Drainage Division (Klunzinger *et al.* 2015). This species has been recorded within the 5 km search area (Figure 3) and the Ellen Brook, which the drainage/creek lines within the study area have historically and potentially continue to connect with (Figure 3). The larval stages of *W. carteri* (glochidia) are obligate parasites of fish, metamorphosing into juvenile freshwater mussels while attached to their host which also provides a means of dispersal (Klunzinger 2013). Considering that a number of waterbodies within the study area are situated along the creek/drainage lines that potentially connect to the Ellen Brook, during years of connectivity, fish carrying glochidia may have migrated into these waterbodies. As a result of infrastructure such as roads and land clearing connectivity may not have occurred in recent times, however, considering that connectivity may have occurred in the past it is considered likely that *W. carteri* may be within the study area. As with *G.*

nigrostriata, isolated manmade dams that have had no previous interconnection are unlikely to contain this species.

3.3 Habitat criteria

Considering that potential exists or has existed for these three conservation significant species to disperse within the study area or that remnant habitat exists within historic ranges, it was considered possible that they may be present within the study area. As such, criteria for assessing the suitability of the aquatic habitat present for each species was developed. To do so, habitat was broken down into several components, considered to be among the most important. This included soil type, waterbody type, vegetation structure/composition and salinity. Literature was subsequently examined to determine the requirements of each species for each component. A summary of these requirements is provided in Table 1 below.

Table 1. Summary of habitat criteria used to assess the suitability of the aquatic habitat at sites within the study area for *Pseudemydura umbrina*, *Galaxiella nigrostriata* and *Westralunio carteri*.

Habitat component	***Pseudemydura umbrina***	***Galaxiella nigrostriata***	***Westralunio carteri***
Soil	Presence of water holding soils - clay, sandy duplex soils or peat soils (Dade *et al*. 2014)	Sandy or peat soils (Galeotti *et al.* 2010)	Primarily sandy or silty *non-anoxic* substrate (Klunzinger 2013)
Waterbody type	Shallow (< 80 cm) ephemeral wetlands that contain water for around seven months with flat to low slope bank angles. Not known to live in permanent waters (Burbidge 1981; Burbidge *et al.* 2010)	Ephemeral wetlands that contain shallow habitat (< 30 cm). Seldom found in permanent waters. (Galeotti *et al.* 2010; Morgan and Beatty 2005)	Australian hyriids can survive in lentic and ephemeral systems however are not widespread in such the latter indicating that permanent water may be required. Influence of depth on freshwater mussels is unclear although have been found in several meters. (Klunzinger 2013; Straka and Downing 2000)
Riparian and emergent vegetation	Intact remnant native vegetation with medium density understorey for aestivation and protection, will avoid very dense vegetation. Dominant genera include Banksia or Melaleuca (Dade *et al*. 2014)	Emergent and riparian vegetation such as Melaleuca sp. sedges and rushes, have not been found in wetlands surrounded by cleared farmland Galeotti *et al.* 2010; Morgan *et al.* 1998	Greatest densities associated with woody debris and overhanging riparian vegetation near banks. Have been found in cleared areas. (Department of Environment and Conservation 2012; Klunzinger 2013)
Salinity	Absence of secondary salinization (< 3 ppt) (Dade *et al*. 2014; Nielsen *et al*. 2003)	Generally found in salinities <1 ppt (Ogston 2015)	Tolerance < 1.6ppt (Klunzinger *et al.* 2015)

4.0 Habitat Assessment

Qualitative data recorded from each site during the visit to the study area are presented in Appendix 1 along with the ranking of each component in comparison to the criteria developed in Section 2.3 (deemed to have met the criteria, almost met the criteria or not met the criteria). The suitability of the overall aquatic habitat at each site for each species is also presented in Appendix 1 and summarised in Table 2, ranked as suitable, marginal or unsuitable if all components met the criteria, all components almost met the criteria, or one or more components did not meet the criteria, respectively. Within Table 2 the likelihood of *P. umbrina*, *G. nigrostriata* and *W. carteri* being present at habitats considered marginal or suitable is also indicated.

4.1 Pseudemydura umbrina

As can be seen, the aquatic habitat at a majority of sites with the study was considered unsuitable for *P. umbrina*, generally as a result of riparian vegetation being cleared (Figure 4). As *P. umbrina* has the ability to traverse over land from one of its natural strongholds (Twin Swamps Nature Reserve) to the study area, and the study area contains remnant suitable habitat (namely 30-4) which lies within the historic range of this species, it was considered likely that the species may occur at all sites that contain suitable or marginal habitat. However, the estimated population of 250 individuals at Twin Swamps Nature Reserve in the early 1960s declined to below 10 individuals by 1984 which was believed to be the result of predation by foxes. The population at this site has since increased as a result of predator proof fences and supplementation with captive-bred individuals since 1994 (Department of the Environment and Energy 2018) and it is clear that this population would have likely disappeared without human intervention. Considering that no intervention or management has occurred in waterbodies within the study area, in addition to the fact a road and railway separates the known sites of occurrence from the study area, the likelihood of *P. umbrina* occurring within the study area at suitable habitats is considered to be somewhat reduced being possible rather than likely (Figure 5).

4.2 Westralunio carteri

With respect to *W. carteri*, as individuals have been found in cleared areas, although in lower densities than those containing dense riparian vegetation, aquatic habitat at a majority of sites was considered marginal for this species (Figure X). Although the study area lies within the known range of *G. W. carteri*, as this species also needs a water pathway to disperse, it was considered unlikely that they would occur in isolated artificial waterbodies. However, a small deep bodied fish, possibly *Bostockia porosa* (Nightfish) or *Nannoperca vittata* (Pygmy Perch), was observed from the shore in the creek passing through Lot 110. This observation provides some evidence that waterbodies located along watercourses within the study area connect or have connected with the wider region at some point in time. As such, it was considered likely that *W. carteri* may be present along the creek lines within the study area which were shown to have suitable or marginal habitats (Figure 6).

Table 2. Summary of aquatic habitat suitability at sites within the study area (ranked as either suitable, marginal or unsuitable) for *Pseudemydura umbrina* (Pu), *Galaxiella nigrostriata* (Gn) and *Westralunio carteri* (Wc) with the likelihood of each species being present at habitats considered marginal or suitable (ranked as unlikely, possible or likely).

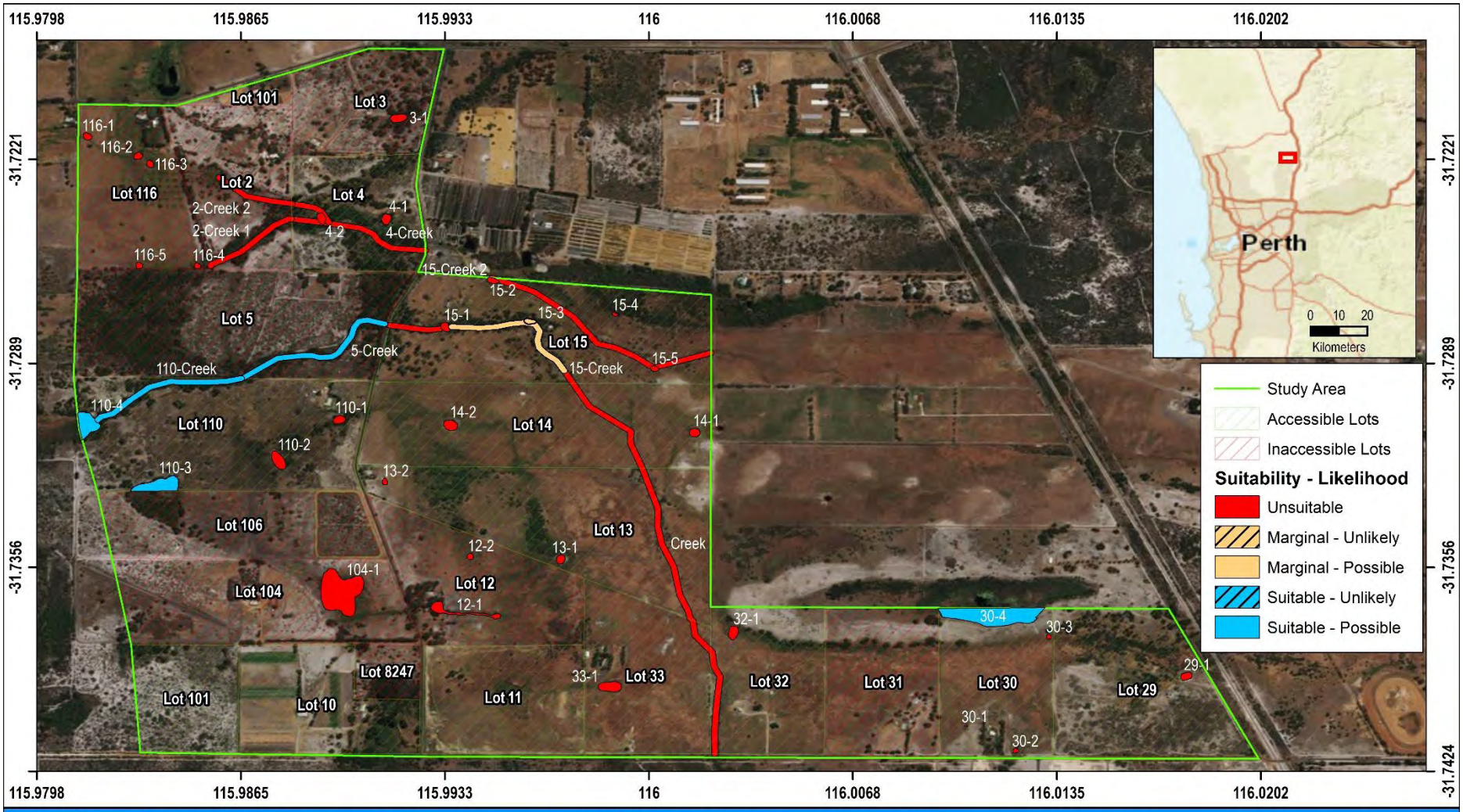
Site	Habitat Suitability			Likelihood of presence at suitable or marginal habitats		
	Pu	Gn	Wc	Pu	Gn	Wc
4-1	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
4-2	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
4-creek	Unsuitable	Unsuitable	Unsuitable	-	-	
14-1	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
14-2	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
15-1	Unsuitable	Unsuitable	Marginal	-	-	Likely
15-2	Unsuitable	Unsuitable	Marginal	-	-	Likely
15-3 + adjoining creek 1	Marginal	Suitable	Suitable	Possible	Possible	Likely
15-4	Unsuitable	Marginal	Marginal	-	Unlikely	Unlikely
15-5	Unsuitable	Unsuitable	Marginal	-	-	Likely
15-Creek 2	Unsuitable	Unsuitable	Unsuitable	-	-	-
30-2	Unsuitable	Unsuitable	Unsuitable	-	-	-
30-3	Unsuitable	Unsuitable	Unsuitable	-	-	-
30-4	Suitable	Suitable	Unsuitable	Possible	Possible	-
110-1	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
110-2	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
110-3	Suitable	Suitable	Suitable	Possible	Possible	Unlikely
110-4	Suitable	Suitable	Suitable	Possible	Possible	Likely
110-Creek	Suitable	Suitable	Suitable	Possible	Possible	Likely
BASED ON OBSERVATIONS AT OTHER SITES AND SATELLITE IMAGERY						
Accessible lots						
Creek that runs through lot 14, 13, 33 and 32	Unsuitable	Unsuitable	Unsuitable	-	-	-
13-1, 13-2, 29-1, 30-1, 32-1, 33-1	Unsuitable	Unsuitable	Marginal	-	-	Unlikely
Inaccessible Lots						
2-Creek	Unsuitable	Unsuitable	Unsuitable			
5-Creek	Suitable	Suitable	Suitable	Possible	Possible	Likely
3-1, 12-1, 12-2, 104-1, 16-1, 116-2, 116-3, 116-4, 116-5	Unsuitable	Unsuitable	Marginal	-	-	Unlikely

4.3 Galaxiella nigrostriata

As with *P. umbrina*, the aquatic habitat at a majority of sites with the study was considered unsuitable for *G. nigrostriata* as a result of riparian vegetation being cleared. As mentioned, the study area lies within the known range of *G. nigrostriata*, however, as this species needs a water pathway to disperse it was considered unlikely that they would occur in isolated artificial waterbodies. As depicted in Figure 7, it was considered possible that *G. nigrostriata* may be present within suitable habitats along the creek that passes through Lot 15, 5 and 110 which connects with what appeared to be a natural remnant

waterbody (110-4). It was also considered possible that *G. nigrostriata* may be present within the large remnant isolated ephemeral swamp on Lot 30 (30-4) which is similar to another site of known occurrence located in close proximity to the study area (Figure 2). Furthermore, the previously mentioned small deep bodied fish sighted during the survey provides evidence of connectivity.

Figure 4. Reference photos of habitat present at sites visited throughout the study area.

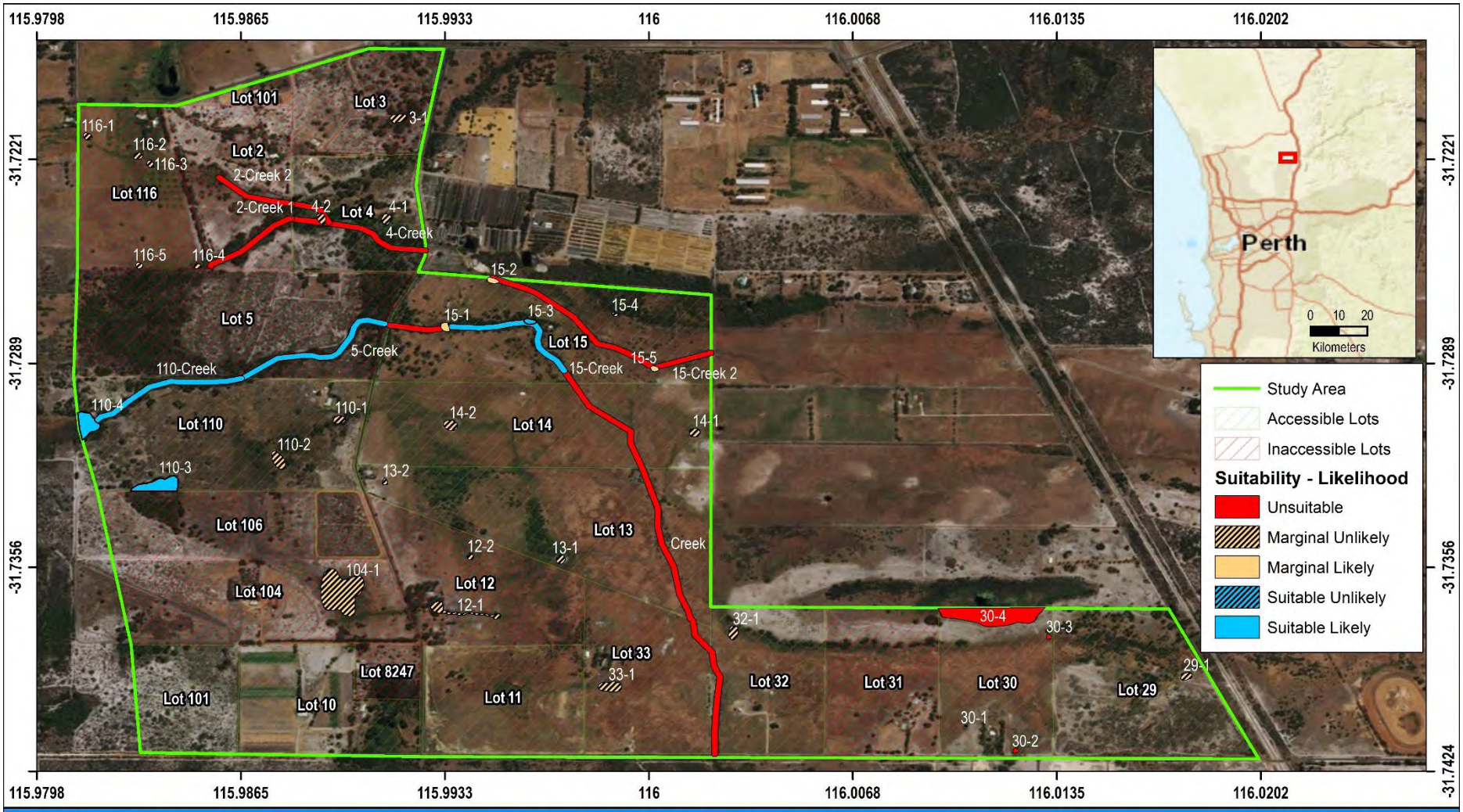


INDOPACIFIC Environmental

Figure 5. Suitability of aquatic habitat for (ranked as suitable, marginal or unsuitable) and likelihood of *Pseudemydura umbrina* being present within the study area (ranked as unlikely, possible or likely).

Project: 18021 WST
Client: Emerge
Coordinate System: GCS WGS 1984
Scale: 21,001
Author: J. Keleher

0 0.4 0.8
Kilometers

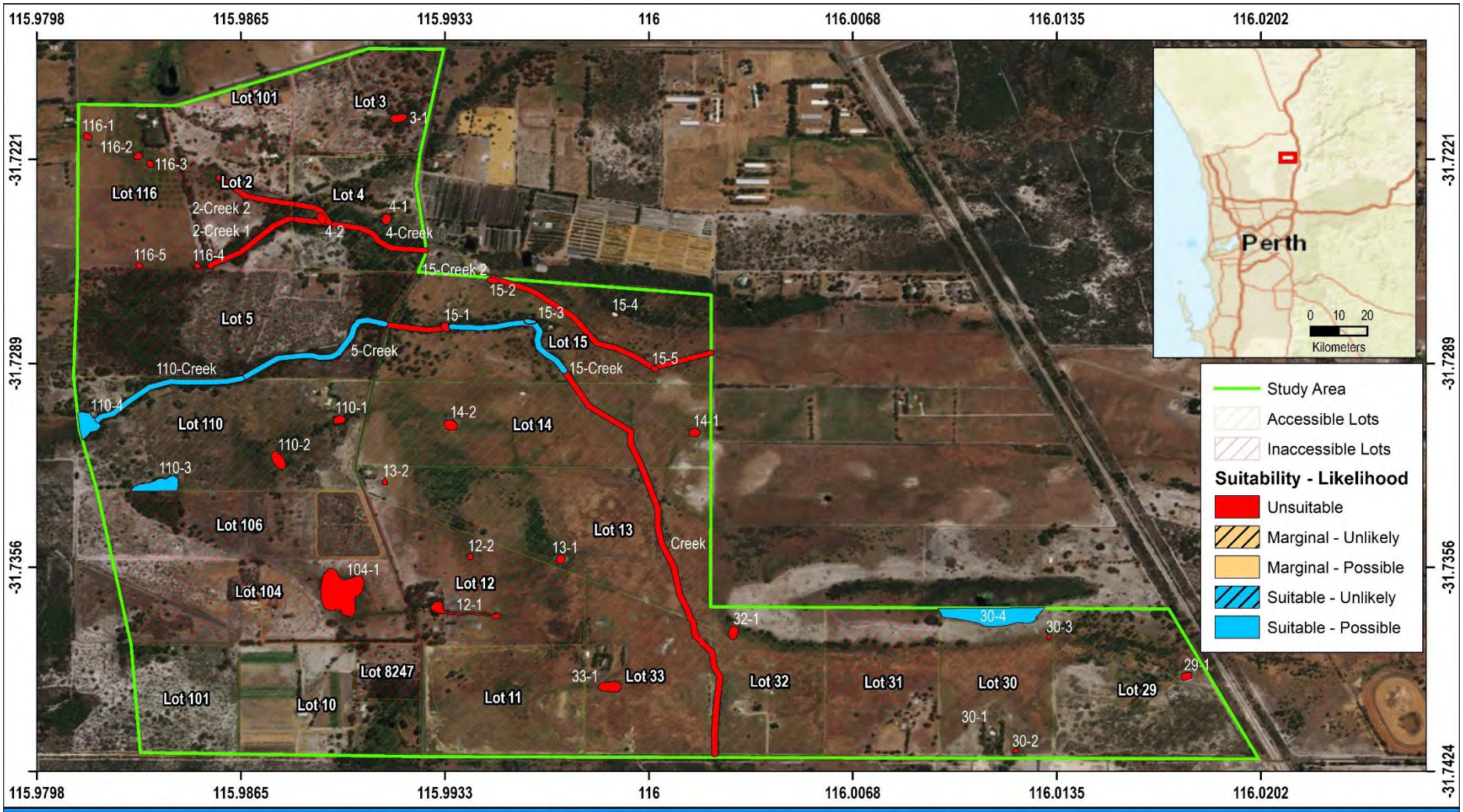


INDOPACIFIC Environmental

Figure 6. Suitability of aquatic habitat for (ranked as suitable, marginal or unsuitable) and likelihood of *Westralunio carteri*being present within the study area (ranked as unlikely, possible or likely).

Project: 18021 WST
Client: Emerge
Coordinate System: GCS WGS 1984
Scale: 21,001
Author: J. Keleher

0 0.4 0.8
Kilometers



INDOPACIFIC Environmental

Figure 7. Suitability of aquatic habitat for (ranked as suitable, marginal or unsuitable) and likelihood of *Galaxiella nigrostriata* being present within the study area (ranked as unlikely, possible or likely).

Project: 18021 WST
Client: Emerge
Coordinate System: GCS WGS 1984
Scale: 21,001
Author: J. Keleher

0 0.4 0.8
Kilometers

5.0 Conclusion and Future Works

Results from the desk top review indicated that three aquatic species of conservation significance including *P. umbrina*, *G. nigrostriata and W. carteri* may potentially exists within the study area based on current distributions and potential connectivity of numerous waterbodies within the study area with the wider region. The habitat assessment indicated the aquatic habitat at a majority of sites with the study was unsuitable for *P. umbrina* and *G. nigrostriata* as a result of riparian vegetation being cleared or absent. However, a limited number of sites containing suitable habitat for these species was present on Lots 5, 15, 30 and 110. With respect to *W. carteri*, sites with habitat lacking riparian vegetation were considered marginal for this species as individuals have historically been found in such habitats. With the exception of the aquatic habitat on Lot 30, those considered suitable for *G. nigrostriata* were also considered suitable for *W. carteri*. Taking into consideration the ability of these species to disperse, the presence of remnant aquatic habitats and current pressures it was considered at least possible that they may occur at sites with suitable or marginal aquatic habitat. However, as *G. nigrostriata* and *W. carteri* need a water pathway to disperse it was considered unlikely that they would occur in isolated artificial waterbodies.

Based on the findings of this assessment it is suggested that further survey work is undertaken, targeting *P. umbrina*, *G. nigrostriata and W. carteri* at sites within the study area that contain suitable or marginal habitat to unequivocally determine their presence or absence. Ideally, further survey work would be conducted between September and November as this period is when *P. umbrina* is known to increase movements and *G. nigrostriata* is yet to aestivate (Burbidge *et al.* 2010; Galeotti *et al.* 2010). In addition, this period is outside of peak flows associated with winter rainfall and reduction in water levels provides an increased chance of capture. In order to comprehensively assess the resident fauna, further survey work would require multiple sampling techniques including fyke nets, turtle traps, seine netting, sweep netting and hand searching to ensure that all species present are recorded, and that accurate quantification of fauna is achieved.

To utilise these techniques, a Section 7 exemption (Instruments of Exemption to the Fish Resources Management Act 1994 for Scientific Research Purposes) would be required from DPIRD to target *G. nigrostriata and W. carteri*. At present a Section 7 Exemption is held by Indo-Pacific Environmental to utilise the above techniques which have been endorsed by DPIRD. With respect to *P. umbrina*, a Regulation 17 licence (Licence to Take Fauna for Scientific Purposes issued under the *Wildlife Conservation Regulations 1970*) to target this species has been approved by DBCA. For this licence, the application process involves the methodology and scope of work being reviewed by the department who consulted with their Western Swamp Tortoise Recovery Team. As the application has been approved, support that the survey work is required has been shown and the methodology endorsed.

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Appendix 1. Qualitative data recorded from each site within the study area along with the ranking of each habitat component in comparison to the criteria developed in Section 3.3 (ranked as having met the criteria = Y, almost met the criteria = A or not met the criteria =N) for *Pseudemydura umbrina* (Pu), *Galaxiella nigrostriata* (Gn) and *Westralunio carteri* (WC) with the overall habitat suitability for each species displayed (ranked as suitable = S, marginal =M or unsuitable =U).

Site	Habitat Component	Description	Criteria met			Suitability		
			Pu	Gn	Wc	Pu	Gn	Wc
4-1	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial dam – Appears mostly deep (>80 cm) with little shallow habitat – Likely permanent – Low - moderate bank angle	N	N	Y			
	Vegetation	– Half cleared only grass, half contains little understory dominated by long grass – Limited *Melaleuca* spp. – Very limited emergent vegetation	N	N	A			
	Salinity	– 0.31	Y	Y	Y			
4-2	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial dam on creek line – Appears mostly deep (>80 cm) with little shallow habitat – Likely permanent – Moderate - acute bank angle	N	N	Y			
	Vegetation	– Majority of bank cleared with only grass – Patchy understorey – *Melaleuca* spp. absent	N	N	A			
	Salinity	– 0.5	Y	Y	Y			
4-Creek	Soil	– water-holding grey sandy duplex and detritus	Y	Y	Y	U	U	U
	Waterbody type	– Creek line – Mostly saturated soil with limited very shallow (<5cm) water. – Likely ephemeral	N	N	N			
	Vegetation	– Little understory dominated by dense long grass – Remnant *Melaleuca* spp.	N	A	A			
	Salinity	-	-	-	-			
14-1	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial isolated dam – Possibly deep middle (>80 cm), mostly shallow habitat around edges – Likely permanent – Flat-low slope bank angle	A	A	Y			
	Vegetation	– Native vegetation absent -only grass	N	N	A			
	Salinity	– 0.28	Y	Y	Y			
14-2	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial isolated dam – Possibly deep middle (>80 cm), mostly shallow habitat around edges – Likely permanent	A	A	Y			

Site	Habitat Component	Description	Criteria met			Suitability		
			Pu	Gn	Wc	Pu	Gn	Wc
		– Flat-low slope bank angle						
	Vegetation	– Native vegetation absent -only grass	N	N	A			
	Salinity	– 0.28	Y	Y	Y			
15-1	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial dam on creek line – Appears mostly shallow (< 80 cm) – Likely permanent – Flat-low slope bank angle	A	A	Y			
	Vegetation	– Very little native vegetation – understorey absent - mostly grass – Very limited emergent vegetation – *Melaleuca* spp. absent	N	N	A			
	Salinity	– 0.21 ppt	Y	Y	Y			
15-2	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial dam on creek line – Possibly deep middle (>80 cm), shallow habitat around edges – Likely permanent – Flat-moderate slope bank angle	A	A	Y			
	Vegetation	– Very little native vegetation and limited *Melaleuca* spp. - mostly grass	N	N	A			
	Salinity	– 0.23	-	-	-			
15-3 + adjoining creek line	Soil	– water-holding grey sandy duplex/peaty soil	Y	Y	Y	M	S	S
	Waterbody type	– Artificial dam on creek line – Few sections of the dam may be deep, remained of dam and creek appear shallow (< 80 cm) – Waterbody likely permanent – Creek line likely ephemeral – Low slope bank angle	Y	Y	Y			
	Vegetation	– Small sections of the dam cleared, remainder of dam and creek have intact native vegetation. – Abundant *Melaleuca* spp. – Understory is dominated by dense grass with a limited number of sections containing a medium density understory – Low to medium density of fringing emergent vegetation	A	Y	Y			
	Salinity	– 0.3	Y	Y	Y			
15-4	Soil	– water-holding grey sandy duplex/peaty soil	Y	Y	A	U	M	M
	Waterbody type	– Artificial isolated dam – Appears mostly shallow (< 80 cm) – Possibly ephemeral – Low slope bank angle	Y	Y	A			
	Vegetation	– Thin belt of small *Melaleuca* spp. mostly cleared	N	A	A			
	Salinity	– 1.51	A	A	A			
15-5	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial dam on creek/drainage line – Possibly deep middle (>80 cm), mostly	A	A	Y			

Site	Habitat Component	Description	Criteria met			Suitability		
			Pu	Gn	Wc	Pu	Gn	Wc
		shallow habitat around edges – Likely permanent – Flat-low slope bank angle						
	Vegetation	– Native vegetation absent -only grass	N	N	A			
	Salinity	– 0.29	Y	Y	Y			
15-Creek 2	Soil	– water-holding deep grey sandy duplex	Y	Y	Y	U	U	U
	Waterbody type	– Narrow creek/drainage line – Ephemeral with short hydroperiod	N	N	N			
	Vegetation	– Mostly cleared with a very limited number of remnant *Melaleuca* spp.	N	N	A			
	Salinity	– Dry	-	-	-			
30-2	Soil	– Unable to tell covered in a thick layer of detritus	N	N	N	U	U	U
	Waterbody type	– Unable to tell covered in *Azolla*, appears deep – Likely ephemeral – Acute bank angle	N	N	N			
	Vegetation	– Very little native vegetation – Dominated by grass – *Melaleuca* spp. absent	N	N	A			
	Salinity	– 0.62	-	-	-			
30-3	Soil	– Unable to tell covered in a thick layer of detritus	N	N	N	U	U	U
	Waterbody type	– Unable to tell covered in *Azolla*, appears deep – Likely ephemeral – Acute bank angle	N	N	N			
	Vegetation	– Very little native vegetation – Dominated by grass – Very little emergent vegetation – *Melaleuca* spp. absent	N	N	A			
	Salinity	– 0.58	-	-	-			
30-4	Soil	– Peat soil	Y	Y	N	S	S	U
	Waterbody type	– Natural wetland – Appears mostly shallow (< 80 cm) – Abundance of woody debris – Ephemeral – Flat-low slope bank angle	Y	Y	A			
	Vegetation	– Mostly intact native vegetation approximately 20 m wide – Dominated by *Melaleuca* spp. and introduced grass's – Sections containing a medium density understory – Low to high density of emergent vegetation	Y	Y	Y			
	Salinity	– 0.42	Y	Y	Y			
110-1	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial isolated dam with island – Middle appears deep (>80 cm) with shallow edge habitat – Likely permanent – Low bank angle	A	A	Y			

Site	Habitat Component	Description	Criteria met			Suitability		
			Pu	Gn	Wc	Pu	Gn	Wc
	Vegetation	– More than half cleared – little understory dominated by long grass – Limited *Melaleuca* spp. – Very limited emergent vegetation	N	N	A			
	Salinity	– 0.31	Y	Y	Y			
110-2	Soil	– water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial isolated dam – Appears mostly deep (>80 cm) with little shallow habitat – Likely permanent – Low - moderate bank angle	N	N	Y			
	Vegetation	– Mostly cleared – Little understory dominated by long grass – Limited *Melaleuca* spp.	N	N	A			
	Salinity	– 0.31	Y	Y	Y			
110-3	Soil	– water-holding grey sandy duplex	Y	Y	Y	S	S	S
	Waterbody type	– Possibly a natural waterbody - isolated – Appears mostly shallow (< 80 cm) – Possibly ephemeral – Flat-low slope bank angle	Y	Y	Y			
	Vegetation	– Mostly intact native vegetation 30 m + wide – Dominated by melaleuca spp. – Half contains medium density understory, other half open understory	Y	Y	Y			
	Salinity	– 0.23	Y	Y	Y			
110-4	Soil	– Mostly water-holding peaty soil with grey sand	Y	Y	A	S	S	S
	Waterbody type	– Four separate waterbodies that may interconnect when water levels are higher – Likely natural waterbodies – Some section may be deep although majority appears shallow (< 80 cm) – Sections likely permanent remainder ephemeral – Flat-low slope bank angle	Y	Y	Y			
	Vegetation	– Mostly intact native vegetation varying from a thin 1 – 2 m belt to 20 + m dominated by *Melaleuca* spp. – Sections containing a medium density understory – Low density of emergent vegetation	Y	Y	Y			
	Salinity	– 0.56	Y	Y	Y			
110-Creek	Soil	– water-holding grey sandy duplex	Y	Y	Y	S	S	S
	Waterbody type	– Natural creek line – Wide variety of water depths, majority < 80 cm – Likely ephemeral – Flat-low slope bank angle	Y	Y	Y			
	Vegetation	– Mostly intact native vegetation varying from a 20 - 60 m belt – Wide variety of plant species with a large	Y	Y	Y			

Site	Habitat Component	Description	Criteria met			Suitability		
			Pu	Gn	Wc	Pu	Gn	Wc
		number of *Melaleuca* spp. present. – Abundant leaf litter – Abundance of sections containing a medium density understory – Low to high density of emergent vegetation						
	Salinity	– 0.17 ppt	Y	Y	Y			
BASED ON OBSERVATIONS AT OTHER SITES AND SATELLITE IMAGERY								
Accessible lots								
Creek that runs through lot 14, 13, 33 and 32	Soil	– water-holding deep grey sandy duplex	Y	Y	Y	U	U	U
	Waterbody type	– Narrow creek/drainage line – Ephemeral with short hydroperiod	N	N	N			
	Vegetation	– Mostly cleared with a very limited number of remnant *Melaleuca* spp.	N	N	A			
	Salinity	– Dry	-	-	-			
13-1 13-2 29-1 30-1 32-1 33-1	Soil	– Likely water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody type	– Artificial dams – Possibly deep middle (>80 cm) and shallow around edges – Likely permanent	A	A	Y			
	Vegetation	– Completely cleared - very little native vegetation – Understorey absent, dominated by grass	N	N	A			
	Salinity	– Likely < 1 ppt	Y	Y	Y			
Inaccessible Lots								
2-Creek	Soil	– water-holding grey sandy duplex and detritus	Y	Y	Y	U	U	U
	Waterbody type	– Creek line – Mostly saturated soil with limited very shallow (<5cm) water. – Likely ephemeral	N	N	N			
	Vegetation	– Little understory dominated by dense long grass – Remnant *Melaleuca* spp.	N	A	A			
	Salinity	-	-	-	-			
5-Creek	Soil	– water-holding grey sandy duplex	Y	Y	Y	S	S	S
	Waterbody type	– Natural creek line – Wide variety of water depths, majority < 80 cm – Likely ephemeral – Flat-low slope bank angle	Y	Y	Y			
	Vegetation	– Mostly intact native vegetation varying from a 20 - 60 m belt – Wide variety of plant species with a large number of *Melaleuca* spp. present. – Abundant leaf litter – Abundance of sections containing a medium density understory – Low to high density of emergent vegetation	Y	Y	Y			
	Salinity	– Approximately 0.17 ppt	Y	Y	Y			
3-1 12-1	Soil	– Likely water-holding grey sandy duplex	Y	Y	Y	U	U	M
	Waterbody	– Artificial dams	A	A	Y			

Site	Habitat Component	Description	Criteria met			Suitability		
			Pu	Gn	Wc	Pu	Gn	Wc
12-2 104-1 116-1 116-2 116-3 116-4 116-5	type	– Possibly deep middle (>80 cm) and shallow around edges – Likely permanent						
	Vegetation	– Completely cleared - very little native vegetation – Understorey absent, dominated by grass	N	N	A			
	Salinity	– Likely < 1 ppt	Y	Y	Y			

Appendix E

Environmental Assessment Report - Lots 29 & 30 Maralla Road (RPS 2019)

Prepared by RPS (2019)

This appendix has been prepared on behalf of the landowner of Lot 29 and 30 Maralla Road, for inclusion as part of the overarching EAR (Emerge Associates 2019) and includes:

- Environmental Assessment Report for Lots 29 & 30 Maralla Road (RPS 2019)
- Flora and Vegetation Assessment for Lots 29 & 30 Maralla Road (PGV 2019)
- Black Cockatoo Habitat Assessment for Lots 29 & 30 Maralla Road (PGV 2019).

The content of the above documents is summarised and presented within the main body of the overarching EAR (Emerge Associates 2019).

ENVIRONMENTAL ASSESSMENT REPORT

Lots 29 and 30 Maralla Road, North Ellenbrook

EEL19080.003
Environmental assessment report
Rev 0
18 December 2019

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
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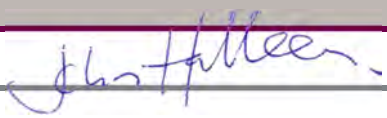
J. Halleen  18 December 2019

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Prepared by:

RPS

Giles Glasson
Principal Scientist

Level 2, 27-31 Troode Street
West Perth WA 6005

T +61 8 9211 1111
E giles.glasson@rpsgroup.com.au

Prepared for:

LWP Group Pty Ltd

Danny Murphy
Executive Chairman

IBM Centre, Level 2, Hay Street
West Perth WA 6005

T +61 8 297 9901
E dmurphy@lwpproperty.com.au

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SUMMARY

LWP Property Group (LWP) is responsible for project managing the planning and future land uses within Lots 29 and 30 Maralla Road, North Ellenbrook (the site).

The 46 hectare (ha) site is located within the City of Swan (CoS), approximately 20 kilometres (km) north-east of the Perth Central Business District and 10 km north of the Midland town centre (Figure A).

The site is currently vacant with an exception of a single dwelling within Lot 30, but historically the majority of the site was cleared for agricultural purposes.

Planning context

The site is currently zoned 'Rural' under both the Metropolitan Region Scheme (MRS) and the CoS's Local Planning Scheme (LPS) No. 17 (Figures B and C). However, the site is located immediately adjacent to the Ellenbrook residential community.

In 2018, the Department of Planning, Lands and Heritage's (DPLH) released the North-East Sub-regional Planning Framework ('the Framework') for Perth and Peel@3.5million. The Framework identified the site as being within the North Ellenbrook (east) 'Urban Investigation' area. The 'Urban Investigation' recognition by DPLH was the catalyst for significant planning and environmental review of an approximately 500 ha landholding area (which includes the site) identified as being within the 'Urban Investigation' area, east of the Perth-Darwin Highway.

The Framework outlines a District Structure Plan (DSP) is required prior to consideration of rezoning requests under the MRS. The DSP will serve as the mechanism for undertaking the detailed planning and investigation into the North Ellenbrook (east) 'Urban Investigation' area and addressing the applicable key environmental considerations. Lendlease is coordinating, in agreement with the landowners in the 500 ha North Ellenbrook (east) 'Urban Investigation' area, the preparation of a DSP. This DSP is titled the North Ellenbrook (east) DSP.

The DSP area and landownership are shown in Figure D. Lots 29 and 30 are located on the south-eastern portion of the DSP.

Purpose of this report

A separate Environmental Assessment Report (EAR) (Emerge Associates 2019) has been prepared for the broader DSP except for Lots 29 and 30.

Specifically, the purpose of this EAR is to:

- Review the existing environment and address key environmental factors within the site that may be impacted as a result of future 'Urban' land use change and development.
- Identify opportunities for input to a responsive urban design to protect and enhance any significant environmental features within the site.
- Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development.
- Support the broader DSP and facilitate the approval of a future MRS Amendment with the Environmental Protection Authority (EPA) through providing an environmental management framework to underpin future subdivision and development.

Key investigations / studies and stakeholder engagement

This EAR is underpinned by the following investigations:

1. Site investigation and state and Commonwealth desktop flora, vegetation and fauna assessment

2. Site visits by RPS and botanical consultants PVG Environmental

3. Detailed Flora and Vegetation Survey of the site was undertaken in accordance with EPA Technical Guidance *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016) – undertaken by PVG Environmental in 2019

4. Black cockatoo habitat assessment – undertaken by PVG Environmental in 2019

5. Site meeting with Department of Biodiversity, Conservation and Attractions (DBCA) officers in October 2019

6. Reviewing the land, water and people-themed environmental factors for the site in accordance with the Environmental Protection Authority's (EPA) Environmental Factor Guidelines.

The outcomes from the environmental assessments and discussions with DBCA were the key drivers informing the Concept Plan for the site and have been subsequently embedded within the North Ellenbrook (east) DSP.

Lots 29 and 30 – concept plan

Project town planners Roberts Day have prepared a specific concept plan for the site (Figure E).

The Concept Plan has been developed to guide the North Ellenbrook (east) DSP and future Local Structure Plan (LSP) for the site.

The Concept Plan incorporates residential areas, roads and road reserves and Public Open Space (POS) areas. Of particular note, approximately 10.65 ha of land within the site been set aside within the Concept Plan for POS and Conservation POS to incorporate the following environmental outcomes:

- The retention of Resource Enhancement Wetland (REW) (UFI 12444), located at the northern portion of Lot 29, including a 30 metre (m) wetland buffer and POS area

- Retention of the REW (UFI 12283) located at the northern boundary of Lot 30, including a 50 m wetland buffer to reflect its proximity to the western swamp tortoise protection policy area

- Retention of the Declared Rare Flora species, *Grevillea curviloba subsp. curviloba* (narrow curved-leaf Grevillea) within a defined 2.39 ha conservation area and buffer, with an additional 2.8 ha surrounding POS area

- The retention of fauna habitat values within Conservation and POS areas, including but not limited to

  – 1.4 ha (or 48%) of the black cockatoo foraging habitat and 30 (or 68%) of potential breeding trees

  – Lots 29 and 30 are adjacent to and south of the western swamp tortoise policy boundary. The REW (UFI 12283) has been retained within the Concept Plan design to protect this habitat

- Adopting best practice groundwater and stormwater management.

The above planning and environmental outcomes demonstrated in the Concept Plan, have been adopted in the North Ellenbrook (east) DSP.

Key environmental factors and management measures

Historically Lots 29 and 30 were cleared of native vegetation and used for agricultural purposes, specifically livestock grazing paddocks. Additionally, approximately 7 years ago Lots 29 and 30 was subject to a significant fire event (Figure F). The result of these actions has been to significantly alter the structure of the remnant native vegetation within the site.

The key environmental factors within the site include:

- Terrestrial environmental quality
  - A moderate to low risk of Acid Sulfate Soils (ASS) occurring across the majority of the site, with a high to moderate risk associated with the wetland located at the northern boundary of Lot 30 (Figure H)
- Flora and vegetation
  - The vegetation types mapped across the site are illustrated in Figure I. The vegetation within the site was assessed as being too degraded to assign to a Floristic Community Type (FCT). An assessment of the potential FCTs and Threatened and/or Priority Ecological Communities (TECs / PECs) against the TECs and PECs that have been recorded within 5 km of the site was undertaken. This assessment clarified that no TECs or PECs are considered to occur within the site. This conclusion is based upon
    - The site's degraded and completely degraded vegetation condition which does not allow for accurate assessment of Floristic Community Types either by computer analysis or qualitatively using Table 12 of Gibson et al. (1994)
    - No understorey native species, no limestone in the topsoil or calcareous silts and no limestone indicator species on site
  - The *Melaleuca rhaphiophylla / M. teretifolia* Open Shrubland over weeds vegetation type that occurs in the wetland at the northern end of Lot 30 has potential to be a 'degraded' example of FCT 15 'Forests and woodlands of deep seasonal wetlands'. However, this wetland is being retained with a 50 m buffer, therefore impacts to the vegetation are unlikely. In the future the wetlands are proposed to be subject to a Wetland Management Plan, as it is considered possible that the wetland vegetation would improve with active management (i.e. weed removal and revegetation)
  - The majority of the vegetation on the site is rated as 'Degraded' to 'Completely Degraded' due to the dominance of weeds in the understorey and significant alteration of the vegetation structure in other areas. Figure J illustrated the vegetation condition mapping. No areas in 'Very Good' condition or better were recorded on the site. The vegetation proposed for retention (the *Grevillea curviloba subsp. ccurviloba*) was assessed as being in 'Good' condition however the REW (UFI 12444) was assessed as being in a 'Degraded' condition
  - Two populations of the Threatened (Declared Rare) species *Grevillea curviloba subsp. curviloba* are located within Lot 29 (Figure K). The proposed conservation and interface treatments to manage this population was the subject of a site meeting and review with DBCA officers. The key interface management measures were discussed in the context of LWP's and DBCA's previous experience in managing the *Grevillea curviloba* subsp*. ccurviloba* species within the Annie's Landing subdivision at Ellenbrook
- Terrestrial fauna
  - The remnant native vegetation located at the site provides potential breeding and foraging habitat for black cockatoos (Figure L)
    - No evidence of recent roosting at the site was observed on site or has previously been recorded on the site
    - No evidence of breeding was observed on the site or has been recorded previously
    - Of the 2.9 ha of potential foraging habitat identified on site, 1.4 ha (or 48% of the foraging habitat) is proposed for retention within the concept plan. A future Local Structure Plan (LSP) and subdivision design will consider, as part of the detailed planning and design, the further retention of trees and foraging habitat

    - Of the 44 potential breeding trees with diameter at breast height (DBH) greater than 500 mm identified on site, 30 (or 68% of the breeding trees) are proposed for retention
    - There is 7,649 ha of black cockatoo habitat in reserved bushland located within less than 12 km from the site
  - REW (UFI 12283) is partially located within the western swamp tortoise policy buffer area and consequently comprises potential western swamp tortoise habitat (Figure M). DBCA has proposed to undertake a survey of the REW, and if the western swamp tortoise is identified during the DBCA survey, they will be relocated by DBCA to more suitable habitat. Specifically, the tortoises would be move to the nature reserves managed by the Department. DBCA manage these reserves specifically for the benefit of the western swamp tortoise. Alternatively, consistent with the revised Recovery Plan the tortoise DBCA could choose to re-locate any found western swamp tortoise to the Perth Zoo as part of its captive breeding program with the University of Western Australia

- Inland waters
    - The mapped wetlands within the site and the western swamp tortoise policy area are shown in Figures 1 and M
    - REW (UFI 12444) located at the northern portion of Lot 29. A 30 m buffer is proposed for this wetland, with an additional POS area separating the wetland from proposed residential development
    - REW (UFI 12283) located at the northern boundary of Lot 30. The concept design has incorporated a 50 m buffer and a road reserve between the wetland and proposed residential development, to reflect the western swamp tortoise policy area
- Social surroundings
  - Registered Aboriginal mythological heritage site 3525 ('Ellen Brook: Upper Swan) is mapped across both the site and the broader North Ellenbrook (east) DSP landholdings. This ethnographic place is restricted (or 'Closed') and the consent of the listed informant is required in order to access the file). An Aboriginal heritage survey will be undertaken on the registered Ellen Brook: Upper Swan site 3525 and determine if Section 18 approval is required under the *Aboriginal Heritage Act 1972* as part of future MRS Amendment or the LSP stage
  - An acoustic assessment of the North Ellenbrook (east) DSP was undertaken by Herring Storer Acoustics. This acoustic assessment included
    - the predicted noise levels received at residence for compliance with the requirements of the WAPC State Planning Policy 5.4 Road and Rail Noise (SPP 5.4).
    - if exceedances are predicted, comment on possible noise mitigation options for compliance with the appropriate criteria.
    - provided a response on noise emissions associated with the Pearce Air Base and the Ellenbrook Speedway.
  - An existing freight railway line lies approximately 60 m east of the site within a gazetted MRS Railways reserve. The freight railway line is separated from the site by Railway Parade. The results from Herring Storer's freight rail line noise assessment indicate that noise emissions received at residences located adjacent to the rail line would exceed the defined "Noise Targets" outlined in SPP 5.4. As the construction of the rail line has already been undertaken, noise levels at the proposed North Ellenbrook (east) DSP residential development were not been considered by the infrastructure provider. Acknowledging this outcome, and the need for noise mitigation, the Herring Storer acoustic modelling a scenario where a 2.4 m noise wall was installed at the boundary of the site (Lot 29). With the inclusion of this noise wall barrier, Herring Storer concluded, that noise levels are attenuated sufficiently to enable residential development behind the wall to meet SPP 5.4 noise criteria. Whilst there is a reduction in noise levels by the barrier, the acoustic report outlines that there would still be the requirement for these premises to incorporate quiet house design and notifications on titles (Herring Storer 2019)

- Ellenbrook Speedway is located approximately 440 m from the south eastern boundary of the site. The speedway operates 12 to 14 meets from April to October with most of the events held during the day (on Sundays with racing commencing at 11.30 am). All speedway meetings are conducted according to the state noise regulations and in accordance to a noise management plan. Based on Herring Storer's acoustic assessment on specifically noise generated from the speedway, noise emissions at the site boundary (Lot 29) would be less than 55 dB(A). For comparison, an individual 2-minute train pass at this same location would be around 75 dB(A). Therefore, noise levels for the train line would be considered higher than noise levels associated with the speedway. The acoustic assessment determined the potential off-site mechanisms for mitigation for the freight rail line noise (e.g. noise walls, building design and materials etc) would mitigate the episodic noise emissions from the speedway

- In terms of bushfire prone areas, a bushfire assessment and plan will be prepared for the North Ellenbrook (east) DSP. To address SPP 3.7 requirements, a bushfire management plan will need to be prepared for the site which provides

    - A bushfire hazard level assessment / bushfire attack level (BAL) contour map

    - Consideration for bushfire protection criteria

- A site-specific BAL and bushfire management plan will be prepared for the site as part of a future LSP approval consistent with SPP 3.7 requirements

- Figure N shown the mapped bushfire prone areas, the freight rail line and the Ellenbrook Speedway.

Project summary

A summary of the site including the proposed *Grevillea curviloba subsp. curviloba* conservation area, REWs and POS areas is provided in Table 1.

Table 1: Key site characteristics and proposed outcomes

Item	Environmental area	Figures / appendix
Subject site	Lot 30 – 19.43 ha Lot 29 – 26.9 ha Total area – 46 ha	Figure A
Wetlands	Lot 30 – REW (UFI 12283) and buffer – 3.07 ha Lot 29 – REW (UFI 12444) and buffer – 2.39 Total area – 5.46 ha	Figure E and M
Grevillea conservation area	Lot 29 – *Grevillea curviloba subsp. curviloba* population and conservation area – 2.39 ha *Grevillea curviloba subsp. curviloba* population area – 0.93 ha	Figure E and K Appendix A
Black cockatoo foraging habitat	Total foraging area – 2.89 ha Proposed retention area (DSP level) is 1.4 ha (or 48% of overall habitat) 44 potential breeding trees identified on site, 30 (or 68% of the trees) are proposed for retention The total area of reserved bushland that contains habitat for black cockatoos within 12 km of the site is greater than 7,600 ha.	Figure L Appendix B
Public Open Space (POS)	Lot 29 – POS surrounding the conservation areas – 2.8 ha Lot 30 – 1.46 ha Total – 4.25 ha	Figure E

The environmental studies and impact assessment demonstrate that the potential environmental impacts from the implementation of the concept design / DSP can be managed through the implementation of responsive planning and development controls to be as low as reasonably practicable. A summary of the environmental factors on the site and potential impacts and proposed management measures is detailed in Table 2. Management plans and further investigations proposed to manage and mitigate potential impacts include:

- Resource Enhancement Wetland Management Plan for the REWs within the site
- Implement the DBCA agreed buffer and management outcomes for the *Grevillea curviloba subsp. curviloba* population
- A District Water Management Strategy will be prepared for the North Ellenbrook (east) DSP. A Local Water Management Strategy (as part of a future LSP approval) and an Urban Water Management Plan(s) will be finalised as part of future subdivision approvals
- Bushfire management plan
- An Aboriginal heritage assessment to assess the significance of the Aboriginal heritage site Ellen Brook: Upper Swan to determine whether a Section 18 approval is required
- Noise and vibration assessment to assess impacts from the freight rail and the Ellenbrook Speedway to future residents
- Appropriate ASS management plan will be prepared at subdivision stage to support the proposed engineering approach (if required).

Table 2: Summary of environmental factors, potential impacts and proposed management measures

Environmental factors	Environmental objective	Applicable legislation and/or guidelines	Potential impacts	Management measures	Timing
Land					
Flora and Vegetation	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.	• *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Flora and Vegetation (Environmental Protection Authority (EPA) 2016a) • Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b)	• Clearing 11.3 ha of vegetation in Degraded to Completely Degraded condition (subject to detailed landscape and engineering design) • Indirect impacts to *Grevillea curviloba* subsp. *curviloba* including introduction and distribution of weed species	Retention of *Grevillea curviloba* subsp. *curviloba* populations within the conservation and POS area totalling 7.57 ha.	Subdivision design
				• The *Grevillea curviloba* subsp. *curviloba* populations will be retained on site within the conservation area (i.e. no impact is proposed to this population) • To avoid impacts to the *Grevillea curviloba subsp. curviloba* population a temporary fence will be maintained until the permanent wall and fence is installed (at the DBCA agreed buffer boundary) during residential development. • No livestock will be permitted within Lot 29.	Prior to construction
				• Consistent with the Annie's Landing interface a buffer will be established between the *Grevillea curviloba* populations and a hard wall constructed. • LWP will install a hard wall at the edge of the buffer surrounding the *Grevillea curviloba* subsp. *curviloba* populations, with an access point. A road is proposed adjacent (on the residential development side) to the hard wall. • Overall Lot 29 will provide 4.8 ha dedicated to the *Grevillea curviloba subsp. curviloba* populations and the REW. This total increases to 7.57 ha including the area of public open space surrounding the buffers. • Depending upon the DBCA's long term management objectives, the *Grevillea curviloba* subsp. *curviloba* populations and buffer could be created as a separate 'Reserve' and then handed over to the DBCA for long term management. Alternatively, the entire consolidated conservation area inclusive of the *Grevillea curviloba* subsp. *curviloba* populations and the REW and 30 m buffer (but excluding the public open space area) could be treated as a single 'Reserve' area and transferred to the DBCA for long-term management. If the Department determined that it did not want to manage the REW, LWP would, as per standard subdivision arrangements, handover the wetland and its 30 m buffer and the surrounding POS to the City of Swan for long-term management. • The landowner will prepare and implement a REW Management Plan for both wetland areas, as part of the development process.	Prior to subdivision approval
				All vehicles to be free of vegetative and soil material during construction activities.	During construction
Terrestrial Environmental Quality – Acid Sulfate Soils (ASS)	To maintain the quality of land and soils so that environmental values are protected.	• Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016c) • Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (Department of Environment Regulation (DER) 2015a) • Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DER 2015b)	• Acidification and release of heavy metals from ASS into groundwater	• Final fill levels and subsequent excavation (e.g. for sewer lines/engineering services and dewatering requirements) will dictate future ASS management requirements. • Appropriate ASS management plan will be prepared at subdivision stage to support the proposed engineering approach (if required).	Prior to subdivision approval
Terrestrial Fauna	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.	• *Environment Protection and Biodiversity Conservation Act 1999* • Revised draft referral guideline for three threatened black cockatoo species: Carnaby's Cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's Cockatoo (Vulnerable) *Calyptorhynchus baudinii*, Forest Red-tailed Black Cockatoo (Vulnerable) *Calyptorhynchus banksii naso* (DEE 2017) • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Terrestrial Fauna (EPA 2016d)	• Of the 2.9 ha of potential foraging habitat identified on site, 1.5 ha (52%) is located outside of conservation and/or POS areas. • Of the 44 potential breeding trees identified on site, 14 (32%) are located outside of conservation and/or POS areas. The foraging and individual trees will be subject to detailed landscape and engineering design • Injury and/or mortality from construction works • Disturbance to fauna behaviour during construction	• Retention of 1.4 ha of potential foraging habitat and 30 potential breeding trees within conservation and POS areas. • A future LSP and subdivision design will consider, as part of the detailed planning and design, the further retention of individual trees and foraging habitat. Post the finalising of the LSP an assessment of the potential impacts on the black cockatoo habitat will be undertaken in accordance with the Commonwealth's Department of Environment and Energy's (DEE) black cockatoo referral guidelines.	LSP stage / subdivision design

Environmental factors	Environmental objective	Applicable legislation and/or guidelines	Potential impacts	Management measures	Timing
Water					
Inland Water	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected	• Environmental Factor Guideline – Inland Waters (EPA 2018) • Better Urban Water Management (Western Australian Planning Commission 2008)	• Alteration of the existing landscape which in turn may alter surface water flow paths and recharge locations during rainfall. • Removal of vegetation and installation of impervious surfaces can lead to an increase in run-off during rainfall events. • Pollutants (nutrients, litter etc) in stormwater runoff from the residential development may impact surface water and groundwater values. • Potential indirect impacts to retained REWs	• A District Water Management Strategy is being prepared to provide an overview of the integrated management of groundwater and surface water that will be implemented at the site in line with the Better Urban Water Management principles.	Scheme Amendment stage
				• A Local Water Management Strategy (LWMS) to be prepared to support the proposed Local Structure Plan (LSP) to the satisfaction of the CoS, on advice from the Department of Water and Environmental Regulation (DWER).	LSP stage
				• Urban Water Management Plan(s) to be prepared at subdivision stage to the satisfaction of the CoS, on advice from the DWER.	Prior to subdivision approval
				• A REW Management Plan will be prepared for the two REWs retained on the site (UFI 12444 and UFI12283)	Subdivision design
Social surroundings					
Social Surroundings – Aboriginal heritage and culture	To protect social surroundings from significant harm	• *Aboriginal Heritage Act 1972* • Environmental Factor Guideline Social Surroundings (EPA 2016e)	• Excavation / construction activities may unearth and/or damage artefacts or other items of Aboriginal cultural significance	• A suitably qualified Aboriginal heritage consultant will be appointed to investigate the significance of the registered Ellen Brook: Upper Swan site 3525 and determine if Section 18 approval is required under the Aboriginal Heritage Act 1972 as part of future MRS Amendment or the LSP stage.	MRS Amendment and LSP stage
				• Should any Aboriginal objects be identified or unearthed then construction will be stopped, and the findings will be reported to the Department of Planning, Lands and Heritage (DPLH)	During construction
Social Surroundings – Noise	To protect social surroundings from significant harm	• Environmental Factor Guideline Social Surroundings (EPA 2016e) • Environment Protection (Noise) Regulations 1997 • State Planning Policy (SPP) 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning	• Ongoing exposure of future residents to the freight rail and speedway related noise	• A noise and vibration assessment have been undertaken by Herring Storer in accordance with SPP 5.4: to determine the baseline noise impacts and to address any management requirements (i.e. noise walls and possibly quiet house design) to mitigate the impacts from noise and vibration from the freight railway. The acoustic modelling included assessing the implementation of a 2.4 m noise wall at the boundary of the site (Lot 29) for noise mitigation. • With the inclusion of this noise wall barrier, Herring Storer concluded, that noise levels are attenuated sufficiently to enable residential development behind the wall to meet SPP 5.4 noise criteria. Whilst there is a reduction in noise levels by the barrier, the acoustic report outlines that there would still be the requirement for these premises to incorporate quiet house design and notifications on titles (Herring Storer 2019). • The acoustic assessment addressed the noise emissions from the Ellenbrook Speedway and determined the potential off-site mechanisms for mitigation for the freight rail line noise (e.g. noise walls, building design and materials etc) would address the episodic noise emissions from the speedway.	MRS Amendment and LSP stage
Social Surroundings – Bushfire	To protect social surroundings from significant harm	• *Fire and Emergency Services Act 1998* • Environmental Factor Guideline Social Surroundings (EPA 2016e) • SPP 3.7: Planning in Bushfire Prone Areas • Guideline for Planning in Bushfire Prone Areas, Version 1.3 (DPLH and Department of Fire and Emergency Services 2017)	• Damage to people, property and infrastructure from fire • Death and/or injury due to fire	• Bushfire Management Plan will be prepared to provide the bushfire management framework proposed to be actioned as part of developing the site to the satisfaction of the DFES and the WAPC	LSP stage
				• Bushfire Attack Level (BAL) contour mapping within the Bushfire Management Plan will be updated (if required) to reflect the proposed subdivision design and landscape management outcomes	Prior to subdivision approval

1 INTRODUCTION

1.1 Location

LWP Property Group (LWP) is responsible for project managing the planning and future land uses within Lots 29 and 30 Maralla Road, North Ellenbrook (the site).

The 46 hectare (ha) site is located within the City of Swan (CoS), approximately 20 kilometres (km) north-east of the Perth Central Business District and 10 km north of the Midland town centre (Figure A).

1.2 Planning context

The site is currently zoned 'Rural' under both the Metropolitan Region Scheme (MRS) and the CoS's Local Planning Scheme (LPS) No. 17 (Figures B and C). However, the site is located immediately adjacent to the Ellenbrook residential community.

In 2018, the Department of Planning, Lands and Heritage's (DPLH) released the North-East Sub-regional Planning Framework ('the Framework') for Perth and Peel@3.5million. The Framework identified the site as being within the North Ellenbrook (east) 'Urban Investigation' area. The 'Urban Investigation' recognition by DPLH was the catalyst for significant planning and environmental review of an approximately 500 ha landholding area (which includes the site) identified as being within the 'Urban Investigation' area, east of the Perth-Darwin Highway.

The Framework outlines a District Structure Plan (DSP) is required prior to consideration of rezoning requests under the MRS. The DSP will serve as the mechanism for undertaking the detailed planning and investigation into the North Ellenbrook (east) 'Urban Investigation' area and addressing the applicable key environmental considerations. Lendlease is coordinating, in agreement with the landowners in the 500 ha North Ellenbrook (east) 'Urban Investigation' area, the preparation of a DSP. This DSP is titled the North Ellenbrook (east) DSP.

The DSP area and landownership are shown in Figure D. Lots 29 and 30 are located on the south-eastern portion of the DSP.

1.3 Purpose of report

A separate Environmental Assessment Report (EAR) (Emerge Associates) has been prepared for the broader DSP except for Lots 29 and 30.

Specifically, the purpose of this EAR is to:

- Review of the existing environment and address key environmental factors within the site that may be impacted as a result of future 'Urban' land use change and development
- Identify opportunities for input to a responsive urban design to protect and enhance any significant environmental features within the site.
- Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development
- Support the broader DSP and facilitate the approval of a future MRS Amendment with the Environmental Protection Authority (EPA) through providing an environmental management framework to underpin future subdivision and development.

1.4 Key investigations / studies and stakeholder engagement

This EAR is underpinned by the following investigations:

- Site investigation and state and Commonwealth desktop flora, vegetation and fauna assessment

- Site visit by RPS and PVG Environmental
- Detailed Flora and Vegetation Survey of the site was undertaken in accordance with EPA Technical Guidance Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, 2016) – undertaken by PVG Environmental 2019
- Black cockatoo habitat assessment – undertaken by PVG Environmental 2019
- Site meeting with the Department of Biodiversity, Conservation and Attractions (DBCA) officers (October 2019)
- Reviewing the land, water and people-themed environmental factors for the site in accordance with the Environmental Protection Authority's (EPA) Environmental Factor Guidelines
- The outcomes from the environmental assessments and discussions with DBCA were the key drivers informing the Concept Plan for the site and have been subsequently embedded within the North Ellenbrook (east) DSP.

1.5 Historical and current land uses

1.5.1 Historical and current land uses

A review of historical aerial photography shows that most of the site was cleared of native vegetation prior to 1974 to facilitate agricultural land uses. Within Lot 30 there is a single dwelling (house), however the majority of Lot 30 primarily comprised of cleared paddock. Agricultural activities appear to have been discontinued in Lot 29 between the late 1990s and early 2000s with ongoing vegetation recruitment evident (Figure F). The historical clearing within the site is illustrated in Plate 1.

Plate 1: Historically cleared areas within Lot 29

1.5.2 Surrounding land uses

The site's western and northern boundaries are bordered by Lot 31 Maralla Road and Lot 52 Railway Parade, which appear to be primarily used for agricultural purposes. A northern portion of Lot 31 and southern section of Lot 52 are intersected by the mapped extent of REW (UFI 12283).

Immediately south of the site is the Ellenbrook residential community. The closest development is the Annie's Landing subdivision which extends to Maralla Road and the railway reserve to the east.

An existing freight railway line lies 60 m to the east of the site within a gazetted MRS Railways reserve. The freight railway line is separated from the site by Railway Parade (Figure B). REW (UFI 12440) is also mapped within the railway corridor. The episodic Ellenbrook Speedway is located 440 m to the east of the site.

The Western Swamp Tortoise Habitat policy area for the Environmental Protection (Western Swamp Tortoise Habitat) Policy 2002 directly abuts the northern and eastern site boundaries, inclusive of Lot 52 Railway Parade and the Railway Parade road reserve (Figure M).

The site's southern boundary abuts Maralla Road with the Annie's Landing residential development located directly to the south. Bush Forever Site No. 300: *Maralla Road Bushland, Ellen Brook / Upper Swan*, which is reserved for Parks and Recreation under the MRS, is situated adjacent to Annie's Landing to the south-west of the site.

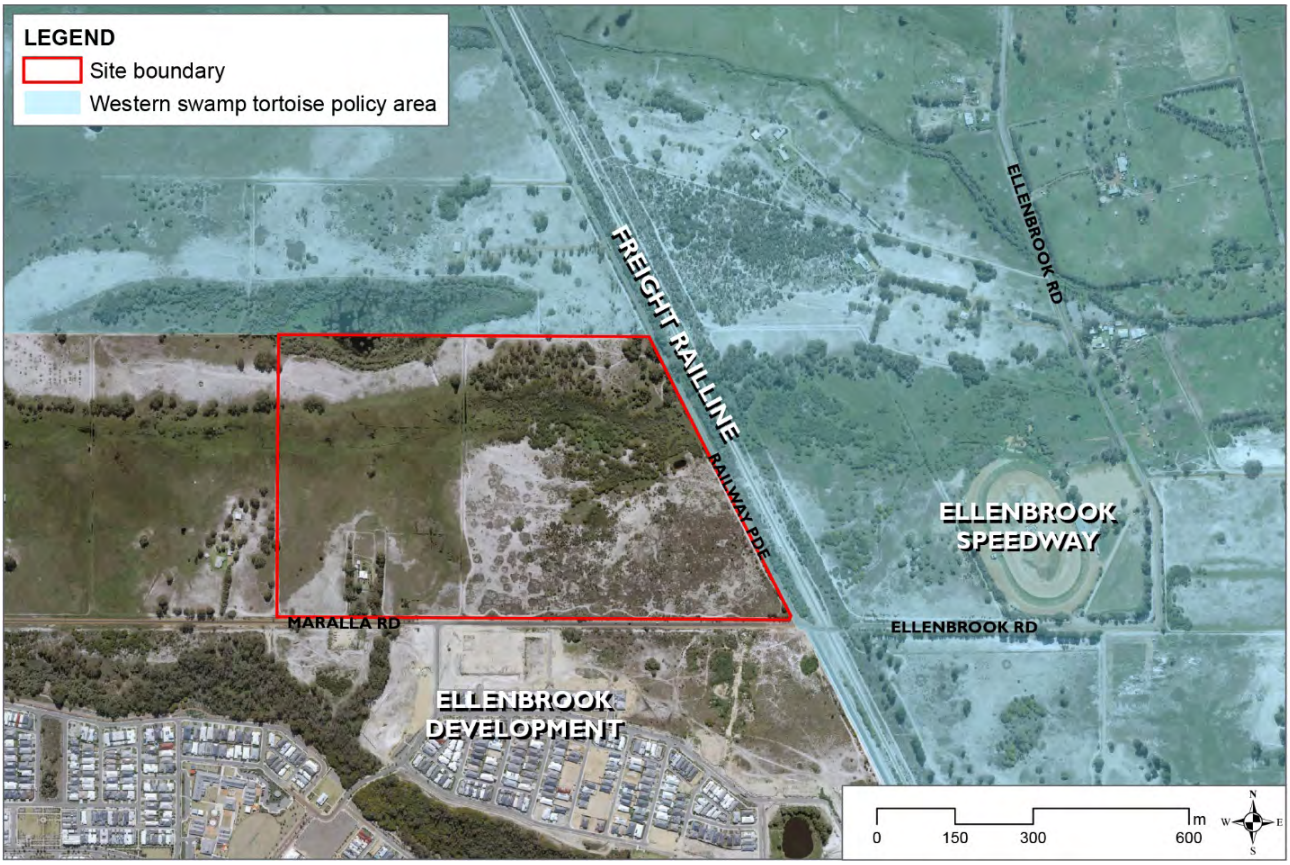

Figure 1: Surrounding land uses

2 LOTS 29 AND 30 – CONCEPT PLAN

Town planners for the site Roberts Day has prepared a Concept Plan for the site (Figure E).

The Concept Plan incorporates the key environmental features and values of the site, particularly within Lot 29. A core focus of the Concept Plan was resolving in the plan the management areas for the *Grevillea curviloba* subsp. *curviloba* (narrow curved-leaf grevillea) and the two REWs inclusive of buffers.

The Concept Plan provides approximately 10.65 ha has for conservation and POS purposes to incorporate the following environmental outcomes:

- The retention of Resource Enhancement wetland (REW) (UFI 12444). This wetland is located at the northern portion of Lot 29. A 30 m buffer has been retained around this wetland, with an additional POS area between the buffer and proposed residential development
- Retention of the REW (UFI 12283) located at the northern boundary of Lot 30, including a 50m wetland buffer and 20 m road reserve
- Retention of the Threatened (Declared Rare) species, *Grevillea curviloba subsp. curviloba* within a defined (2.39 ha) conservation area and buffer, within an additional surrounding POS area
- The retention of fauna habitat values within conservation and POS areas, including but not limited to
  - 1.4 ha (48% of the habitat mapped on the site) of potential black cockatoo foraging habitat and 30 trees (68% of the overall number identified on the site)
  - Lots 29 and 30 are adjacent to the western swamp tortoise policy boundary (Figure M). The REW (UFI 12283) has been retained within the Concept Plan design to protect this habitat
- Groundwater and stormwater management (as outlined in the District Water Management Strategy).

The Concept Plan additionally provides for residential areas, roads and Public Open Space (POS) areas.

The above planning and environmental outcomes (demonstrated in the Concept Plan) have been adopted in the North Ellenbrook (east) DSP.

Planning, environmental and engineering services studies have been undertaken for Lots 29 and 30. These studies demonstrate the ability to progress the future planning and environment approvals for Lots 29 and 30 on an independent basis given:

- Roads / access, services can be extended to the site
- Water supply can be provided for irrigation
- Acoustic and bushfire management can be suitably addressed.

3 LAND FACTORS

3.1 Landform

3.1.1 Topography

The topography of the site is generally flat with a gradual decline trending westerly and northerly from a slightly elevated area located centrally within Lot 29. The highest point within the site is approximately 29 metres Australian Height Datum (m AHD) with the lower sections in the south-east of Lots 29 and 30 being approximately 25 m AHD and 26m AHD, respectively (Figure G).

3.1.2 Geology

The site is primarily underlain by S8 and S10 sands. Peaty clay is closely associated with the mapped extent of REW (UFI 12283) in the north of Lot 30 and pebbly silt is more broadly associated with REW (UFI 12444) (Figure G).

3.2 Terrestrial environmental quality

3.2.1 Potential contamination

A search of the Department of Water and Environmental Regulation's (DWER) Contaminated Sites Database on 08 October 2019 did not identify and recorded contaminated sites on the site.

3.2.2 Acid sulfate soils

The WAPC Planning Bulletin No. 64 (WAPC 2009) sets out planning guidelines and risk maps for Acid Sulfate Soils (ASS) in the metropolitan area. Most of the site is mapped as having moderate to low risk of ASS occurring within three metres of the natural surface. A small area of high to moderate risk of ASS occurring within three metres of the natural surface has been mapped is association with REW (UFI 12283) in the north of Lot 30 (Figure H).

3.3 Flora and vegetation

3.3.1 Regional vegetation

The original vegetation on the site is mapped as part of the Yanga vegetation Complex, which is described as predominantly a closed scrub of *Melaleuca* species and low open forest of *Casuarina obesa* (Swamp Sheoak) on the flats subject to inundation. On drier areas the vegetation reflects the adjacent vegetation complexes of Bassendean and Coonambidgee (Heddle et al 1980).

The reservation status of this vegetation type within the Swan Coastal Plain, at regional and local levels, is presented in Table 3 and Table 4. The percentage of the original extent of the Yanga Complex remaining is less than the EPA's target for minimum 30% retention of vegetation complexes state-wide and the percentage protection is below the 10% minimum criteria for vegetation complexes in the Perth and Peel Region Constrained Areas (PGV Environmental, 2019).

With the exception of the *Grevillea curviloba* subsp. c*urviloba* populations on site, the vegetation on site was assessed as being in a 'Degraded' to 'Completely Degraded' condition and consequently, PGV Environmental consider the vegetation on site to be too degraded to comprise a significant remnant of the Yanga Complex. Consequently, the proposed development on the site will not further reduce the extent of this complex.

The Concept Plan facilitates 10.65 ha for conservation and POS purposes. This includes the two REW areas and the *Grevillea curviloba* subsp. c*urviloba* populations. These areas will be subject to future management plans which will require weed and revegetation actions. This management outcome will significantly improve the degraded state of the vegetation units within the site.

Table 3: Regional conservation status of Yanga Complex

Description	Perth Metropolitan region	Percentage of original area
Original extent	26,176 ha	N/A
Remaining area	4,312 ha	16.5%

(Source: EPA 2015)

Table 4: City of Swan status of Yanga Complex

Description	Area	Percentage of original area
Original extent	5,776 ha	N/A
Remaining area	882.31 ha	15.28%

(Source: Perth Biodiversity Project 2011)

3.3.2 Flora and vegetation survey

PGV Environmental undertook a Detailed flora and vegetation survey of the site in July and September, 2019 in accordance with EPA Technical Guidance *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016).

The PGV Environmental's detailed flora and vegetation survey for the site is provided as Appendix A.

The survey included the following:

- Review of DBCA and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) databases for Threatened and Priority flora and vegetation
- Examination of historic and recent aerial photography and contour and soil maps to provisionally identify vegetation types and condition
- Field survey using quadrats to record native and introduced species as well as a thorough site walkover of any areas of native vegetation
- Recording of any significant plant species using a hand-held GPS
- Description and mapping of vegetation types and vegetation condition
- Compilation of a flora list
- Identification of any flora and vegetation of conservation significance.

In addition to the detailed survey, RPS and PGV Environmental met with DBCA officers on site to formally confirm the presence of a *Grevillea curviloba* subsp*. curviloba* population and discuss potential conservation measures.

Results of the detailed flora and vegetation survey are summarised below.

3.3.2.1 Vegetation type

Eight vegetation types were described and mapped on the site (Figure I), these are described in Table 5.

Table 5: Vegetation types

Vegetation type	Description	Area (ha)	
		Retained within POS and conservation areas	Within the development footprint
Corymbia calophylla Low Woodland over weeds (Cc)	Two stands of marri trees occurred at the northern end of Lot 29. The trees were mostly young, up to 8 m high and at a low density of around 20%. The understorey was almost completely comprised of weed species, with veldtgrass (*Ehrharta calycina*) and lupin (*Lupinus cosentinii*) the most common. The soils were dry, grey sand.	1.40	1.31
Melaleuca rhaphiophylla Shrubland to Tall Open Scrub over Weeds (Mr)	This vegetation type occurs on low-lying land on the southern edge of the wetland at the northern end of Lot 30 as well as at the western end of Lot 29. *Melaleuca rhaphiophylla* trees are 2–4 m high and 25–40% cover. *Melaleuca teretifolia* is sometimes present as a smaller shrub. The understorey is herbaceous and varies depending on the degree of inundation. Wetter areas contain abundant *Cotula coronopifolia,* while drier areas contain *Ehrharta calycina*. *Lotus subbiflorus* is a very common ground cover. The soils vary from dark grey sand to black peaty sand and can be inundated up to 5 cm in winter–spring.	0.94	0.67
Melaleuca *rhaphiophylla/ M. teretifolia* Open Shrubland over weeds (MrMt)	This vegetation type occurred on the RE wetland at the northern end of Lot 30. *Melaleuca rhaphiophylla* and *M. teretifolia* shrubs were sparse and up to 2 m high. Inundated areas contained the floating aquatic *Lemna disperma* and *Cotula coronopifolia*. *Lotus subbiflorus* and couch grass (*Cynodon dactylon*) are abundant on the edge of the water line. The soils are black, peaty sand with no evidence of near surface clays. The area was inundated during both survey times on 24 July and 16 September 2019.	0.63	0
Acacia saligna/ Melaleuca rhaphiophylla Tall Open Scrub over weeds (AsMr)	This vegetation type commonly occurs on low lying land at the northern end of Lot 29. *Acacia saligna* is up to 4 m high, with 20% cover over *Melaleuca rhaphiophylla* 2–3.5 m high. *Melaleuca teretifolia* is a common smaller shrub. The understorey is low and sparse and mostly consists of weed species such as *Rumex pulcher, Cynodon dactylon, Arctotheca calendula* and *Lolium perenne*. Only a few flooded gums (*Eucalyptus rudis*) occur near the eastern end of the unit. The soils are dark peaty sand and damp in winter/spring.	1.14	0.63
Acacia saligna Tall Shrubland to Tall Open Scrub over Weeds (As)	This vegetation types comprises the dense stands of *Acacia saligna* up to 4 m high which occur at the southern end of the AsMr vegetation unit on Lot 29. The understorey was completely comprised of weeds with veldtgrass the most common species, as well as Cape tulip (*Moraea flaccida*), ryegrass (*Lolium perenne*) and *Vulpia uros*. The soils were dry, dark grey sand.	1.37	1.43
Jacksonia furcellata Tall Shrubland over *Alexgeorgea nitens* Closed Sedgeland (Jf)	Occurred over most of the southern half of Lot 29 on land that had been previously cleared. *Jacksonia furcellata* has regrown up to 3 m high and occurs in small stands as well as individual plants. The ground cover appears weedy but contains abundant low native species such as *Alexgeorgea nitens* and *Dasypogon bromeliifolius. Ursinia anthemoides* and *Ehrharta calycina* are common introduced species. The soils are dry grey sand.	1.15	9.04

Vegetation type	Description	Area (ha)	
		Retained within POS and conservation areas	Within the development footprint
Grevillea curviloba subsp. *curviloba* Open Heath over *Xanthorrhoea preissii* Low Shrubland (Gc)	The two stands of the Threatened species *Grevillea curviloba* subsp. *curviloba* were large enough to be mapped as a vegetation type. The grevillea plants were up to 1.6 m high, at a density of 50–60%. One of the stands contained many *Xanthorrhoea preissii* plants but the species was absent from the other. Most of the species in both stands were introduced weeds including bridal creeper (*Asparagus asparagoides*), Veldtgrass (*Ehrharta calycina*) and ryegrass (*Lolium perenne*). The soil type was a light brown sand.	0.93	0
Banksia menziesii/B. attenuata Low Open Woodland over *Alexgeorgea nitens/ Dasypogon Bromeliifolius* (BmBa)	A small stand of Banksia woodland occurred at the south eastern end of Lot 29. The Banksia trees were up to 4 m high and sparse over a low weedy understorey with common native species *Alexgeorgea nitens* and *Dasypogon bromeliifolius* and introduced species *Eragrostis curvula* (lovegrass) and *Ehrharta calycina*. Some *Eucalyptus todtiana* trees were also present in low numbers. The soils were dry, whitish-grey sand.	0	0.18
Regelia ciliata Low Shrubland	A small area containing *Regelia ciliata* shrubs up to 1 m occurred in the centre of Lot 30. on slightly higher ground than the broader As unit. *Acacia saligna* was sparsely present to 3 m. The balance of the area contained grassy weeds. The soils were dry, whitish-grey sand.	0.05	0.15
Cleared	Cleared pasture	3.04	21.34

3.3.2.2 Vegetation condition

The condition of the vegetation assessed by PVG Environmental is provided in Figure J.

The majority of the vegetation on the site was rated as ‘Degraded’ to ‘Completely Degraded’ due to the dominance of weeds in the understorey and significant alteration of the vegetation structure in other areas.

The only area recorded in ‘Good’ condition *Grevillea curviloba* subsp. *Curviloba,* which is proposed to be maintained in a conservation area.

3.3.2.3 Conservation significant flora and vegetation

3.3.2.3.1 Flora

Two stands of the Threatened species *Grevillea curviloba* subsp. *curviloba*, listed as Threatened (Declared Rare) species under the *Biodiversity Conservation Act 2016*, and Endangered under the EPBC Act were recorded within Lot 29 (Figure K).

Plate 2: *Grevillea curviloba* subsp. *curviloba* (narrow curved-leaf grevillea) within Lot 29

Research on the genetic diversity of *Grevillea curviloba* by H. Nistelberger (2006) indicates that stands of the species may be clonal and represent one or a very few number(s) of individual plants. Consequently, the two stands on the site, which have thousands of stems each, may actually only be two individuals that have spread by underground runners. Therefore, it is not possible to determine the number of individual plants present.

This species was identified on the site as part of the flora and vegetation survey by PGV Environmental. The spring survey confirmed the identification of the *Grevillea curviloba* subsp. *curviloba* species by lodging a specimen (under an Authorisation to Take) at the Perth Herbarium. In addition, DBCA botanist Anne Harris confirmed the positive likelihood of the species at the 23 October 2019 site visit.

The *Grevillea curviloba* subsp*. curviloba* populations will be retained on site within the conservation area (i.e. no impact is proposed to this population) as shown in the Concept Plan. Table 6 outlines the proposed *Grevillea curviloba* subsp*. curviloba* conservation area.

Table 6: *Grevillea curviloba subsp. curviloba* conservation strategy

Concept design area	Description	Area (ha)
Grevillea population	-	0.93 ha
Conservation area	A conservation area has been incorporated into the concept design to protect the grevillea populations. The boundary of this conservation area ranges from 5.5 m to 20 m from the edge of the grevillea population.	2.39 ha
POS area	A POS area surrounds the proposed conservation area to provide a further buffer between the grevillea populations and proposed development, creating an overall buffer as agreed with DBCA between the populations and proposed development. Further interface treatments are discussed in Section 5 and include: • A temporary fence at least 10 m from the edge of the population during construction activities. • A hard wall will be installed at the edge of the buffer to provide an additional interface treatment. • A road reserve between the POS area and proposed development will provide additional interface treatment.	2.8 ha With an overall POS and conservation area of 7.6 ha on Lot 29 (incorporating the REW wetland, buffer, grevillea population, buffer and POS area).

3.3.2.3.2 Ecological communities

PGV Environmental undertook an assessment of the likelihood of Threatened Ecological Communities (TEC) and/or Priority Ecological Communities (PEC) occurring on site. This assessment was based upon reviewing TECs and PECs that have been recorded within 5 km of the site. The outcomes from this assessment are summarised in Table 7.

The only TEC with the potential to occur on site is FCT 15 'Forests and woodlands of deep seasonal wetlands'. The *Melaleuca rhaphiophylla / M. teretifolia* Open Shrubland over weeds vegetation type that occurs in the REW ((UFI 12283) at the northern boundary of Lot 30 has potential to be a degraded example of FCT 15, which is a TEC at State level. This vegetation is proposed to be retained within the REW and the REW buffer.

Table 7: Threatened and priority ecological communities

Ecological community	Description	Assessment
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	Not on site – no springs or associated vegetation on site
SCP3c	*Corymbia calophylla – Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain	Not on site – Understorey of *Corymbia calophylla* (marri) woodland completely degraded and does not contain *Xanthorrhoea preissii*
Muchea Limestone	Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain	Not on site – No limestone in the topsoil. No limestone indicator species on site.
SCP08	Herb rich shrublands in clay pans	Not on site – wetland is not herb rich
SCP15	Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	Possible – vegetation in the wetland at the northern end of Lot 30 contains characteristic species but is in weedy condition.
SCP18	Shrublands on calcareous silts of the Swan Coastal Plain	Not on site – no calcareous silts on the site
Banksia WL SCP	Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region	Not on site – small area containing *Banksia attenuata* and *B. menziesii* too degraded and not sufficient size to meet the criteria for the TEC
Tuart WL SCP	Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community	Not on site – no tuarts on site
SCP21c	Low-lying *Banksia attenuata* woodlands or shrublands	Not on site – small area of Banksia woodland not low-lying

Ecological community	Description	Assessment
SCP22	*Banksia ilicifolia* woodlands	Not on site – *Banksia ilicifolia* only present as individual trees in a parkland cleared setting
SCP23b	Swan Coastal Plain *Banksia attenuata* – *Banksia menziesii* woodlands	Not on site – small area containing *Banksia attenuata* and *B. menziesii* too degraded to meet the definition of this community

3.4 Terrestrial fauna

The fauna assessment for the site is underpinned by the following surveys and assessment methodology:

- PGV Environmental's detailed flora and vegetation survey
- PGV Environmental's black cockatoo survey
- Description of broad fauna habitats present with the site
- Desktop search of the DBCA's NatureMap database to identify conservation significant species within the general area
- Site visit undertaken by DBCA to assess significant vegetation and flora and review the potential for western swamp tortoise to occur in the two wetland areas
- Desktop search of the Commonwealth's Protected Matters Search Tool to identify conservation significant species within the general area protected under the EPBC Act.

3.4.1 Fauna habitat

Based on site visits and the vegetation survey, the following broad habitat types have been identified on the site:

- *Corymbia calophylla* low woodland
- Shrubland to tall open scrub (comprising either *Melaleuca rhaphiophylla, Melaleuca teretifolia* and / or *Acacia saligna*) over weeds
- *Jacksonia furcellata* tall shrubland over *Alexgeorgea nitens* closed sedgeland
- *Grevillea curviloba subsp. curviloba* open heath over *Xanthorrhoea preissii* low shrubland
- Low open banksia woodland.

3.4.2 Conservation significant fauna

Based on the following site investigations and desktop assessments, RPS has undertaken an assessment of the potential for significant fauna species to occur on the site. Species identified with the potential to occur within the site, based on species biology, habitat requirements, the quality and availability of suitable habitat and records of the species in the area that are listed under the *Biodiversity Conservation Act 2016* or EPBC Act are identified in Table 8.

The assessment concluded that one species was likely to visit the site while 15 species could possibly occur within the site.

Table 8: Conservation significant fauna species with potential to occur within the site

Species	Conservation status (state)	Conservation status (EPBC Act)	Habitat requirements	Site occurrence	Direct impacts	Significance of direct impacts
Carnaby`s Black-Cockatoo (*Calyptorhynchus latirostris*)	Schedule 2	Endangered	Carnaby's Black-Cockatoo is found in the south-west of Australia from Kalbarri through to Ravensthorpe. It has a preference for feeding on the seeds of *Banksia, Hakea, Eucalyptus, Grevillea, Pinus* and *Allocasuarina* spp. It is nomadic, often moving toward the coast after breeding. It breeds in tree hollows that are 2.5–12 m above the ground and have an entrance of 23–30 cm with a depth of 1–2.5 m. Nesting mostly occurs in smooth-barked trees (e.g. salmon gum, wandoo, red morrell) (PGV Environmental, 2019). The site is inside the boundary of the modelled distribution and breeding range for Carnaby's Black-Cockatoos (PGV Environmental, 2019).	Likely visitor to the site (foraging evidence identified during site survey)	Potentially clearing: • Up to 1.5 ha (48%) of native vegetation comprising potential foraging habitat • 14 (32%) potential breeding trees (subject to detailed landscape and engineering design)	• To assist in determining the significance of any impact on black cockatoo habitat on the site an assessment of black cockatoo habitat within 12 km of the site was undertaken. The total area of reserved bushland that contains habitat for black cockatoos within 12 km of the site is greater than 7,600 ha. • The black cockatoo habitat assessment identified approximately 2.9 ha of native vegetation containing foraging habitat for Carnaby's Black-Cockatoos and forest red-tailed black cockatoos, of this 1.5 ha has been identified for retention within the concept plan and of the 44 potential breeding trees, only 14 (32%) are being impacted. • Although nearly half of the potential foraging habitat and over 65% of the potential habitat trees are proposed to be retained on the site, impacting 1.4 ha of potential foraging habitat and 14 potential breeding trees may be considered a significant impact under the EPBC Act and a referral to the Commonwealth DEE may be required.
Forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*)	Schedule 2	Vulnerable	The range of forest red-tailed black cockatoos is bound by Gingin in the north to Mt Helena, Christmas Tree Well, West Dale, North Bannister, Mt Saddleback, Kojonup, Rocky Gully, upper King River and Green Range (east of Albany). It nests in tree hollows with a depth of 1–5 m, that are predominately marri, jarrah and karri and it feeds primarily on the seeds of marri and jarrah. The site is inside the modelled distribution for forest red-tailed black cockatoos (PGV Environmental, 2019).	Possible visitor to the site	Potentially clearing: • Up to 1.5 ha (48%) of native vegetation comprising potential foraging habitat • 14 (32%) potential breeding trees (Subject to detailed landscape and engineering design)	• To assist in determining the significance of any impact on black cockatoo habitat on the site an assessment of black cockatoo habitat within 12 km of the site was undertaken. The total area of reserved bushland that contains habitat for black cockatoos within 12 km of the site is greater than 7,600 ha. • The black cockatoo habitat assessment identified approximately 2.9 ha of native vegetation containing foraging habitat for Carnaby's Black-Cockatoos and forest red-tailed black cockatoos, of this 1.5 ha has been identified for retention within the concept plan and of the 44 potential breeding trees, only 14 (32%) are being impacted. • Although nearly half of the potential foraging habitat and over 65% of the potential habitat trees are proposed to be retained on the site, impacting 1.4 ha of potential foraging habitat and 14 potential breeding trees may be considered a significant impact under the EPBC Act and a referral to the DEE may be required.
Peregrine falcon (*Falco peregrinus*)	Schedule 7	-	Peregrine falcons are widely distributed throughout Australian habitats inclusive of woodlands, wetlands and open country, although they are generally absent from treeless and waterless deserts and dense forests. Peregrine falcons prefer cliff faces as nest sites (Birds Australia 2019).	May infrequently fly over or utilise the site.	Potentially clearing of native vegetation (subject to detailed landscape and engineering design)	• Peregrine falcons may be observed overflying the site or utilising it infrequently. However, given the substantial extent of potential habitat available within 12 km of the site, the peregrine falcon is considered unlikely to be significantly impacted by the proposed development of the site for residential purposes. • The development footprint incorporates 31.48 ha of 'Completely Degraded' vegetation and no vegetation in 'Good' or better condition. Consequently, the vegetation on site is unlikely to comprise significant habitat for this species.
Australasian bittern (*Botaurus poiciloptilus*)	Endangered	Endangered	In Western Australia, Australasian bitterns feed and breed in large, fresh to moderately brackish wetlands. Shallow water, less than 30 cm deep with a low to medium density of water plants mixed with, or near short fine sedges are favoured for foraging while higher density emergent vegetation is preferred for nesting (Department of Biodiversity, Conservation and Attractions, 2018)	Infrequent/opportunistic visitor – Potential habitat present in REW UFI 12283	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Australian painted-snipe (*Rostratula australis*)	Endangered	Endangered	The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and clay pans. They also use inundated or waterlogged grassland or saltmarsh, dams, rice crops, sewage farms and bore drains (DEE, 2019).	Infrequent/opportunistic visitor – Potential habitat present in REW UFI 12283	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Common sandpiper (*Actitis hypoleucos*)	-	Marine Migratory	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 (DEE, 2019).	Infrequent/opportunistic visitor – Potential habitat present in REW UFI 12283	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Sharp-tailed sandpiper (Calidris acuminate)	-	Marine Migratory	In Australasia, the sharp-tailed sandpiper prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergent sedges, grass, saltmarsh or other low vegetation (DEE, 2019).	Infrequent/opportunistic visitor – Potential habitat present in REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.

Species	Conservation status (state)	Conservation status (EPBC Act)	Habitat requirements	Site occurrence	Direct impacts	Significance of direct impacts
Curlew sandpiper (*Calidris ferruginea*)	Critically Endangered	Critically Endangered Marine Migratory	The curlew sandpiper is generally recorded near the coast, however are occasionally observed inland including around ephemeral and permanent lakes, dams, waterholes and bore drains, usually with bare edges of mud or sand and there is therefore potential for this species to occur within wetlands on the site (DEE, 2019)	Infrequent/opportunistic visitor – Potential habitat present in REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Common greenshank (*Tringa nebularia*)	-	Marine Migratory	The common greenshank is found in a wide variety of inland wetlands and sheltered coastal habitats of varying salinity. The species uses both permanent and ephemeral terrestrial wetlands, including swamps, lakes, dams, rivers, creeks, billabongs, waterholes and inundated floodplains, claypans and salt flats (DEE, 2019)	Potential habitat in REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Blue-billed duck (*Oxyura australis*)	Priority 4	-	The blue-billed duck is almost entirely aquatic, preferring habitats with deeper water (Birdlife Australia, 2019).	Infrequent/opportunistic visitor – Potential habitat present in REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Glossy ibis (*Plegadis falcinellus*)	-	Marine Migratory	The glossy ibis' preferred habitat for foraging and breeding are fresh water marshes at the edges of lakes and rivers, lagoons, flood plains, wet meadows, swamps, reservoirs, sewage ponds, rice-fields and cultivated areas under irrigation (DEE, 2019).	Infrequent/opportunistic visitor – Potential habitat present in REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Southwestern brown bandicoot (*Isoodon fusciventer*)	Priority 4	-	Southwestern brown bandicoots are broadly distributed near the south-west coast from Guilderton, north of Perth, to east of Esperance with a more patchy distribution through the jarrah and karri forests, Swan Coastal Plain and inland regions. They are generally found in scrubby, often swampy, vegetation with dense cover up to 1 m high and on the Swan Coastal Plain are often associated with wetlands (Department of Environment and Conservation 2012).	Potential habitat on site, particularly around wetlands and more densely vegetated areas. Areas proposed to be cleared are unlikely to comprise significant habitat for this species due to the degraded condition.	No direct impacts.	• The high levels of disturbance across the majority of the site, as well as the likely presence of introduced predators such as cats and foxes, would limit the population size of this species on the site. However, there is potential habitat for this species present on the site, particularly associated with the wetlands and denser areas of vegetation. • The potentially significant habitat associated with the wetlands and denser areas of vegetation is being retained within the POS and conservation areas. The development footprint incorporates 31.48 ha of Completely Degraded vegetation and no vegetation in Good or better condition. Consequently, the vegetation on site is unlikely to comprise significant habitat for this species, which prefers dense vegetation cover. • Considering the habitat being retained on the site and area of potential habitat present within 12 km of the site, the proposal is unlikely to have a significant impact on this species (if present on the site).
Water rat (*Hydromys chrysogaster*)	Priority 4	-	The water rat inhabits permanent water bodies and there is potential habitat for this species within REW 12283.	Potential to occur within REW (UFI 12283).	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Blackstriped dwarf galaxias (*Galaxiella nigrostriatal*)	Endangered	Endangered	The blackstriped dwarf galaxias inhabits coastal wetlands of south-west Western Australia. During summer when ephemeral pools dry out, individuals burrow into the moist soil below to aestivate until the rains return in autumn (Bray, 2019).	Potential to occur within REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas.
Western swamp tortoise (*Pseudemydura umbrina*)	Critically Endangered	Critically Endangered	Ellen Brook Nature Reserve population is the only viable, naturally occurring population in the wild. The Twin Swamps Nature Reserve and Mogumber Nature Reserve populations are maintained with translocated individuals.	Potential to occur within REW (UFI 12283)	No direct impacts.	No direct impacts are anticipated as a result of the proposal as all wetland habitat potentially suitable for this species is being retained within conservation and POS areas. Furthermore, the DBCA propose to survey REW (UFI 12283) for the western swamp tortoise. If the western swamp tortoise is identified during the DBCA survey, they will be relocated by DBCA to more suitable habitat. Specifically, the western swamp tortoise would be move to the nature reserves managed by the Department. DBCA manage these reserves specifically for the benefit of the western swamp tortoise. Alternatively, consistent with the revised Recovery Plan the tortoise DBCA could choose to re-locate any found western swamp tortoise to the Perth Zoo as part of their captive breeding program with the University of Western Australia.
Black-striped snake (*Neelaps calonotos*)	Priority 3	-	This species occurs in the sandy coastal strip of dune habitat between Mandurah and Lancelin on dunes and sandplains vegetated with heaths and eucalypt/Banksia woodlands. There is potential habitat within the sandy areas on site.	There is potential habitat within the sandy areas on site.	Potentially clearing of native vegetation (subject to detailed landscape and engineering design)	• The total area of reserved bushland within 12 km of the site is greater than 7,600 ha. • The development footprint incorporates 31.48 ha of 'Completely Degraded' vegetation and no vegetation in 'Good' or better condition. Consequently, the vegetation on site is unlikely to comprise significant habitat for this species and the proposal is unlikely to have a significant impact on this species.

3.4.3 Western swamp tortoise (*Pseudomydura umbrina*)

Lots 29 and 30 are adjacent to the Western Swamp Tortoise Policy 2011 buffer boundary (Figures 1 and M).

There are no historical records of the western swamp tortoise occurring within the site, however, in discussions with DBCA there is the potential of the tortoise to occur within the Lot 30 REW (UFI 12283).

In liaison with DBCA it was proposed to undertake an assessment of the REW (UFI 12283) at the northern boundary of Lot 30 to confirm the presence or absence of this species. If the western swamp tortoise is identified, it will be relocated by DBCA to more suitable habitat. Specifically, the western swamp tortoise would be move to the nature reserves managed by the Department. DBCA manage these reserves specifically for the benefit of the western swamp tortoise, this includes monitoring water quantity and quality, fire management, predator control, weed control, revegetation and implementing dieback hygiene procedures. Predator management includes fox-proof fencing around both the reserves near Perth, fox, rat and feral cat control, and quenda removal from inside the fenced reserves. Alternatively, consistent with the revised Recovery Plan the tortoise DBCA could choose to re-locate any found western swamp tortoise to the Perth Zoo as part of their captive breeding program with the University of Western Australia.

The EPA's Guidance Statement for the Protection of the Western Swamp Tortoise Habitat (EPA 2005) specifies a buffer to REWs within the policy boundary as 50 m. Consequently, a buffer of 50 m from the mapped REW boundary has been incorporated into the Concept Plan, as well as a further interface treatment of a 20 m road reserve.

The Guidance Statement also specifies a development setback of 100 m from the boundary of the Ellen Brook and Twin Swamps Nature Reserves. As Lots 29 and 30 are approximately 1 km south of the Twin Swamps Nature Reserve and over 1.5 km north of the Ellen Brook Nature Reserve, this requirement has been complied with.

3.4.4 Black cockatoos

PGV Environmental undertook a black cockatoo habitat assessment of the site on 30 July 2019 (Appendix B).

The assessment included a survey of the potential foraging, roosting and breeding habitat on the site for Carnaby's Black-Cockatoo, Baudin's black cockatoo and the forest red-tailed black cockatoo. Results of this survey are summarised below.

3.4.4.1 Potential foraging habitat

PGV Environmental recorded the following five plant species on the site which are known to be used by black cockatoos for foraging:

- Candlestick Banksia (*Banksia attenuata*)
- Firewood Banksia (*Banksia menziesii*)
- Marri (*Corymbia calophylla*)
- Blackbutt (*Eucalyptus todtiana*)
- Grass tree (*Xanthorhoea preissii*).

Evidence of foraging observed during the survey included:

- Foraging on marri nuts and Banksia cones.

The majority of potential foraging habitat is located on the northern portion of Lot 29. The key foraging species consist primarily of two stands of marri trees. The Banksia and blackbutt trees are restricted to a small area along the eastern boundary of Lot 29 (Figure L).

The area of potential foraging habitat on site is approximately 2.9 ha, of this 1.4 ha (48% of the overall foraging habitat) is proposed to be retained within POS and conservation areas (Figure L).

Marri and Banksia trees are considered to be a 'High Resource' for black cockatoos and therefore the scattered foraging habitat on the site is considered to be 'quality' foraging. The *Xanthorrhoea preissii* and *Eucalyptus todtiana* plants on the site are considered low value foraging habitat (PGV Environmental, 2019).

3.4.4.2 Potential breeding habitat

The site does not contain any known black cockatoo breeding habitat, with the nearest confirmed breeding sites for the Carnaby's Black-Cockatoos located approximately 15 km to the north and 16 km to the southeast. The survey did not observe any evidence of current or past breeding by black cockatoos on the site.

Forty four (44) potential breeding habitat trees (certain tree species with a DBH of 500 mm or greater) were recorded on this site, comprising (Figure L):

- 38 marri trees
- Three flooded gums
- Three standing dead trees.

Two of these trees were recorded as containing a potential hollow or spout. However, these were recorded from the ground and their suitability as black cockatoo breeding habitat was not able to be determined and there were no obvious chew marks on the rim of the hollows that indicate recent or past use by black cockatoos. Other hollows may be present that are not visible from the ground.

Of the 44 trees identified during the survey, 30 will be retained within conservation and POS areas.

3.4.4.3 Roosting habitat

There are no confirmed or unconfirmed roost sites for Carnaby's Black-Cockatoos on the site, with nearest confirmed roost site for Carnaby's Black-Cockatoos located approximately 8 km to the south-west in the Gnangara Pine Plantation (PGV Environmental, 2019).

No roosting by Carnaby's or forest red-tailed black cockatoos has been recorded on the site during the Great Cocky Count and the survey did not observe any evidence of roosting by Carnaby's or forest red-tailed black cockatoos on the site (PGV Environmental, 2019).

3.4.4.4 EPBC Act context

The Commonwealth's revised draft referral guideline for three threatened black cockatoo species: Carnaby's Black-Cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (Vulnerable) *Calyptorhynchus baudinii*, forest red-tailed black cockatoo (Vulnerable) *Calyptorhynchus banksii nas*o specifies actions that are at risk of having a significant impact on black cockatoos. PGV Environmental undertook an assessment of the potential back cockatoo habitat on the site against these guidelines. The assessment is summarised Table 9 below.

Table 9: Assessment of significance of impacts to potential black cockatoo habitat

Habitat type	Significance criteria	Black cockatoo habitat		Significance assessment
		Retained within POS and conservation areas	Impacted	
Potential foraging (quality habitat)	The Referral Guidelines state that clearing more than 1 ha of quality foraging habitat constitutes a high risk of a significant impact.	1.4 ha (48%)	1.5 ha (52%)	Clearing 1.5 ha of quality foraging habitat will exceed the 1 ha guideline and may be considered a significant impact.
Potential roosting	The Referral Guidelines consider the clearing or degradation (including pruning the top canopy) of a known night roosting site as a high risk of being a significant impact.	None recorded	None recorded	The site does not contain a known roosting site and therefore, development of the site would not lead to a significant impact on any roosting habitat.
Potential breeding	The Referral Guidelines state that the following constitutes a high risk of a significant impact: • Clearing of any known nesting tree • Clearing or degradation of any part of a vegetation community known to contain breeding habitat	30 (68%)	14 (32%)	There are no known nesting trees that occur on the site. However, development of the concept plan will involve clearing 14 potential breeding trees. As the site is within the range for both the Carnaby's Black-Cockatoo and forest red tailed black cockatoo, clearing these potential breeding trees may be considered a significant impact.

The Concept Design (adopted within the DSP) has been designed to retain the majority of environmental values identified on site including black cockatoo habitat. The potential impacts to the black cockatoo foraging and roosting habitat, while they have been minimised as part of the site assessment and subsequent concept design should also be reviewed in the local and regional context. The total area of reserved bushland that contains habitat for black cockatoos within 12 km of the site is greater than 7,600 ha.

A future Local Structure Plan (LSP) and subdivision design will consider as part of the detailed planning and design the further retention of trees and foraging habitat.

After the finalising of the LSP an assessment of the potential impacts on the black cockatoo habitat will be undertaken in accordance with the Commonwealth's Department of Environment and Energy's (DEE) black cockatoo referral guidelines.

4 WATER FACTOR

4.1 Inland waters

4.1.1 Groundwater

The site is located within the Swan groundwater area and the following sub-areas (DWER 2019a):

- Unconfined Superficial Aquifer: North Swan sub-area
- Semi-confined Mirrabooka Aquifer: North Swan sub-area
- Confined Leederville Aquifer: Swan confined sub-area.

The Superficial Aquifer across the Gnangara Mound has an average thickness of approximately 45 m and a maximum thickness of approximately 75 m. This aquifer comprises the Quaternary–Tertiary sediments of the coastal plain, and consists of Safety Bay Sand, Becher Sand, Tamala Limestone, Bassendean Sand, Gnangara Sand, Guildford Clay, Yoganup Formation and Ascot Formation. Groundwater recharge results directly from rainfall infiltration and there is some leakage into underlying aquifers (Department of Water 2009).

The Mirrabooka Aquifer is a locally important, semi-confined to confined aquifer, and ranges in thickness to a maximum of 160 m. This aquifer comprises the Cretaceous Poison Hill Greensand, Gingin Chalk, Molecap Greensand and Mirrabooka Member of the Osborne Formation. The Mirrabooka Aquifer is recharged from the downward component of groundwater flow from the overlying Superficial Aquifer. Much of the throughflow in the Mirrabooka Aquifer eventually discharges by upward leakage into the Superficial Aquifer (Department of Water 2009).

The Leederville Aquifer is of Cretaceous age and consists of interbedded sandstone, siltstone and shales made up by the Mariginiup, Wanneroo, Pinjar and Henley Sandstone Members. It ranges in thickness to a maximum of 550 m and is separated from the overlying Superficial Aquifer by the Kardinya Shale, which acts as a confining layer between the two aquifers (Davidson and Yu 2008).

The Water Register (DWER 2019a) identifies that groundwater within the North Swan and Swan Confined sub-areas is fully allocated.

4.1.1.1 Groundwater depth, flow and quality

Regional groundwater mapping from the Perth Groundwater Map (which provides indicative levels only) shows that the historical maximum groundwater levels of the Superficial Aquifer range from 21 m AHD in the south-east to 26 m AHD in the north-west the site (DWER 2019b). Groundwater contours indicate a general south-easterly flow across the site towards Sawpit Gully and Ellen Brook (DWER 2019b).

The Perth Groundwater Map (DWER 2019b) identifies the following physiochemical information for the groundwater below the site:

- Salinity is estimated to vary from between 250–500 mg/L (fresh) for the majority of the site increasing to between 500–1,000 mg/L (marginal) in the site's south-east
- Low risk of iron staining
- Unsuitable for additional garden bores (due to groundwater availability)
- Not within a Public Drinking Water Source Area.

4.1.2 Watercourses

The Maralla Creek watercourse is approximately 0.4 m in depth and mapped as extending from Lot 30 (within the site) and discharging into Sawpit Gully (Figure M). This remnant creek line within Lot 30 was historically cleared for agricultural land uses and there is no riparian or native vegetation within the creek line. It is now essentially an intermittent agricultural drain.

4.1.3 Wetlands

DBCA employs a tiered approach for evaluating wetlands. This approach is widely used to identify highly valuable wetlands that should receive the greatest protection, moderately valuable wetlands that need rehabilitation and the least valuable wetlands where alterations may be allowed, perhaps with some conditions

This tiered approach resulted in the creation of three evaluation/management categories for wetlands: Conservation Category Wetland (CCW), REW and Multiple Use wetland (MU) (Table 10).

Table 10: Management objectives of the wetland categories

Management category	General description	Management objectives
CCW	Wetlands support a high level of ecological attributes and functions	Highest priority wetlands. Objective is preservation of wetland attributes and functions through various mechanisms including: • Reservation in national parks, Crown reserves and state-owned land • Wetland covenanting by landowners. These are the most valuable wetlands and the Commission will oppose any activity that may lead to the further loss or degradation. No development.
REW	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is for management, restoration and protection towards improving their conservation value. These wetlands have the potential to be restored to conservation category. This can be achieved by restoring wetland structure, function and biodiversity. Protection is recommended through a number of mechanisms.
MU	Wetlands with few important ecological attributes and functions remaining	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through land care. Should be considered in strategic planning.

Source: Water and River Commission 2001

4.1.3.1 Detailed wetland description

Three geomorphic wetlands are located within the site, two REWs and one MU wetland (Figure M). Vegetation structure across the REWs is severely altered with vegetation condition ranging from ‘Degraded’ to ‘Completely Degraded’.

4.1.3.1.1 MU wetland (UFI 15732)

This MU wetland covers a central portion of the site as part of a broader 13,742 ha palusplain system. Within the site, the majority of the vegetation associated with MU wetland was mapped as cleared pasture in a ‘Completely Degraded’ condition (Figure J).

4.1.3.1.2 REW (UFI 12444)

The REW is located entirely within the northern half of Lot 29 and covers an approximate 1.07 ha area extent. The vegetation within REW was mapped as ‘Degraded’ to ‘Completely Degraded’ condition (Figure J). This wetland, including its 30 m buffer, is being retained within the conservation POS on site.

4.1.3.1.3 REW (UFI 12283)

A 1.20 ha portion of REW (UFI 12283) intersects the northern boundary of Lot 30. Within the site, the vegetation within REW (UFI 12283) was mapped as being in 'Degraded' condition (Figure J). This wetland, including its 50 m buffer, is being retained within the site

4.1.3.2 Water quality treatment and drainage

A District Water Management Strategy (DWMS) is being prepared for the North Ellenbrook (east) DSP. The development drainage management outcome for Lots 29 and 30 will be consistent with the DWMS. The DWMS specifies that development at the site will:

- Consider water sensitive urban design (WSUD) principles and ensure that development is consistent with current best management practices and best planning practices for the sustainable use of water resources, particularly stormwater.
- Seek to achieve no net difference in water quality and quantity, unless necessary to meet identified environmental water requirements, such that post-development water quality and quantity conditions are equal to or better than pre-development conditions.
- Promote management of the urban water cycle as a single system in which all urban water flows are recognised as a potential resource and where the interconnectedness of water supply, stormwater, wastewater, flooding, water quality and wetlands is recognised.
- Maximise the opportunities for compliance with best practice stormwater management, including infiltration/detention of stormwater on site/ at the source.
- Promote water conservation mechanisms that increase the efficiency of the use of water including stormwater.
- Incorporate the reuse and recycling of water, where possible, particularly stormwater and grey water, consistent with state water strategy recycling objectives. Alternative non-potable water sources could also be considered where appropriate for fit for purpose use.
- Promote the retention and use of local native vegetation in developments to minimise water use and maximise filtration, particularly where landscaping is proposed.
- Any water reuse and recycling of water, in particular wastewater, will be undertaken with consideration of restrictions in drinking water areas (as per WQPN 25: Land Use Compatibility in public drinking water source areas).

5 PEOPLE FACTOR

5.1 Social surroundings

5.1.1 Aboriginal heritage and culture

A search of the DPLH Aboriginal Heritage Inquiry System undertaken on in October 2019 identified one registered heritage site of mythological significance (ID 3525; Ellen Brook: Upper Swan) is mapped over the extent of the site and the North Ellenbrook (east) DSP landholdings.

RPS has reviewed recent Aboriginal Heritage assessment in the local area including the 2014 Amergin Consulting (Australia) Pty Ltd assessment undertaken for the NorthLink WA Project (Perth–Darwin National Highway). This report detailed earlier heritage assessment completed by heritage consultant Edward McDonald (1989) and Rory O'Connor.

McDonald (1989) reported in relation to heritage site 3525; Ellen Brook: Upper Swan reported that Ellen Brook (Gynning) is a mythological site associated with the spiritual 'turtle' and plays a mythological role as their Dreaming Track. He noted that Ellen Brook is also part of the greater system of waterways associated with the Rainbow Serpent or Waugal.

Between 1985 and 2005 heritage consultant Rory O'Connor undertook a number of consultations in relation to Ellen Brook. For example, in 1987 he and Corrie Bodney conducted a survey for Aboriginal sites at a proposed mineral sands plant site at Muchea. O'Connor reported that:

> The Aboriginal people consulted were satisfied that no sites of cultural significance were located within the area of proposed development. However … Ellen Brook is an area of current interest, due to its association with a Waugal myth. Accordingly, the people interviewed requested that the Brook and its banks should remain undisturbed, and that a reasonable buffer zone should be maintained between it and the proposed development at all times (O'Connor and Quartermaine 1987).

Historically, the focus of the heritage sites has been focused upon the wetlands and waterways. Noting, within the site, the mapped wetlands are being retained.

A suitably qualified Aboriginal heritage consultant will be appointed to investigate the significance of the registered Ellen Brook: Upper Swan site and determine if Section 18 approval is required under the *Aboriginal Heritage Act 1972* to facilitate earthworks.

5.1.2 Natural and historical heritage

Searches of the Heritage Council's Inherit database and the CoS' Heritage List was undertaken on 8 October 2019, with no matches recorded for the site.

5.1.3 Amenity

5.1.3.1 Railway noise

An existing freight railway line lies approximately 60 m east of the site within a gazetted MRS Railways reserve. The freight railway line is separated from the site by Railway Parade.

The results from Herring Storer's freight rail line noise assessment indicate that noise emissions received at residences located adjacent to the rail line would exceed the defined "Noise Targets" outlined in SPP 5.4.

As the construction of the rail line has already been undertaken, noise levels at the proposed North Ellenbrook (east) DSP residential development were not been considered by the infrastructure provider. Acknowledging this outcome, and the need for noise mitigation, the Herring Storer acoustic modelling a scenario where a 2.4 m noise wall was installed at the boundary of the site (Lot 29). With the inclusion of this

noise wall barrier, Herring Storer concluded, that noise levels are attenuated sufficiently to enable residential development behind the wall to meet SPP 5.4 noise criteria. Whilst there is a reduction in noise levels by the barrier, the acoustic report outlines that there would still be the requirement for these premises to incorporate quiet house design and notifications on titles (Herring Storer 2019).

5.1.3.2 Ellenbrook Speedway

Ellenbrook Speedway is located approximately 440 m from the south eastern boundary of the site. The speedway operates 12 to 14 meets from April to October with most of the events held during the day (on Sundays with racing commencing at 11.30 am). All speedway meetings are conducted according to the state noise regulations and in accordance to a noise management plan. Race officials give full support to noise control monitoring procedures.

It is noted there are existing sensitive land uses (houses) approximately 400 m from the speedway. This urban development located approximately 400 m from the speedway was approved based upon a detailed noise assessment.

Based on Herring Storer's acoustic assessment on specifically noise generated from the speedway, noise emissions at the site boundary (Lot 29) would be less than 55 dB(A). For comparison, an individual 2-minute train pass at this same location would be around 75 dB(A). Therefore, noise levels for the train line would be considered higher than noise levels associated with the speedway (Herring Storer 2019).

The acoustic assessment determined the potential off-site mechanisms for mitigation for the freight rail line noise (e.g. noise walls, building design and materials etc) would mitigate the episodic noise emissions from the speedway.

5.1.3.3 RAAF Base Pearce

RAAF Base Pearce is located approximately 5.5 km north of the site. The airbase aircraft noise management plan shows that the 20 Australian Noise Exposure Forecast (ANEF) contour is located approximately 3.5 km to the north of the site. The proposed development is located outside the ANEF 20 contour. Therefore, residential development (without any noise amelioration) is acceptable within the development.

5.1.4 Bushfire

The WAPC released SPP 3.7: Planning in Bushfire Prone Areas to reduce the risk of bushfire to people, property and infrastructure. SPP 3.7 defines a bushfire-prone area as an area that has been designated by the Fire and Emergency Services Commissioner under Section 18 of the *Fire and Emergency Services Act 1998* (as amended) as an area that is subject, or likely to be subject, to bushfires.

A search of the Department of Fire and Emergency Services' (DFES) Map of Bushfire Prone Areas identified that portions of the site which are primarily associated with areas of remnant vegetation are mapped as a Bushfire Prone Area (Figure N).

A bushfire assessment and plan will be prepared for the North Ellenbrook (east) DSP.

To address SPP 3.7 requirements, a bushfire management plan will be prepared for the site which provides:

- A bushfire hazard level assessment / Bushfire Attack Level (BAL) contour map
- Consideration for bushfire protection criteria.

A site specific BAL and bushfire management plan will be prepared for the site as part of a future LSP approval consistent with SPP 3.7 requirements.

6 ENVIRONMENTAL IMPACTS AND PROPOSED MANAGEMENT

6.1 Potential environmental impacts and proposed management measures

The following key environmental factors are considered applicable to the site:

- Flora and vegetation
- Terrestrial environmental quality
- Terrestrial fauna
- Inland waters
- Social surroundings.

Table 11 summarises the potential impacts to the environmental factors from the proposed land use change and recommends management measures to mitigate the potential environmental impacts.

Table 11: Summary of the potential environmental impacts and proposed mitigation measures

Flora and vegetation	
EPA objective	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
Policy and guidance	• *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Flora and Vegetation (EPA 2016a) • Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b)
Potential impacts	• Direct impacts include: – Clearing 11.3 ha of vegetation • Potential indirect impacts to vegetation and flora retained within the concept design include: – Introduction of weeds and disease – Increased risk of fire and altered fire regimes – Accidental clearing during construction activities of vegetation and flora identified for retention
Mitigation	The following management measures, in regard to the interface treatment with the *Grevillea curviloba* subsp. *curviloba* populations, subject to DBCA agreement include: • A temporary fence will be installed approximately 10 m from the surveyed to *Grevillea curviloba* subsp. *curviloba* populations to avoid impacts to the two populations during construction activities. This temporary fence will be maintained until the permanent wall and fence is installed (at the buffer boundary) during residential development. • No livestock will be permitted within Lot 29 • A DBCA agreed buffer will be established between the *Grevillea curviloba* populations and residential development, the buffer will incorporate conservation area and POS area. Additional interface treatments include a hard wall and road reserve. This approach is similar to the Annie's Landing interface with *Grevillea curviloba* which was approved and adopted to the south of the site. • A consolidated conservation area consisting of the following significant elements is incorporated into the concept design – *Grevillea curviloba* subsp. *curviloba* populations and conservation area –2.39 ha – REWs and 30 m buffer (UFI 12444) – approximately 2.39 ha – The consolidated conservation area will be surrounded by managed POS – approximately 2.81 ha. • Depending upon the DBCA's long term management objectives, the *Grevillea curviloba* subsp. *curviloba* populations and buffer could be created as a separate Lot and then handed over to the DBCA for long term management. Alternatively, the entire consolidated conservation area inclusive of the *Grevillea curviloba* subsp. *curviloba* populations and the REW and 30 m buffer (but excluding the public open space area) could be treated as a single lot and transferred to the DBCA for long term management. If the Department determined that it did not want to manage the REW, then LWP would, as per standard subdivision arrangements, hand over the wetland and the buffer to the CoS for long term management. • Preparation and implementation of a bushfire management plan. • The following management measures will also reduce potential indirect impacts to the wetland vegetation proposed to be retained on the site, further management measures specific to the REWs include: • The landowner will prepare and implement a REW Management Plan for both wetland areas, as part of the development process.

	• A 50 m REW buffer and additional road reserve interface between the proposed development and REW (UFI 12283) (in Lot 30). • A 30 m REW buffer and additional POS and road reserve interface between the proposed development and REW (UFI 12444) (in Lot 29). • The proposed interface treatment and consolidated conservation area concept is reflected in the Concept Plan provided in Figure E. This conservation outcome has been adopted in the North Ellenbrook (east) DSP.
Outcome	• Overall, Lot 29 will provide 4.8 ha dedicated to the *Grevillea curviloba* subsp. *curviloba* populations and the REW. This total increases to 7.6 ha including the area of POS adjacent to the buffers. • With the proposed management and mitigation measures implemented, RPS considers that the EPA's flora and vegetation objective can be met.

Terrestrial environmental quality

EPA objective	To maintain the quality of land and soils so that environmental values are protected	
Policy and guidance	Acid Sulfate Soils	• Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016c). • Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (Department of Environmental Regulation (DER) 2015a). • Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DER 2015b).
	Potential contamination	• *Contaminated Sites Act 2003* • Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016c) • Assessment and Management of Contaminated Sites (DER 2014) • Identification, Reporting and Classification of Contaminated Sites in Western Australia (DER 2017)
Potential impacts	Acid Sulfate Soils	Acidification and release of heavy metals from ASS into groundwater.
	Potential contamination	• No known contaminated sites are located within the site • Due to the presence of buildings on Lot 30, there is potential for localised contamination to be present on the site.
Mitigation	Acid Sulfate Soils	• Final fill levels and subsequent excavation (e.g. for sewer lines/engineering services and dewatering requirements) will dictate future ASS management requirements. • Appropriate ASS management plan will be prepared at subdivision stage to support the proposed engineering approach (if required).
	Potential contamination	• Any dumped rubbish within the site should be identified and relocated to an appropriate landfill facility prior to commencement of earthworks. • Clean fill certification to be provided for all imported fill materials to prevent the introduction of potential contaminants.
Outcome	With appropriate management it is considered that the quality of land and soils will be protected from significant harm so that EPA's terrestrial environmental quality objective is met	

Terrestrial fauna

EPA objective	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained
Policy and guidance	• *Environment Protection and Biodiversity Conservation Act 1999* • Revised draft referral guideline for three threatened black cockatoo species: Carnaby's cockatoo (Endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (Vulnerable) *Calyptorhynchus baudinii*, forest red-tailed black cockatoo (Vulnerable) *Calyptorhynchus banksii naso* (DEE 2017) • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Terrestrial Fauna (EPA 2016d)
Potential impacts	• The fauna and botanical surveys undertaken on the site identified the following potentially significant impacts to fauna and fauna habitat – Clearing 1.5 ha of potential black cockatoo foraging habitat – Clearing 14 potential breeding trees – Indirect impacts to potential western swamp tortoise habitat (a survey by the DBCA will be undertaken to confirm whether this wetland contains western swamp tortoise). • The following minor impacts may be realised as a result of developing the site in accordance with the Concept Plan – Injury and/or mortality during clearing activities and construction – Disturbance during construction (clearing activities and noise) may affect the local abundance of fauna populations due to interruption to fauna behaviour – Potential degradation to retained vegetation and fauna habitat through edge effects such as the spread of weeds and disease, altered hydrology, increased risk of fire and altered fire regimes.
Mitigation	• Retention of 1.4 ha (or 48% of the foraging habitat identified on site) of potential black cockatoo foraging habitat • Retention of 30 (or 68% of the potential breeding trees identified on site) potential black cockatoo breeding trees • Retention of 10.65 ha of native vegetation, including two REWs (with buffers) and upland vegetation comprising potential fauna habitat • The DBCA propose to undertake a survey of REW (UFI 12283) for the western swamp tortoise. If identified within the wetland, individuals will be relocated to more suitable habitat, with better conservation and protection for the species.
Outcome	• Through the retention of 48% of the potential black cockatoo foraging habitat and 68% potential black cockatoo breeding habitat identified on site, the potential impacts to terrestrial fauna will be managed to be as low as reasonably practicable and it is considered that biological diversity and ecological integrity will be maintained so that EPA's terrestrial fauna objective is met. • A future LSP and subdivision design will consider as part of the detailed planning and design the further retention of trees and foraging habitat. After the finalising of the LSP an assessment of the potential impacts on the black cockatoo habitat will be undertaken in accordance with the Commonwealth's DEE black cockatoo referral guidelines. • LWP will liaise with DBCA to co-ordinate an assessment of the REW (UFI 12283) at the northern boundary of Lot 30 to confirm the presence or absence of this species. If the western swamp tortoise is identified, it will be relocated by DBCA to more suitable habitat. Specifically, the western swamp tortoise would be move to the nature reserves managed by the Department. DBCA manage these reserves specifically for the benefit of the western swamp tortoise. Alternatively, consistent with the revised Recovery Plan the tortoise DBCA could choose to re-locate any found western swamp tortoise to the Perth Zoo as part of their captive breeding program with the University of Western Australia.

Inland waters		
EPA objective	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected	
Policy and guidance	• Environmental Factor Guideline – Inland Waters (EPA 2018) • Better Urban Water Management (WAPC 2008)	
Potential impacts	• Alteration of the existing landscape which in turn may alter surface water flow paths and recharge locations during rainfall. • Removal of vegetation and installation of impervious surfaces can lead to an increase in run-off during rainfall events. • Pollutants (nutrients, litter etc) in stormwater runoff from the residential development may impact surface water and groundwater values. • REWs have been retained within the proposed Concept Design, however potential indirect impacts to REWs include – Changes in the quality and / or quantity of stormwater run-off entering the REWs present on site. – Disturbance of acid sulfate soils during construction and earthworks – Introduction of weeds and / or disease impacting wetland vegetation – Increased risk of fire impacting wetland vegetation – Accidental clearing of wetland vegetation during construction – Dust and erosion during construction impacting water quality during construction activities.	
Mitigation	• DWMS is being prepared to provide an overview of the integrated management of groundwater and surface water that will be implemented at the site in line with the Better Urban Water Management principles. • A Local Water Management Strategy (LWMS) will be prepared to support the proposed Local Structure Plan. • Urban Water Management Plan(s) (UWMP) to be prepared at subdivision stage (to the satisfaction of the City of Swan, on advice from the DWER). • A Wetland Management Plan will be prepared to address potential indirect impacts to wetlands retained within the Concept Design	
Outcome	• Through the implementation of the DWMS and future LWMS and UWMP(s), the potential hydrological impacts will be managed to ensure pre hydrological regimes are maintained • The objectives of the DWMS and LWMS and the specific management strategies including engineering drainage requirements and landscape actions within drainage basins will be implemented through future UWMP(s).	
Social surroundings		
EPA objective	To protect social surroundings from significant harm	
Policy and guidance	**Aboriginal heritage and culture**	• *Aboriginal Heritage Act 1972* • Environmental Factor Guideline Social Surroundings (EPA 2016e)
	Noise	• Environmental Factor Guideline Social Surroundings (EPA 2016e) • Environment Protection (Noise) Regulations 1997 • SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning
	Bushfire	• *Fire and Emergency Services Act 1998* • Environmental Factor Guideline Social Surroundings (EPA 2016e) • SPP 3.7: Planning in Bushfire Prone Areas • Guideline for Planning in Bushfire Prone Areas, Version 1.3 (DPLH and DFES 2017)

Potential impacts	**Aboriginal heritage and culture**	Excavation and / or construction activities may unearth and / or damage artefacts or other items of Aboriginal cultural significance
	Noise	Ongoing exposure of future residents to the rail-related noise
	Bushfire	• Damage to people, property and infrastructure from fire • Death and/or injury due to fire
Mitigation	**Aboriginal heritage and culture**	• A suitably qualified Aboriginal heritage consultant will be appointed to investigate the significance of the registered mythological Ellen Brook: Upper Swan site and determine if Section 18 approval is required under the *Aboriginal Heritage Act 1972* to facilitate earthworks • Should any Aboriginal objects be identified or unearthed during construction and earthworks activities, construction will be ceased, and the findings be reported to the DPLH
	Noise	• A noise and vibration assessment have been undertaken by Herring Storer in accordance with SPP 5.4: to determine the baseline noise impacts and to address any management requirements (i.e. noise walls and possibly quiet house design) to mitigate the impacts from noise and vibration from the freight railway. The acoustic modelling included assessing the implementation of a 2.4 m noise wall at the boundary of the site (Lot 29) for noise mitigation. • With the inclusion of this noise wall barrier, Herring Storer concluded, that noise levels are attenuated sufficiently to enable residential development behind the wall to meet SPP 5.4 noise criteria. Whilst there is a reduction in noise levels by the barrier, the acoustic report outlines that there would still be the requirement for these premises to incorporate quiet house design and notifications on titles (Herring Storer 2019). • The acoustic assessment addressed the noise emissions from the Ellenbrook Speedway and determined the potential off-site mechanisms for mitigation for the freight rail line noise (e.g. noise walls, building design and materials etc) would address the episodic noise emissions from the speedway.
	Bushfire	• A Bushfire Management Plan will be prepared to provide the bushfire management framework proposed to be actioned as part of developing the site at the LSP stage to the satisfaction of the DFES and the WAPC • BAL contour mapping within the Bushfire Management Plan will be updated (if required) to reflect the proposed subdivision outcomes
Outcome	Through the implementation of the proposed mitigation measures the potential impacts to Aboriginal heritage and culture, noise and bushfire have been / will be managed to be as low as reasonably practicable through engineering design and subdivision approval process.	

7 CONCLUSION

Table 11 provides a summary of the potential impacts, proposed mitigation measures and predicted outcomes for the EPA's environmental factors of specific relevance to the site. The key factors include:

- **Flora and vegetation**
  - Two populations of the Threatened (Declared Rare) species *Grevillea curviloba* subsp*. curviloba* are located within Lot 29 (Figure K). RPS and PVG Environmental met with DBCA officers on site in October 2019 to review the existing vegetation and the *Grevillea curviloba subsp. curviloba* population
  - The proposed conservation and interface treatments to manage this population was at and reviewed at a site meeting with DBCA officers. The key interface management measures were discussed in the context of LWP's and DBCA's previous experience in managing the *Grevillea curviloba subsp. curviloba* species within the Annie's Landing subdivision.
  - The key management measures include
    - Avoidance of any direct impact
    - No livestock will be permitted within Lot 29
    - A temporary fence will be installed approximately 10 m from the surveyed to *Grevillea curviloba* subsp*. curviloba* populations to avoid impacts to the individual grevillea population
    - This temporary fence will be maintained until the permanent wall and fence is installed (at the 10 m buffer boundary) during residential development
    - LWP will install a hard wall at the edge of the 10 m buffer surrounding the *Grevillea curviloba* subsp. *curviloba* populations, with an access point consistent with the Annie's Landing management approach. A road is proposed adjacent (on the residential development side) to the hard wall
    - RPS will issue the DBCA with the detailed flora and vegetation assessment report inclusive of the *Grevillea curviloba* subsp*. curviloba* populations boundary
    - Protection *of Grevillea curviloba* subsp*. curviloba* populations and buffer – approximately 2.40 ha
  - Protection of REWs (UFI 12283 and UFI 12444) and buffers (50 m and 30 m) – approximately – 5.46 ha
    - The consolidated conservation area will be surrounded by managed public open space – approximately 2.39 ha
    - Conservation POS area is 10.65 ha
    - Depending upon the DBCA's long term management objectives, the *Grevillea curviloba* subsp. *curviloba* populations and buffer could be created as a separate 'Reserve' and then handed over to the DBCA for long term management. Alternatively, the entire consolidated conservation area inclusive of the *Grevillea curviloba* subsp. *curviloba* populations and the REW (UFI 12444) and 30 m buffer (but excluding the public open space area) could be treated as a single 'Reserve' area and transferred to the DBCA for long-term management. If the Department determined that it did not want to manage the REW, LWP would, as per standard subdivision arrangements, handover the wetland and its 30 m buffer to the City of Swan for long-term management

- The majority of the vegetation on the site is rated as 'Degraded' to 'Completely Degraded' due to the dominance of weeds in the understorey and significant alteration of the vegetation structure in other areas. No areas in 'Very Good' condition or better were recorded on the site. The vegetation proposed for retention (the *Grevillea curviloba subsp. curviloba*) was assessed as being in 'Good' condition however the REW (UFI 12444) was assessed as being in a 'Degraded' condition

- The vegetation types mapped across the site are considered too degraded to assign to a Floristic Community Type (FCT). An assessment of the potential FCTs and Threatened and/or Priority Ecological Communities (TECs / PECs) against the TECs and PECs that have been recorded within 5 km of the site was undertaken. This assessment clarified that no TECs or PECs are considered to occur within the site. This conclusion is based upon

    - The site's degraded and completely degraded vegetation condition which does not allow for accurate assessment of Floristic Community Types either by computer analysis or qualitatively using Table 12 of Gibson et al. (1994)

    - No understorey native species, no limestone in the topsoil or calcareous silts and no botanical limestone indicator species on site

- The *Melaleuca rhaphiophylla / M. teretifolia* Open Shrubland over weeds vegetation type that occurs in the wetland at the northern end of Lot 30 has potential to be a 'degraded' example of FCT 15 'Forests and woodlands of deep seasonal wetlands'. However, this wetland is being retained with a 50 m buffer, therefore impacts to the vegetation are unlikely. In the future the wetlands are proposed to be subject to a Wetland Management Plan, it is considered the wetland vegetation would improve with active management (i.e. weed removal and revegetation).

- **Terrestrial fauna**

    - The remnant native vegetation located at the site provides potential breeding and foraging habitat for black cockatoos (Figure H)

        - No evidence of recent roosting at the site was observed on site or has previously been recorded on the site

        - No evidence of breeding was observed on the site or has been recorded previously

        - Of the 2.9 ha of potential foraging habitat identified on site, 1.4 ha (or 48% of the foraging habitat) is proposed for retention within the concept plan. A future LSP and subdivision design will consider as part of the detailed planning and design the further retention of trees and foraging habitat

        - Of the 44 potential breeding trees identified on site, 30 (or 68% of the breeding trees) are proposed for retention

        - There is 7,649 ha of black cockatoo habitat in reserved bushland located within less than 12 km from the site

    - REW (UFI 12283) is partially located within the western swamp tortoise policy area and consequently comprises potential western swamp tortoise habitat (Figure M). DBCA propose to undertake a survey of this wetland to confirm the presence or absence of this species. If the western swamp tortoise is identified during the DBCA survey, they will be relocated by DBCA to more suitable habitat. Specifically, the western swamp tortoise would be move to the nature reserves managed by the Department. DBCA manage these reserves specifically for the benefit of the western swamp tortoise. Alternatively, consistent with the revised Recovery Plan the tortoise DBCA could choose to re-locate any found western swamp tortoise to the Perth Zoo as part of its captive breeding program with the University of Western Australia.

- **Inland waters**

  - REW (UFI 12444) located at the northern portion of Lot 29. A 30 m buffer is proposed for this wetland, with an additional POS area separating the wetland from proposed residential development

  - REW (UFI 12283) located at the northern boundary of Lot 30. The concept design has incorporated a 50 m buffer and 20 m road reserve between the wetland and proposed residential development. The larger buffer is in recognition of the wetlands location adjacent to the Western Swamp Tortoise policy area.

- **Social surroundings**

  - Registered Aboriginal mythological heritage site 3525 ('Ellen Brook: Upper Swan) mapped across both the site and the broader North Ellenbrook (east) DSP landholdings. This ethnographic place is restricted (or 'Closed') and the consent of the listed informant is required in order to access the file. An Aboriginal heritage survey will be undertaken on the registered Ellen Brook: Upper Swan site 3525 and determine if Section 18 approval is required under the *Aboriginal Heritage Act 1972* as part of future MRS Amendment or the LSP stage

  - An acoustic assessment of the North Ellenbrook (east) DSP was undertaken by Herring Storer Acoustics. This acoustic assessment included

    - the predicted noise levels received at residence for compliance with the requirements of the WAPC State Planning Policy 5.4 Road and Rail Noise (SPP 5.4)

    - if exceedances are predicted, comment on possible noise mitigation options for compliance with the appropriate criteria

    - provided a response on noise emissions associated with the Pearce Air Base and the Ellenbrook Speedway

  - An existing freight railway line lies approximately 60 m east of the site within a gazetted MRS Railways reserve. The freight railway line is separated from the site by Railway Parade (Figure B). The results from Herring Storer's freight rail line noise assessment indicate that noise emissions received at residences located adjacent to the rail line would exceed the defined "Noise Targets" outlined in SPP 5.4. As the construction of the rail line has already been undertaken, noise levels at the proposed North Ellenbrook (east) DSP residential development were not been considered by the infrastructure provider. Acknowledging this outcome, and the need for noise mitigation, the Herring Storer acoustic modelling a scenario where a 2.4 m noise wall was installed at the boundary of the site (Lot 29). With the inclusion of this noise wall barrier, Herring Storer concluded, that noise levels are attenuated sufficiently to enable residential development behind the wall to meet SPP 5.4 noise criteria. Whilst there is a reduction in noise levels by the barrier, the acoustic report outlines that there would still be the requirement for these premises to incorporate quiet house design and notifications on titles (Herring Storer 2019)

  - Ellenbrook Speedway is located approximately 440 m from the south eastern boundary of the site. The speedway operates 12 to 14 meets from April to October with most of the events held during the day (on Sundays with racing commencing at 11.30 am). All speedway meetings are conducted according to the state noise regulations and in accordance to a noise management plan. Based on Herring Storer's acoustic assessment on specifically noise generated from the speedway, noise emissions at the site boundary (Lot 29) would be less than 55 dB(A). For comparison, an individual 2-minute train pass at this same location would be around 75 dB(A). Therefore, noise levels for the train line would be considered higher than noise levels associated with the speedway. The acoustic assessment determined the potential off-site mechanisms for mitigation for the freight rail line noise (e.g. noise walls, building design and materials etc) would mitigate the episodic noise emissions from the speedway

- Bushfire Prone Areas. A bushfire assessment and plan will be prepared for the North Ellenbrook (east) DSP. To address SPP 3.7 requirements, a Bushfire Management Plan will be prepared for the site which provides
    - A bushfire hazard level assessment / Bushfire Attack Level (BAL) contour map
    - Consideration for bushfire protection criteria
- A site specific BAL and bushfire management plan will be prepared for the site as part of a future LSP approval consistent with SPP 3.7 requirements.

- **Conclusion**
    - The potential environmental impacts from the implementation of the urban concept design can be managed through the implementation of responsive planning and development controls to be as low as reasonably practicable. Management plans and further investigations proposed to manage and mitigate potential impacts include
        - Implement the DBCA agreed buffer and management outcomes to protect the *Grevillea curviloba* subsp. *curviloba* population in perpetuity
        - Resource Enhancement Wetland Management Plan for each REW on site
        - An Aboriginal heritage assessment to assess the significance of the Aboriginal heritage site Ellen Brook: Upper Swan to determine whether a Section 18 approval is required
        - Noise mitigations to be implemented in accordance with the Herring Storer acoustic assessment report
        - Bushfire management plan.

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FIGURES

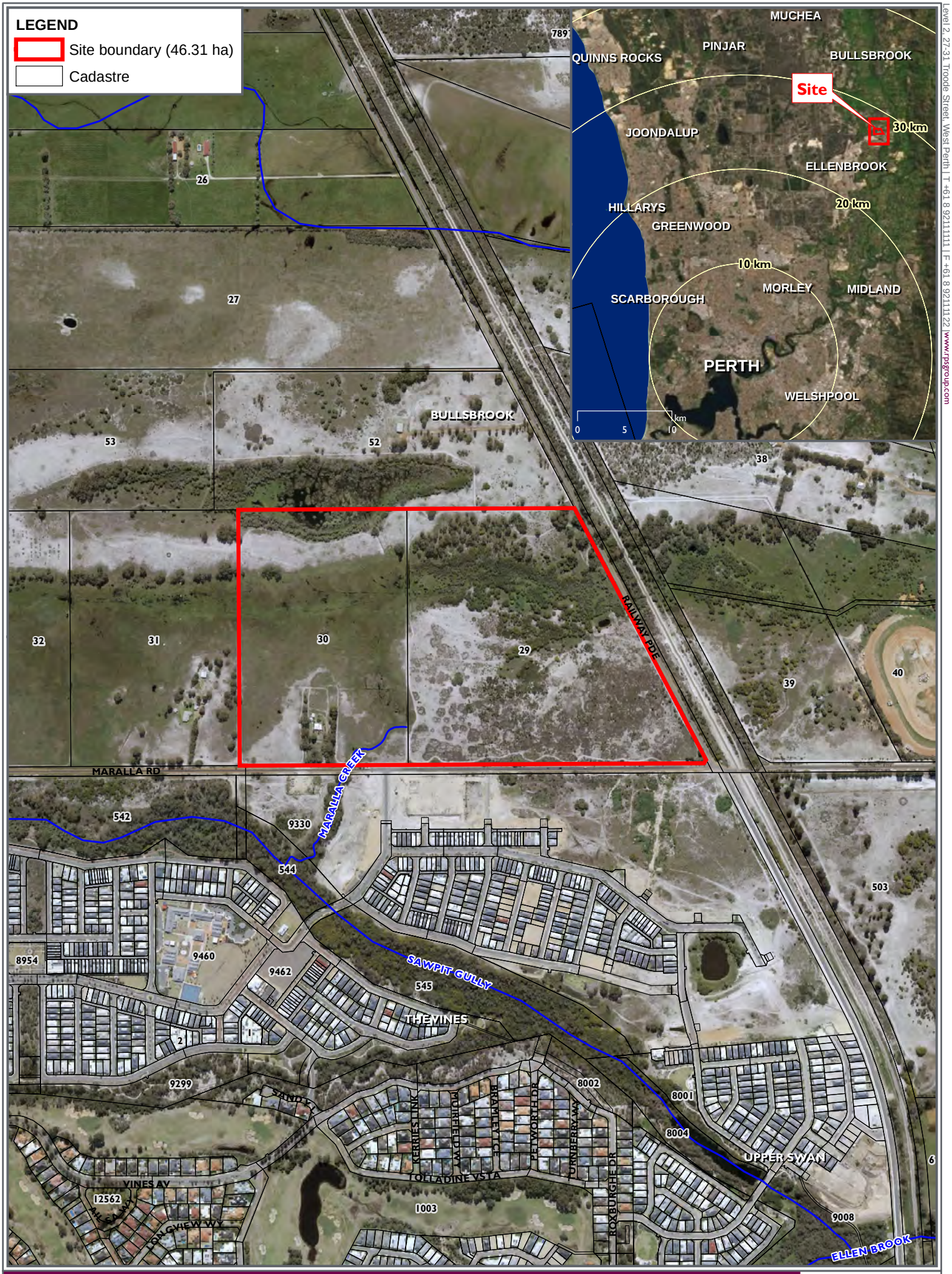

Figure A

Site location

GDA 1994 MGA Zone 50

0 100 200 400 m

Job Number: L19080-003
Doc Number: 001
Date: 15.10.19
Scale: Map 1:10,000 Overview 1:500,000 @ A4
Created by: MA
Source: Imagery - Landgate

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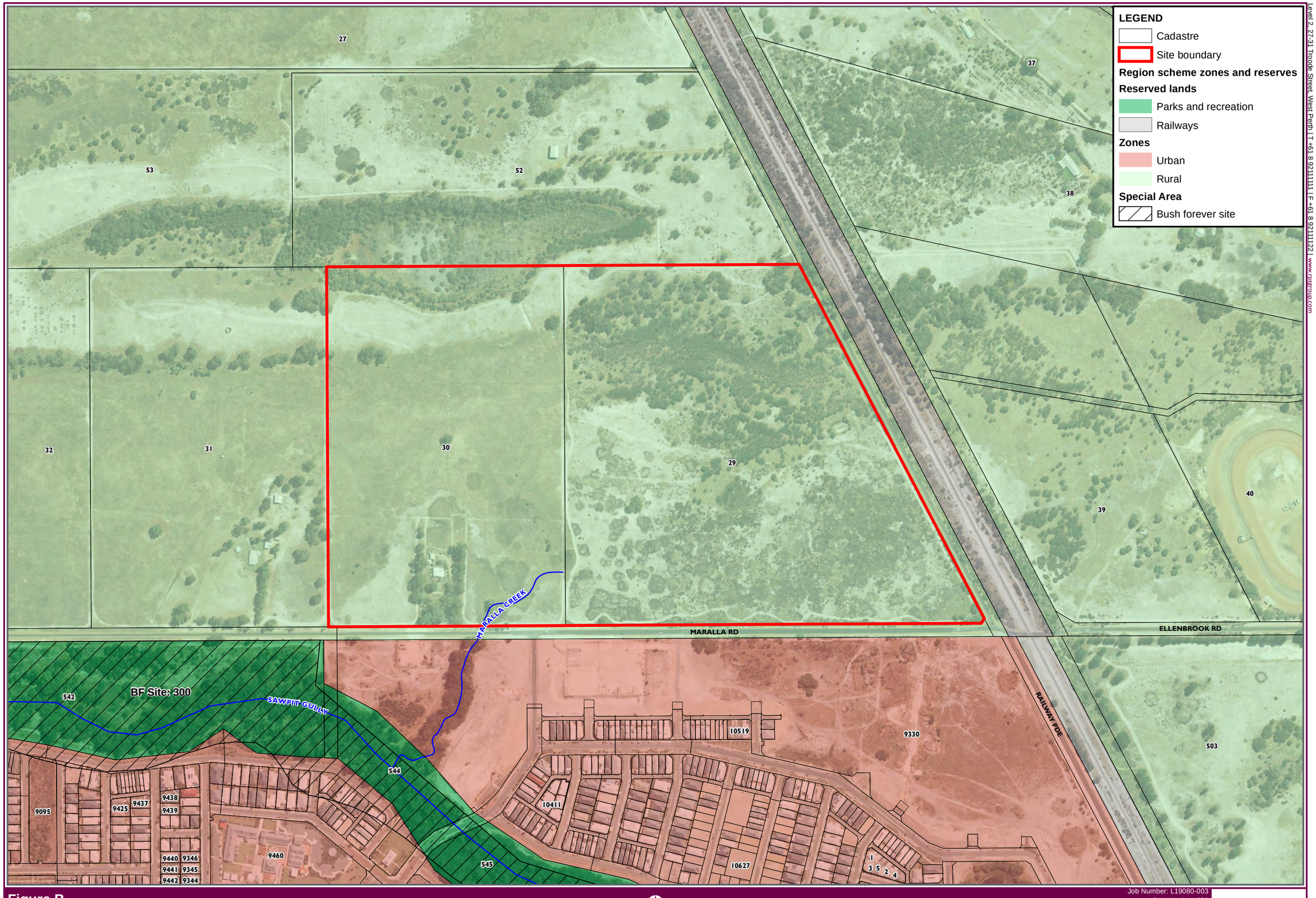

Figure B

Metropolitan region scheme

GDA 1994 MGA Zone 50

0 62.5 125 250 m

Job Number: L19080-003
Doc Number: 002
Date: 15.10.19
Scale: 1:5,000 @ A3
Created by: MA

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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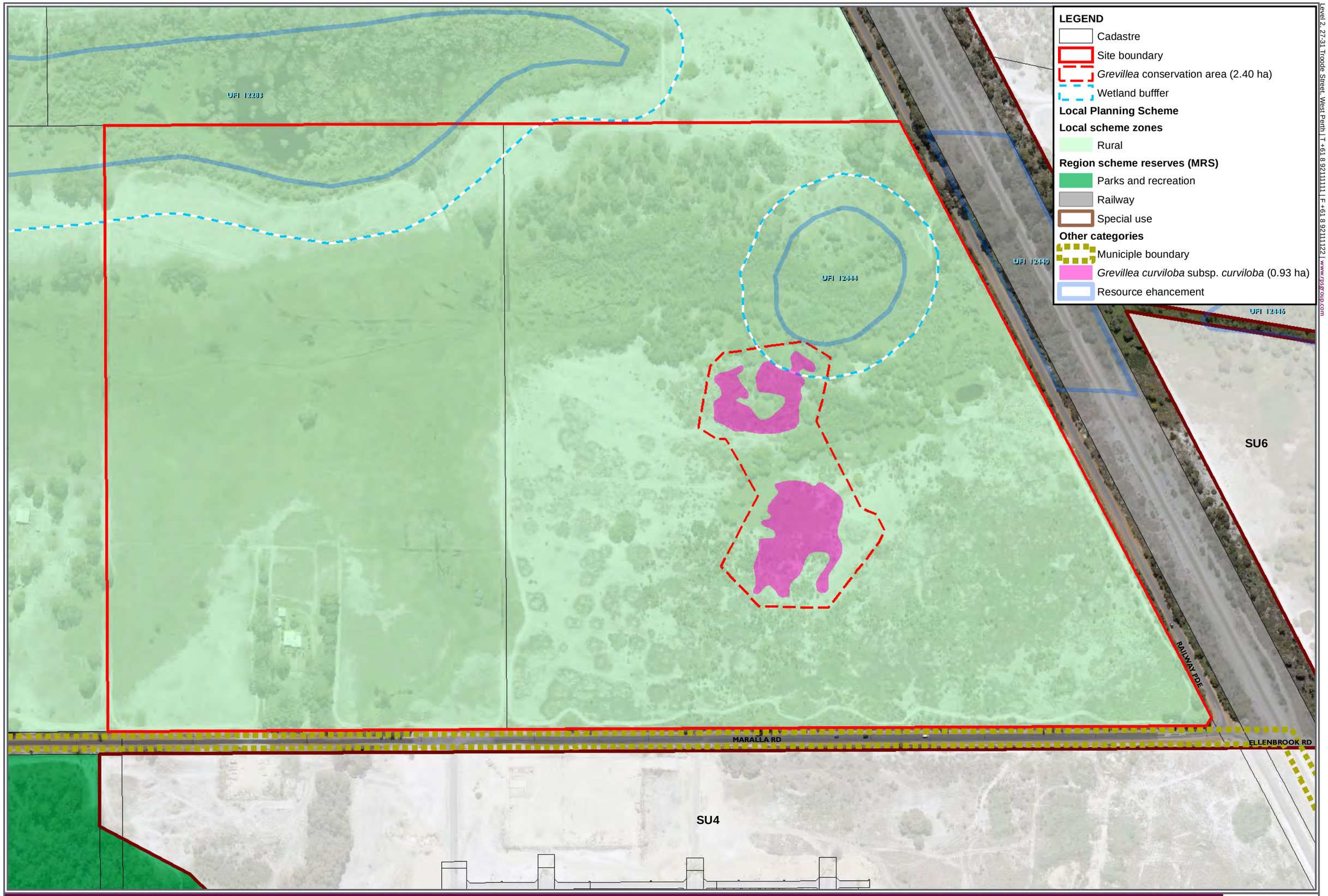

Figure C
City of Swan
Local Planning Scheme No.17

GDA 1994 MGA Zone 50

0 50 100 200 m

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Doc Number: 003
Date: 09.12.19
Scale: 1:3,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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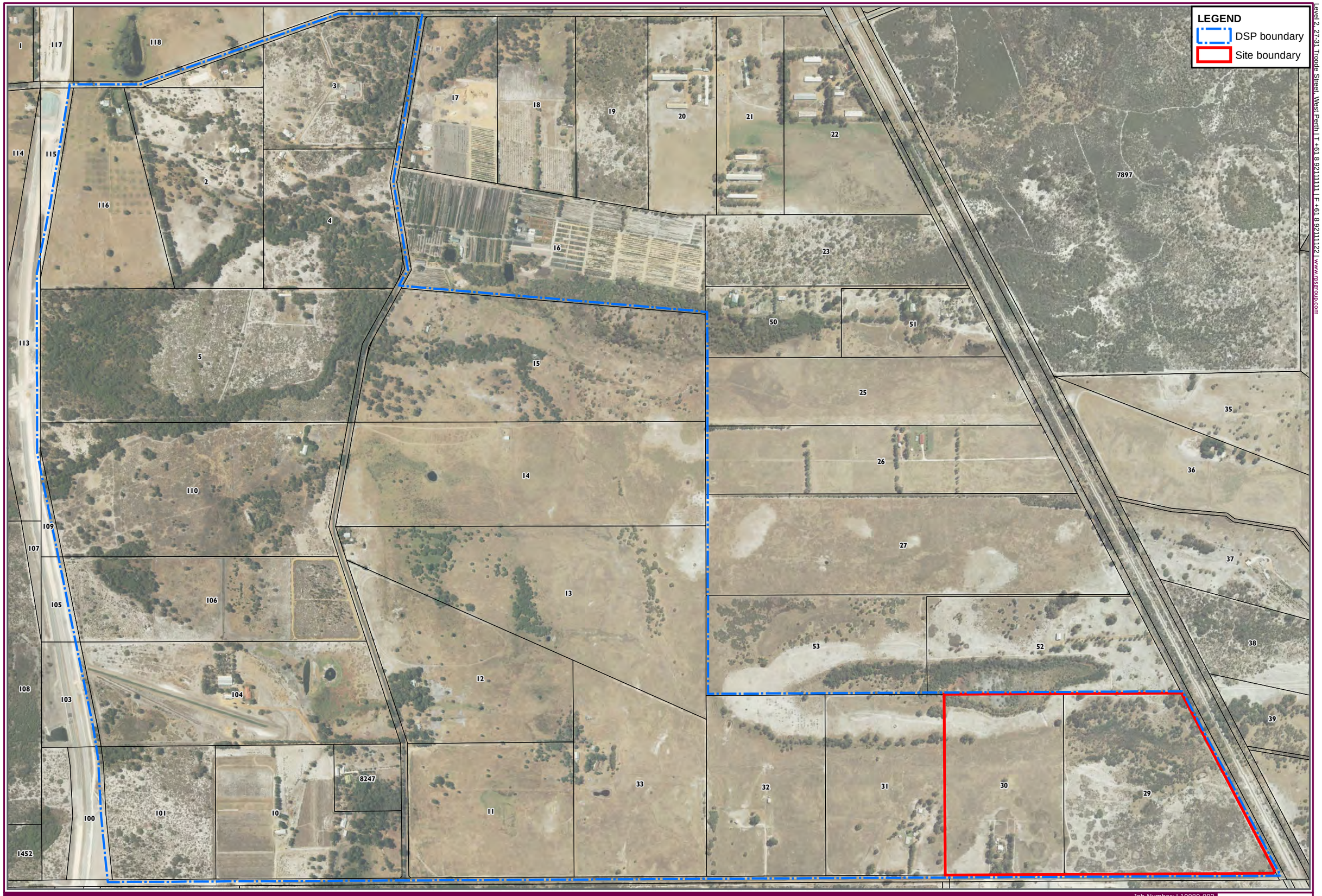

Figure D

North Ellenbrook Landholdings and Area

GDA 1994 MGA Zone 50

0 125 250 500 m

Job Number: L19080-003
Doc Number: 002
Date: 09.12.19
Scale: 1:10,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019 DSP - CLE, 17.12.19

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N

WESTERN SWAMP TORTOISE POLICY AREA

WETLAND

50

WETLAND BUFFER

20m ROAD RESERVE

22m ROAD RESERVE

15m ROAD RESERVE

20m ROAD RESERVE

POS
2.34ha

WETLAND BUFFER

30

WETLAND

CONSERVATION (GREVILLEA)

20m ROAD RESERVE

LOT 30

20m ROAD RESERVE

12.5m ROAD RESERVE

20m ROAD RESERVE

LOT 29

POS

20m ROAD RESERVE

POS

20m ROAD RESERVE

CONSERVATION (GREVILLEA)

POS
0.47ha

15m ROAD RESERVE

15m ROAD RESERVE

22m ROAD RESERVE

RAILWAY PARADE

WESTERN SWAMP TORTOISE POLICY AREA

6.9m ROAD WIDENING

20.1m

MARALLA ROAD

27m

6.9m ROAD WIDENING

Figure E

Concept plan

Job Number: L19080.003
Doc Number: 005
Date: 09.12.19
Scale: NTS @ A3
Created by: GK
Source: Roberts Day - Indicative Concept Plan RD1 009 Rev B, Feb 2019

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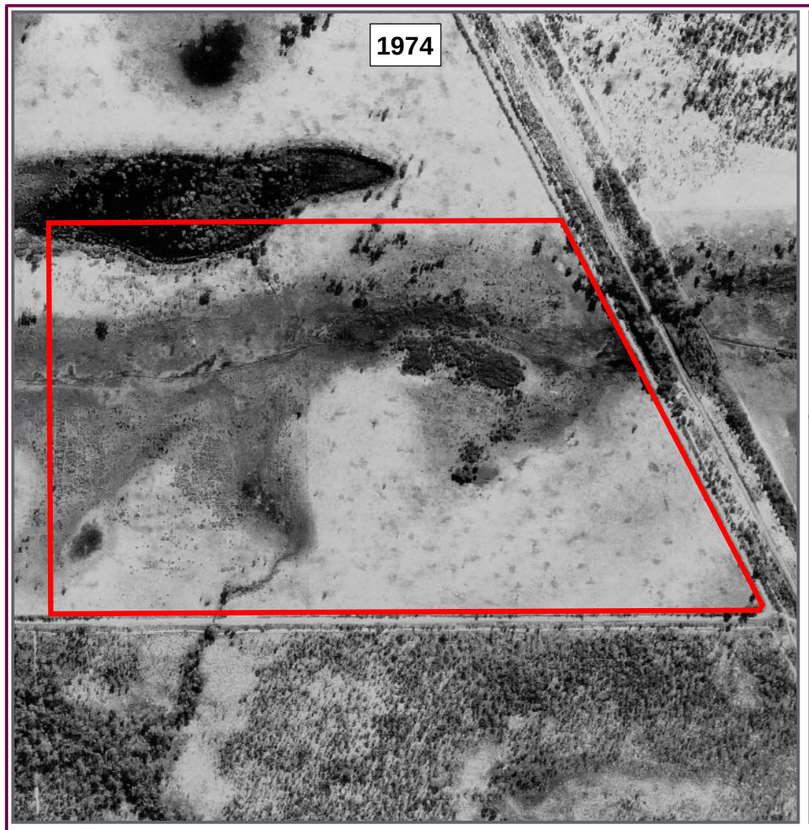

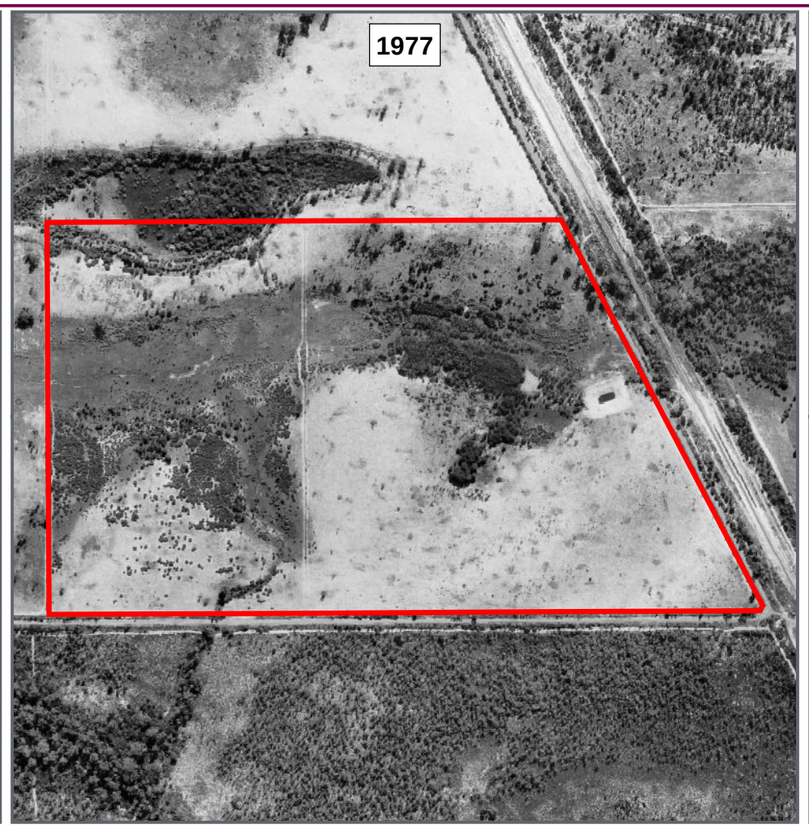

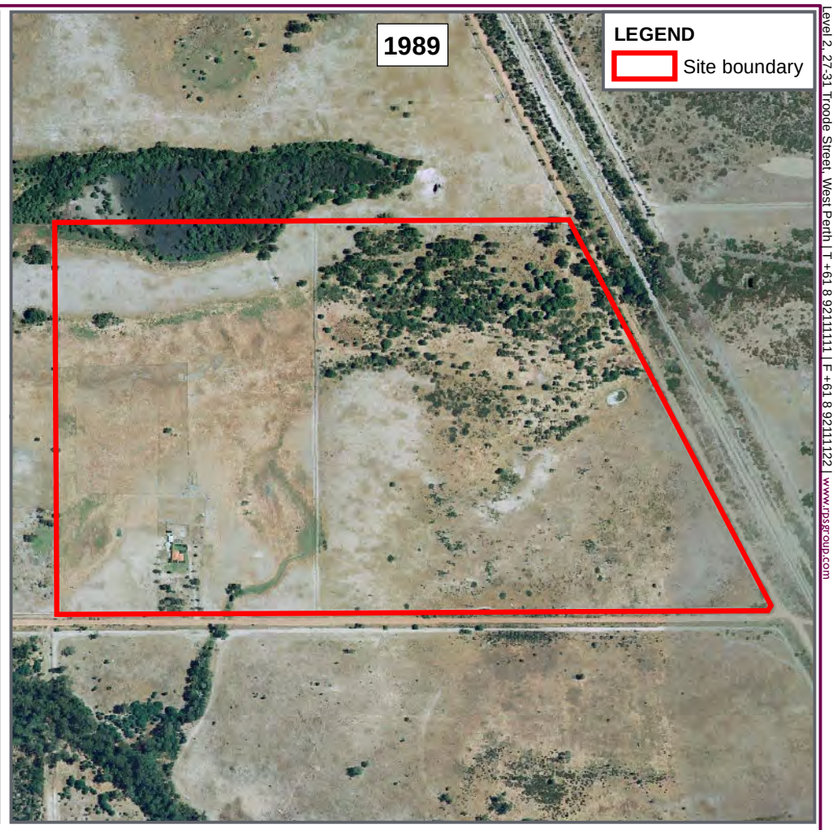

Figure F

Historical land uses

GDA 1994 MGA Zone 50

0 100 200 400 m

Job Number: L19080-003
Doc Number: 009
Date: 09.12.19
Scale: 1:8,333 @ A3
Created: GK
Source: Orthophoto - Landgate

Document Path: G:\Jobs\L_Jobs\L19080 - North Ellenbrook Review\Figures L19080-003\L19080-003_G_009_FigI_Historical land uses_191015.mxd

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LEGEND

- Cadastre
- Site boundary
- Contour (mAHD)

Geology (DMP, 50K Mapsheets)

- Cps - PEATY CLAY dark grey and black with variable sand content, of lacustrine origin
- Mgs1 - PEBBLY SILT - strong brown, silt with common fine to occasionally coarse grained, sub-rounded laterite quartz, heavily weathered granite pebbles, some fine to medium-grained quartz sand, of alluvial o
- S10 - SAND over PEBBLY SILT - sand as S8 overlying Mgs1 gravelly silt
- S8 - SAND - very light grey at surface, yellow at depth, fine to medium-grained, sub-rounded quartz, moderately well sorted, of eolian origin

Cps
Mgs1
S8
S10
MARALLA RD
ELLENBROOK RD
RAILWAY PDE

Figure G

Topography and Geology

GDA 1994 MGA Zone 50

0 75 150 300 m

Job Number: L19080-003
Doc Number: 013
Date: 09.12.19
Scale: 1:5,000 @ A3
Created by: GK
Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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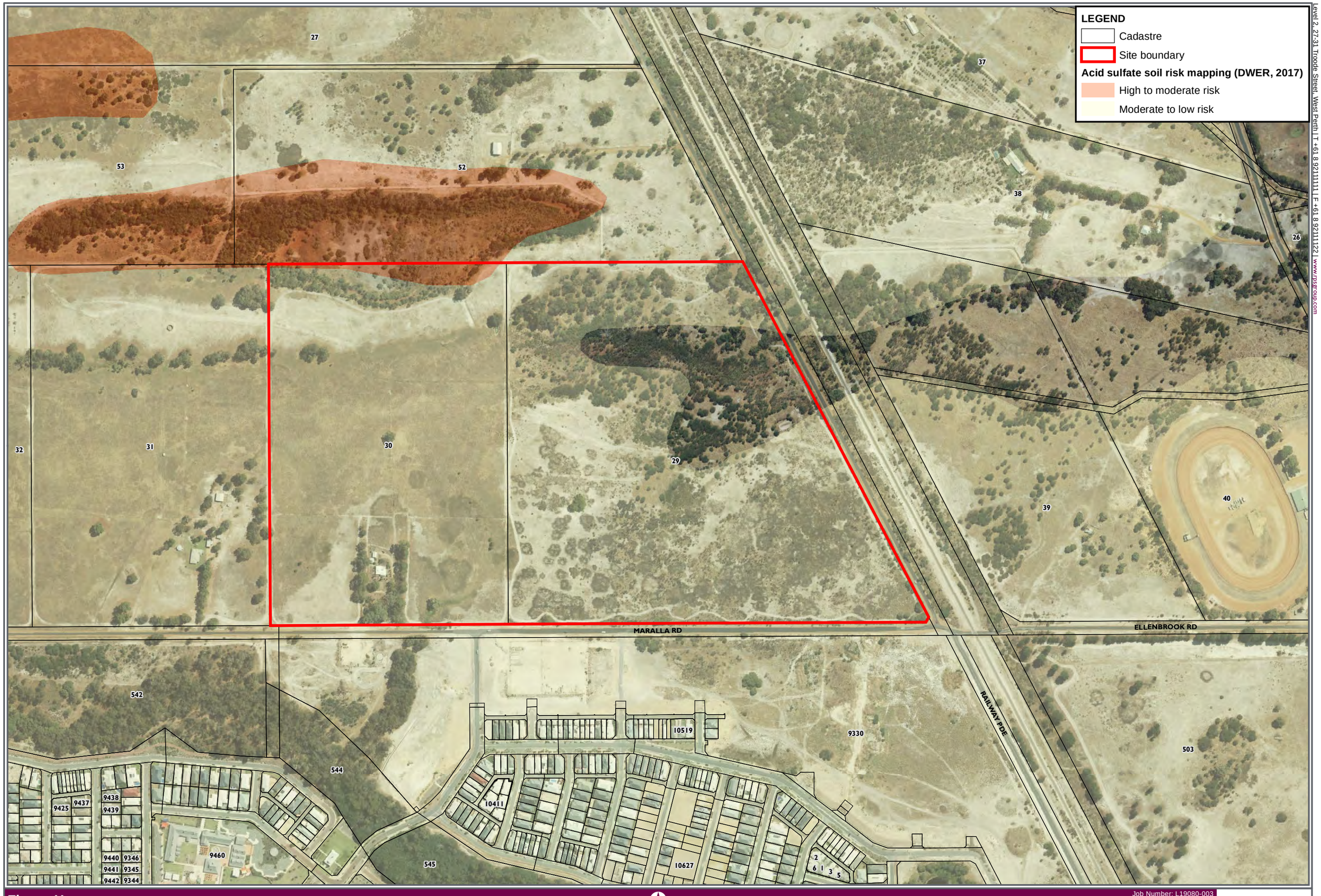

Figure H

Acid sulfate soils risk mapping

GDA 1994 MGA Zone 50

0 75 150 300 m

Job Number: L19080-003
Doc Number: 014
Date: 09.12.19
Scale: 1:5,000 @ A3
Created by: GK
Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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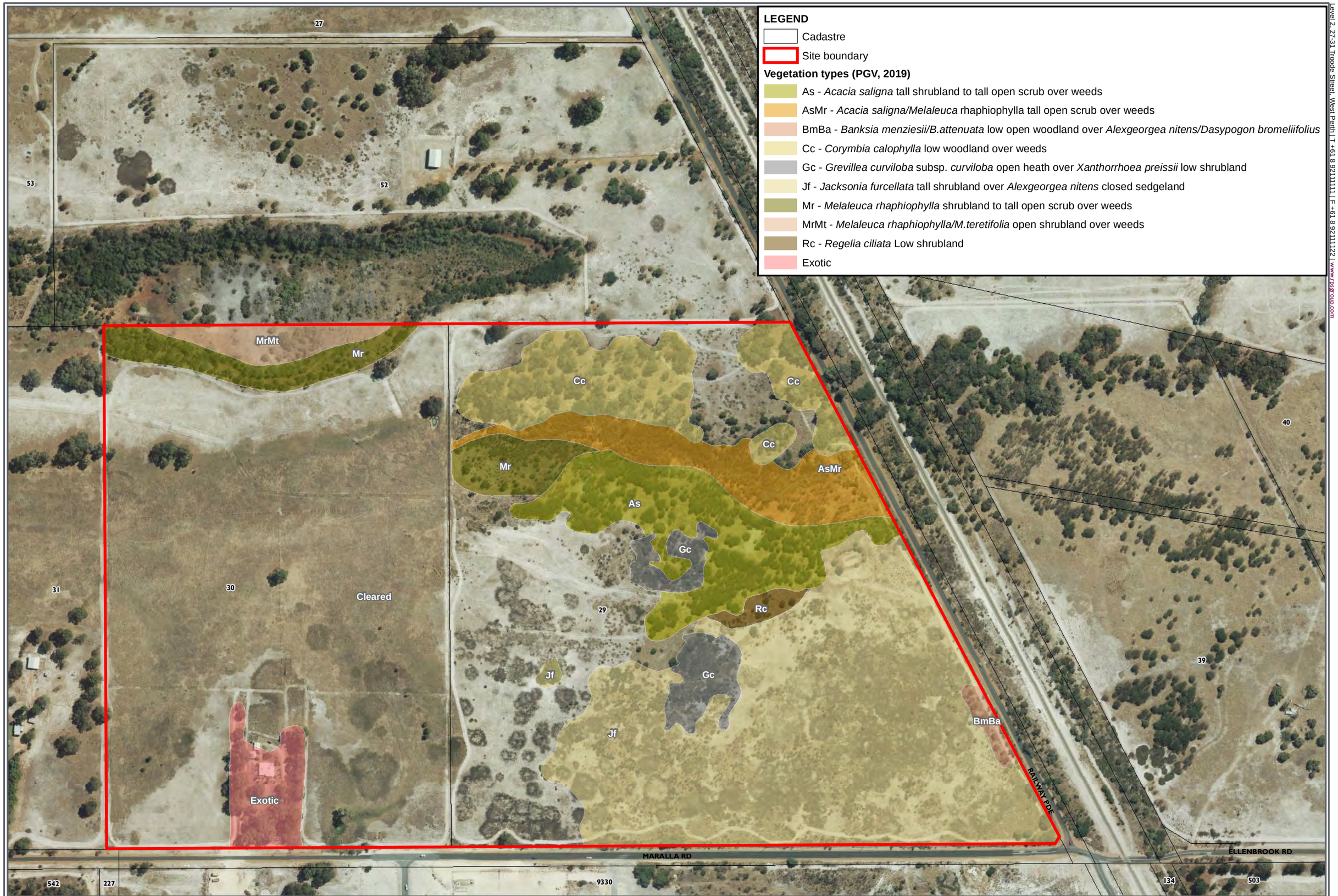

Figure I

Vegetation types

GDA 1994 MGA Zone 50

0 50 100 200 m

Job Number: L19080-003
Doc Number: 011
Date: 09.12.19
Scale: 1:3,500 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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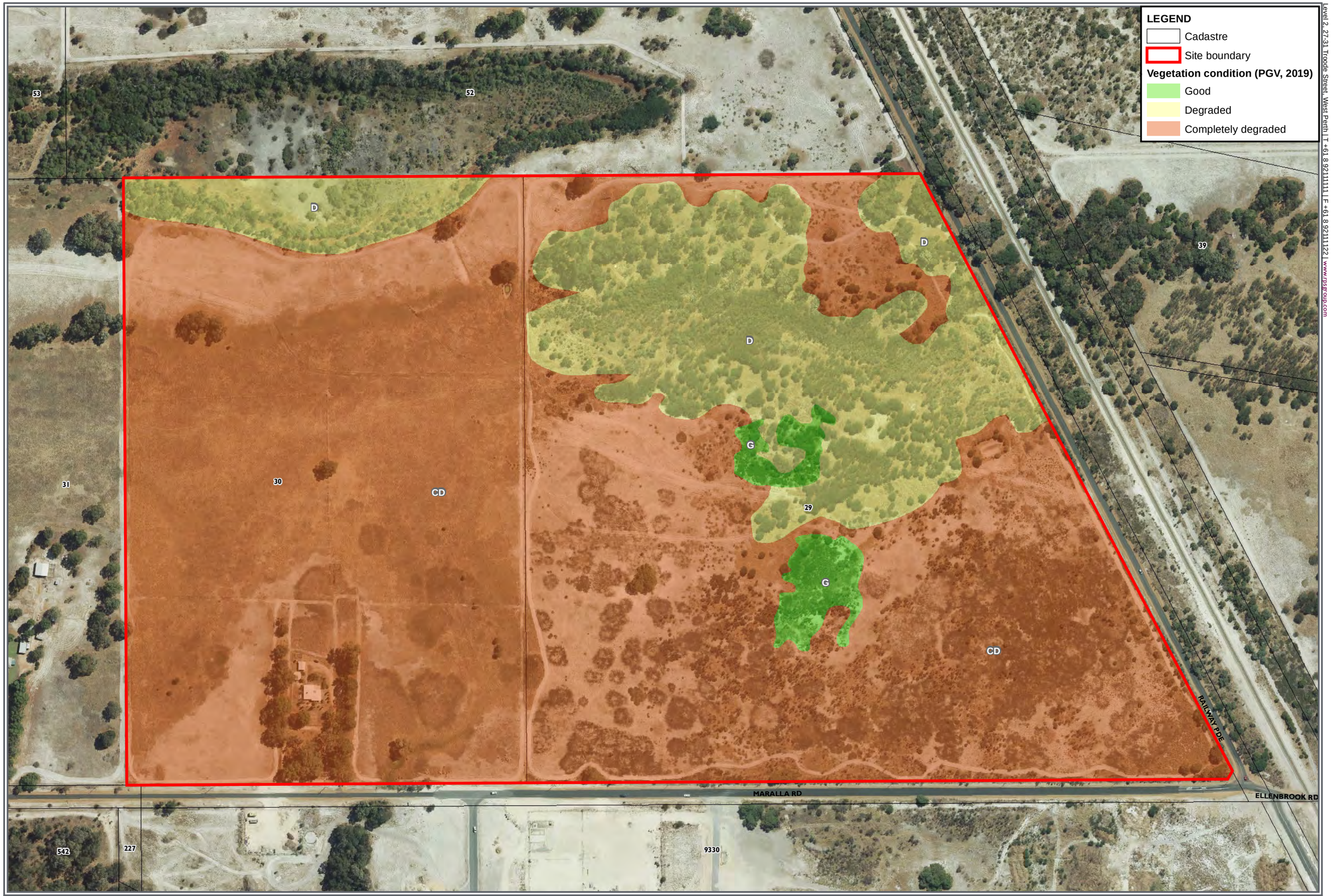

Figure J

Vegetation condition

GDA 1994 MGA Zone 50

0 50 100 200 m

Job Number: L19080-003
Doc Number: 012
Date: 09.12.19
Scale: 1:3,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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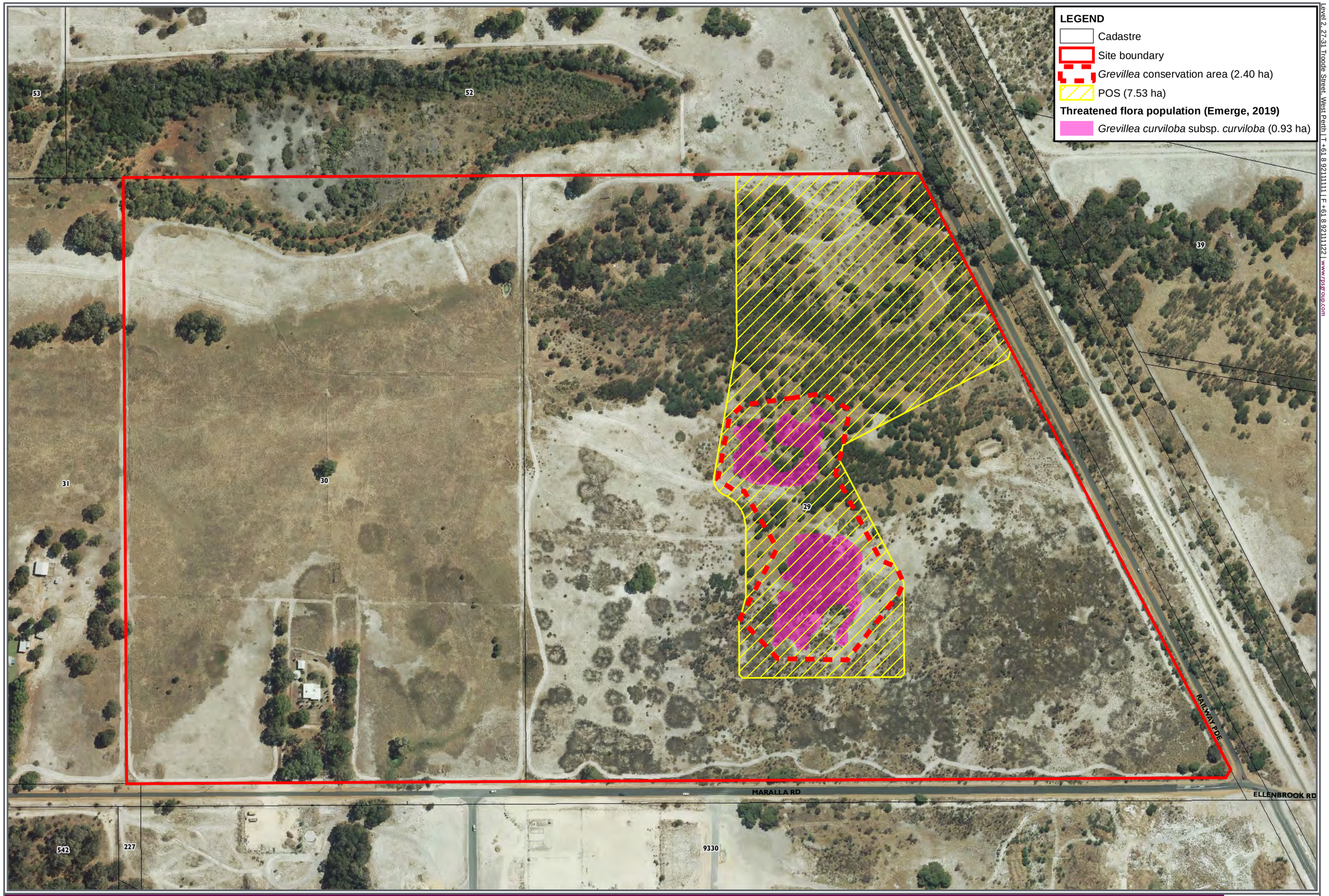

Figure K

***Grevillea curviloba* subsp. *Curviloba* populations**

GDA 1994 MGA Zone 50

0 50 100 200 m

Job Number: L19080-003
Doc Number: 006
Date: 09.12.19
Scale: 1:3,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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Document Path: G:\Jobs\L_Jobs\L19080 - North Ellenbrook Review\Figures L19080-003\L19080-003_G_006_FigK_Grevillea curviloba subsp Curviloba_191209.mxd

LEGEND

- Cadastre
- Site boundary
- *Grevillea* conservation area (2.40 ha)
- POS (7.53 ha)
- Potential black cockatoo foraging habitat (2.89 ha)

Potential black cockatoo breeding habitat

- Flooded gum (*Eucalyptus rudis*)
- Marri (*Corymbia calophylla*)
- Standing dead tree

Geomorphic wetlands (DBCA, 2019)

- Resource ehancement
- Wetland bufffer

53
52
UFI 12283
UFI 12444
UFI 12440
UFI 12446
31
30
29
RAILWAY PDE
MARALLA RD
ELLENBROOK RD
227
542
543
544
9330

Figure L

Potential black cockatoo habitat

GDA 1994 MGA Zone 50

0 50 100 200 m

Job Number: L19080-003
Doc Number: 008
Date: 09.12.19
Scale: 1:3,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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Document Path: G:\Jobs\L_Jobs\L19080 - North Ellenbrook Review\Figures L19080-003\L19080-003_G_008_FigL_Potential black cockatoo habitat_191209.mxd

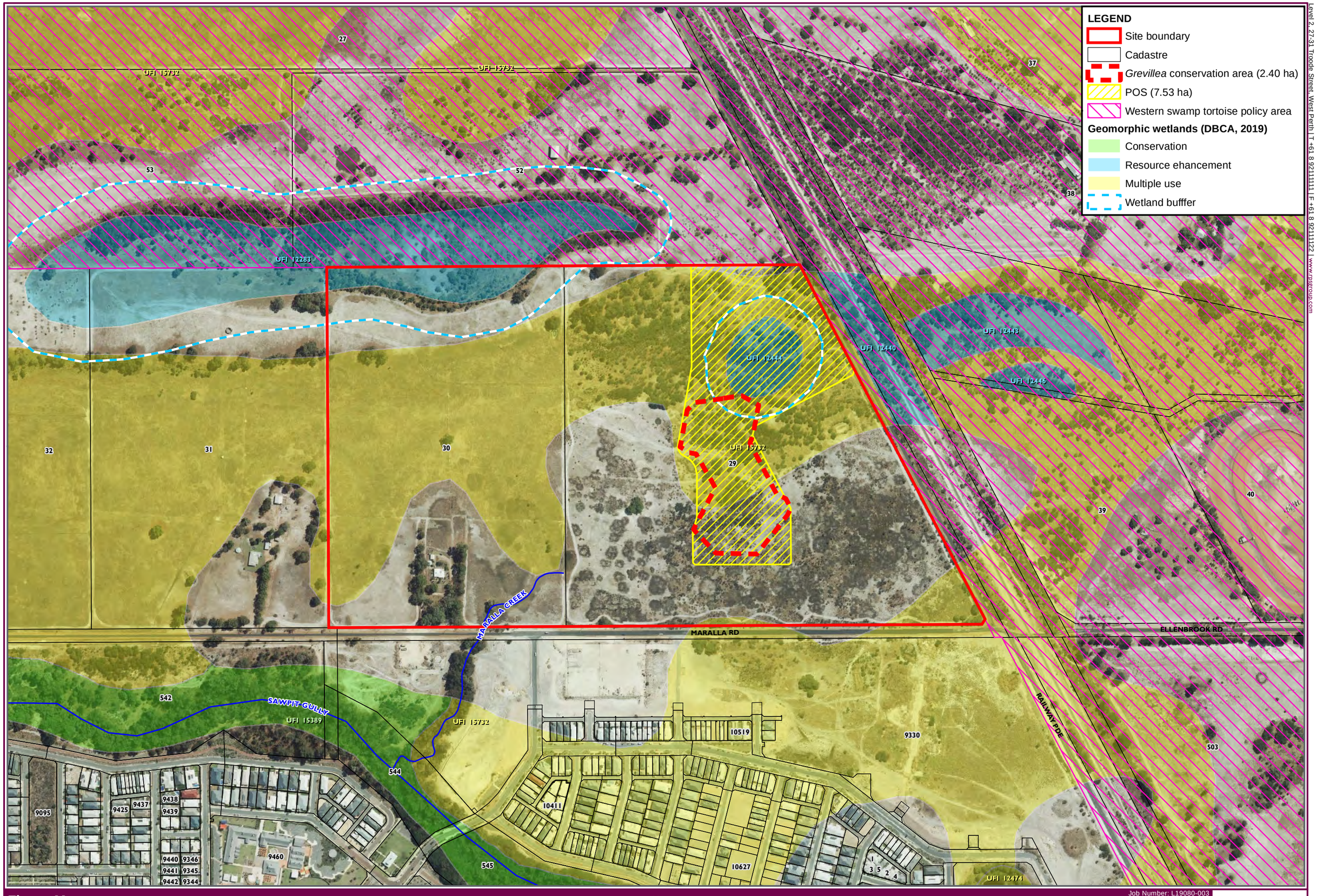

Figure M

Surface water and wetlands

GDA 1994 MGA Zone 50

0 50 100 200 m

Job Number: L19080-003
Doc Number: 013
Date: 09.12.19
Scale: 1:5,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

Document Path: G:\Jobs\L_Jobs\L19080 - North Ellenbrook Review\Figures L19080-003\L19080-003_G_013_FigM_Surface water and wetlands_191209.mxd

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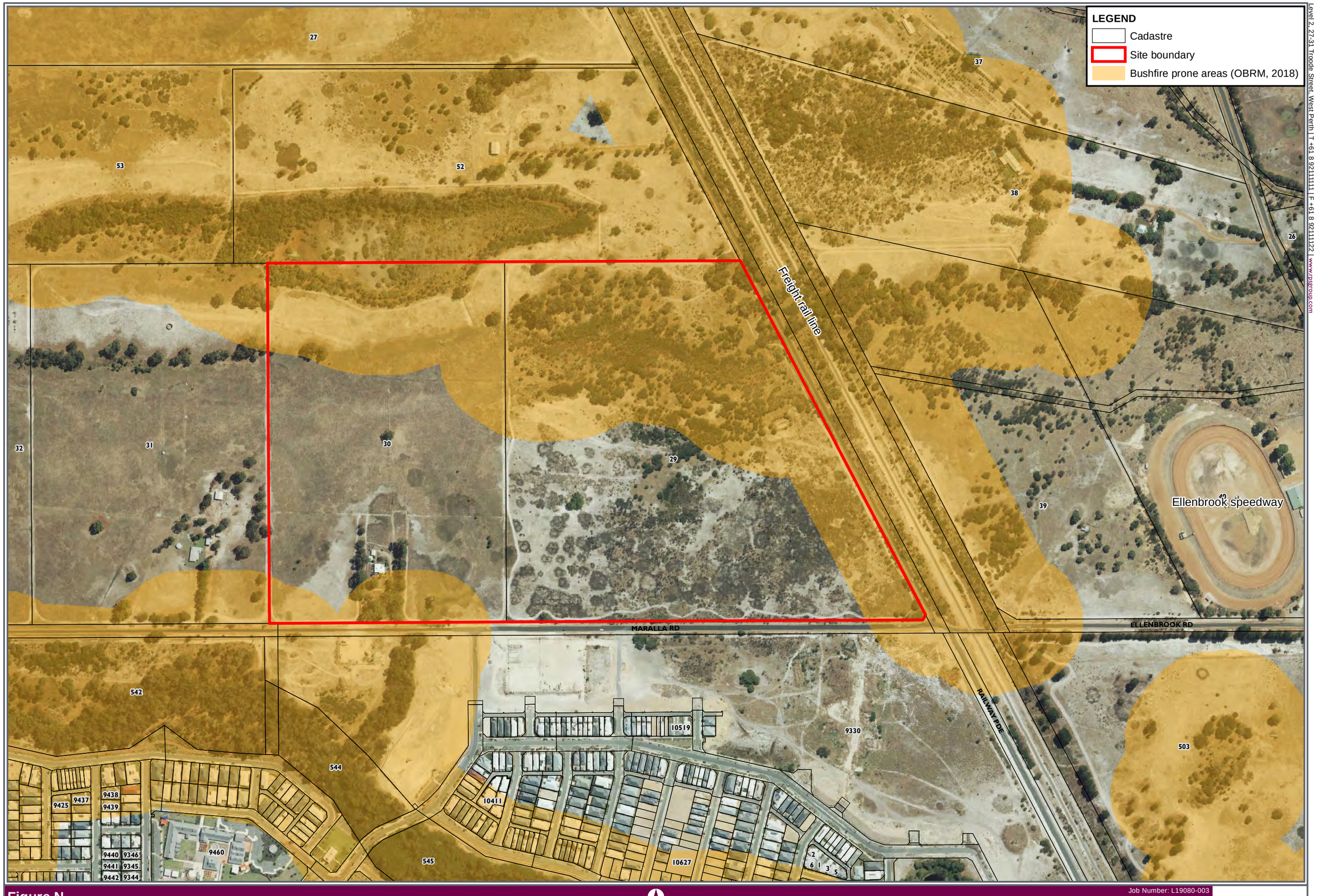

Figure N

Bushfire prone areas and noise sources

GDA 1994 MGA Zone 50

0 75 150 300 m

Job Number: L19080-003
Doc Number: 014
Date: 09.12.19
Scale: 1:5,000 @ A3
Created by: GK

Source: Cadastre - Landgate, 2019 Orthophoto - Landgate, Feb 2019

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Document Path: G:\Jobs\L_Jobs\L19080 - North Ellenbrook Review\Figures L19080-003\L19080-003_G_014_FigN_Bushfire Prone Areas_191209_A3.mxd

Appendix A

Detailed Flora and Vegetation Survey (PGV Environmental 2019)

LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

FLORA AND VEGETATION SURVEY

Prepared for:	RPS Australia West Pty Ltd
Report Date:	29 November 2019
Version:	3
Report No.	2019-467

pgv ENVIRONMENTAL

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Table 7: Vegetation Condition Rating Scale

Plates

Plate 1: Historical Aerial Photography from 1965 (Landgate, 2019)

Plate 2: Historical Aerial Photography from December 1989 (Landgate, 2019)

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Figure 1: Site Location

Figure 2: Site Boundary

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Appendix 1: DBCA Flora database Searches

Appendix 2: Naturemap Report

Appendix 3: Protected Matters Search Tool Report

Appendix 4: Conservation Codes

Appendix 5: TEC and PEC Database Searches

Appendix 6: Species List

Appendix 7: Quadrat Data

1 INTRODUCTION

1.1 Background

Lots 29 and 30 Maralla Road, North Ellenbrook (the site) are located in the City of Swan, approximately 28km north-east of the Perth Central Business District (Figure 1). The site is approximately 48ha and is bounded by Maralla Road to the south, Railway parade to the east, and large rural lots to the west and north (Figure 2).

The owners of the site are investigating the future development potential of the site.

Native vegetation occurs on the site, predominantly on Lot 29 as well as the northern end of Lot 30. PGV Environmental was commissioned to undertake a flora and vegetation survey of the site to assist in the assessment of the site's development potential.

1.2 Scope of Works

A Detailed Flora and Vegetation Survey of the site was undertaken in accordance with EPA Technical Guidance *Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA, 2016). The survey included the following:

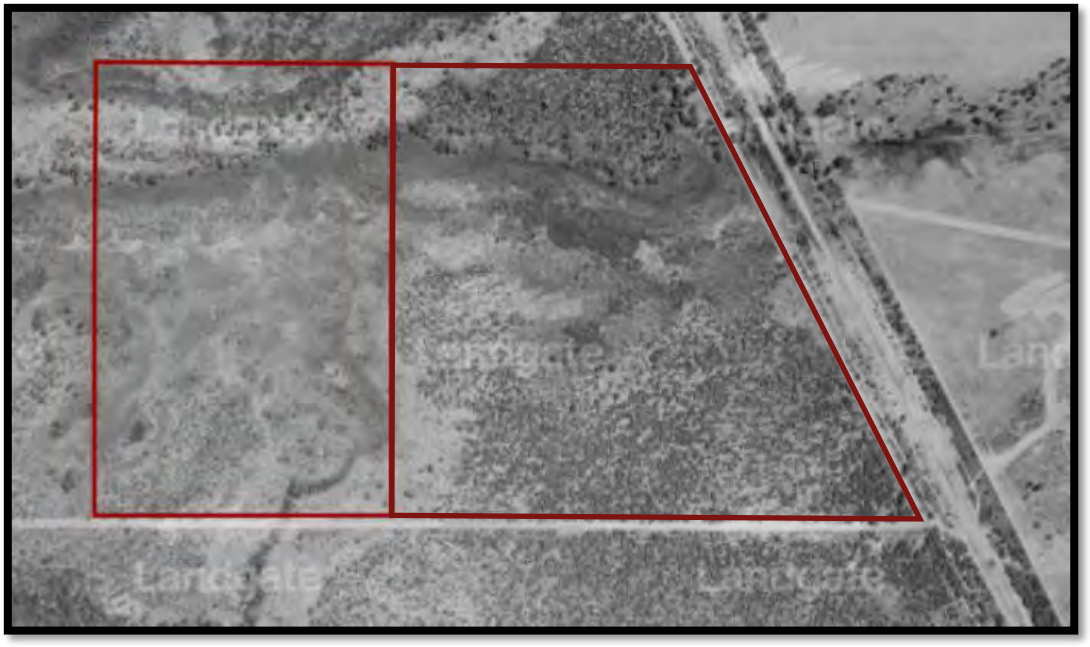
- Review of DBCA and EPBC databases for Threatened and Priority flora and vegetation;
- Examination of historic and recent aerial photography and contour and soil maps to provisionally identify vegetation types and condition;
- Field survey using quadrats to record native and introduced species as well as a thorough site walkover of any areas of native vegetation;
- Recording of any significant plant species using a hand-held GPS;
- Description and mapping of vegetation types and vegetation condition;
- Compilation of a flora list; and
- Identification of any flora and vegetation of conservation significance.

2 EXISTING ENVIRONMENT

2.1 Land Use

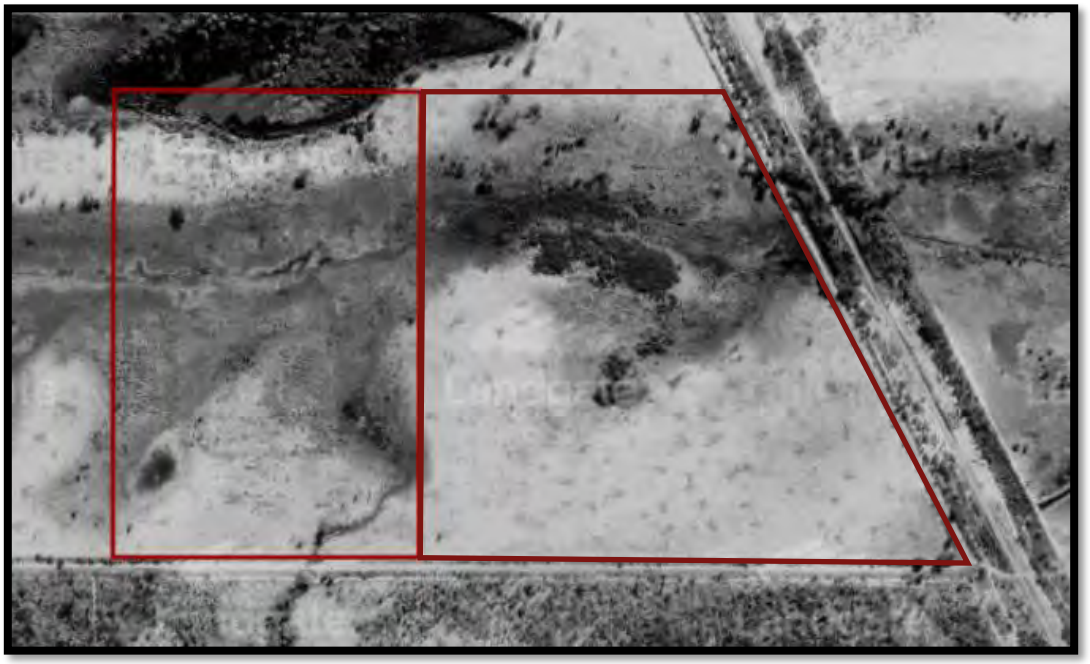
Examination of historical aerial photography shows that the site was fully vegetated in 1965 with some perimeter firebreaks cleared on the southern and eastern boundaries (Plate 1).

Plate 1: Historical Aerial Photography from 1965 (Landgate, 2019)



The 1974 photo shows that most of the site was completely cleared apart from a small area on Lot 29 and the wetland at the northern end of Lot 30 (Plate 2).

Plate 2: Historical Aerial Photography from December 1989 (Landgate, 2019)



The 2019 photo shows house has been constructed on Lot 30, which remains largely cleared, and vegetation has regrown on Lot 29 (Plate 3).

Plate 3: Aerial Photography from December 2019 (Landgate, 2019)

2.2 Surrounding Land Use

The site is bounded on the eastern side by Railway Parade and to the south by Maralla Road. Urban development occurs south of Maralla Road. Rural lots occur to the west and north of the site (Figure 2). The rural lots are predominantly cleared of native vegetation apart from a portion of wetland abutting the northern end of Lot 30.

2.3 Topography

The site is very gently undulating and varies slightly between approximately 25m and 27m Australian Height Datum (AHD) (Figure 2).

2.4 Geology and Soils

The site is located in the Bassendean and Yanga System (National Map, 2019). The Yanga soil system is on poorly drained plain with grey sandy benches and intervening swamps; also areas of bog iron ore, marl or solonetzic soils (Churchward and McArthur 1980) The system consists of a poorly drained plain with pale sands and deep sandy duplexes, wet, semi-wet and saline wet soils (DPIRD, 2019). The Bassendean System is, the oldest of the three dune systems on the Swan Coastal Plain (Bolland, 1998) and consists of very low relief, leached, grey siliceous Pleistocene sand dunes, intervening sandy and clayey swamps and gently undulating plains (DPIRD, 2019).

The soils mapped on the site are:

- Yanga 6x Phase (213Ya_6x) consists of flat plains with occasional low dunes and yellowish, brown duplex and poorly structured clay soils often with pans underlying;

- Yanga 8x Phase (213Ya_8x) which are on flat plains with occasional low dunes and are subject to seasonal inundation. The soils are deep white and pale yellow sands interspersed with swamp and generally underlain by siliceous/humic pans at depth;
- Yanga 9x Phase (213Ya_9x) which are on flat plain with occasional low dunes that are subject to seasonal inundation. The soils are humic and peaty sands, wet and semi-wet soils generally underlain by siliceous / humic pans at depth;
- Yanga 9w Phase (213Ya_9l) which are water areas of lakes and permanent swamps;
- Yanga 14x Phase (213Ya_14x) which are sandy rises on flat to gently sloping plain with occasional low dunes with pale sands overlying siliceous / humic pans, bog iron and clay;
- Bassendean Joel Phase (212Bs_J) which are poorly drained depressions with humus podzols; and
- Bassendean Jandakot Phase (212Bs_Ja) which are Jandakot low dunes with slopes <10% and generally more than 5m relief. The soils are grey sand over pale yellow sands generally underlain by humic and iron podzols (DPIRD, 2019).

2.5 Hydrology

Groundwater under the site is at approximately 22-24mAHD (DWER, 2019), which is between 2m and 4m below ground level.

The site contains a Multiple Use Palusplain mapped on the central part of the site (Unique Feature Identifier (UFI) 15732) and two Resource Enhancement wetlands: UFI 12283 (Sumpland) in the northern part of Lot 30 and UFI 12444 (Palusplain) at the eastern central part of Lot 29 (Plate 4) (National Map, 2018).

Plate 4: Wetland Mapping on the Site

3 METHODOLOGY

3.1 Database Searches

Searches of the following databases were undertaken for a 10km radius around the central point of the site prior to the site survey:

- Department of Biodiversity, Conservation and Attractions (DBCA) Declared Rare and Priority Flora database and Threatened Ecological Communities database;
- DBCA Naturemap Database; and
- The Commonwealth Government's Protected Matters Search Tool to identify species potentially that potentially have habitat within the area that are protected under the *Environment Protection and Biodiversity Conservation* (EPBC) *Act 1999*. A radius of 5km was used for this database.

Other available information was also researched to determine any additional studies that had been completed on or near the site.

3.2 Site Survey

A flora and vegetation survey of the site was conducted by Dr Paul van der Moezel on 30 July 2019 and 16 September 2019.

The whole site was thoroughly walked to record all species in the survey area. In addition, ten 10m x 10m non-permanent quadrats were recorded on the site.

Most plant species were identified in the field. Some specimens were photographed or taken for identification at the Perth Reference Herbarium or office using standard reference guides. Collection of a suspected Threatened species was undertaken in accordance with Authorisation under Section 40 of the *Biodiversity Conservation Act 2016* to take Threatened Flora for Identification Purposes and/or Taxonomic Research (Authorisation Number TFL 45-1920).

3.3 Survey Conditions

The conditions that the survey was undertaken in are presented in Table 1. In summary, there were no constraints to the survey.

Table 1: Statement of Botanical Survey Conditions

Issue	Constraints (Y/N)*	Comment
Competency/experience of the consultant conducting the survey	No	Dr Paul van der Moezel has extensive botanical survey experience in the Perth Metropolitan Region.
Proportion of the flora identified^	No	The timing of the survey in July and September was optimal to record most of the native species.
Sources of information (historic/recent or new data)	No	The flora in the Perth Metropolitan Region is well documented.

Issue	Constraints (Y/N)*	Comment
Proportion of the task achieved and further work that may need to be undertaken	No	No follow-up survey required as no Threatened Flora expected to occur in other seasons.
Timing/weather/season/cycle	No	The spring survey was optimal for most flora species.
Disturbances (Fire)	No	The fire age of the vegetation was greater than 5 years.
Intensity of survey (e.g. In retrospect was the intensity adequate)	No	The small site and ease of access made for a full coverage.
Completeness (e.g. was relevant area fully surveyed)	No	
Resources (e.g. degree of expertise available for plant identification)	No	Experienced botanist undertook most plant identifications on site. Threatened species verified by DBCA on site.
Remoteness and/or access problems	No	Easily accessible site in the Perth Metropolitan Region.
Availability of contextual (e.g. bioregional) information for the study area.	No	Perth's Bush Forever

*Constraints have been rated as Significant, Moderate or No constraints

^Fungi and nonvascular flora (e.g. algae, mosses and liverworts) were not specifically surveyed for during the survey.

4 RESULTS

4.1 Flora Database Searches

A search of the DBCA Threatened Flora Databases: Threatened and Priority Flora List (TPList), the WA Herbarium database (WAHerb), the Threatened (Declared Rare) and Priority Flora Species List (TFPL) (Appendix 1), Naturemap (Appendix 2) indicates that a number of species that are listed as Endangered, Threatened or Priority are identified as being recorded within 10km of the site. The EPBC Act Protected Matters Search Tool (Appendix 3) indicates species that potentially have habitat within 5km of the site. The results from these database searches are shown in Table 2.

Table 3 lists the likelihood that any of these species could occur on the site based on the soil types and vegetation condition.

Table 2: Conservation Significant Identified in Database Searches

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act
Caladenia huegelii	King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid	Schedule 1	Endangered
Drakaea elastica	Glossy-leafed Hammer Orchid	Schedule 1	Endangered
Eucalyptus x balanites	Cadda Road Mallee	Schedule 1	Endangered
Grevillea curviloba subsp. *curviloba*	Narrow curved-leaf Grevillea	Schedule 1	Endangered
Synaphea sp. Fairbridge Farm (D Papenfus 696)	Selena's Synaphea	Schedule 1	Critically Endangered
Thelymitra dedmaniarum	Cinnamon Sun-orchid	Schedule 1	Endangered
Trithuria occidentalis (Hydatella dioica)	Swan Hydatella	Schedule 1	Endangered
Darwinia foetida	Muchea Bell	Schedule 2	Critically Endangered
Diplolaena andrewsii	Native Wild Rose	Schedule 2	Endangered
Diuris purdiei	Purdie's Donkey-orchid	Schedule 2	Endangered
Grevillea christineae	Christine's Grevillea	Schedule 2	Endangered
Grevillea curviloba subsp. *incurva*	Narrow curved-leaf Grevillea	Schedule 2	Endangered
Lepidosperma rostratum	Beaked Lepidosperma	Schedule 2	Endangered
Thelymitra stellata	Star Sun-orchid	Schedule 2	Endangered
Acacia anomala	Grass Wattle, Chittering Grass Wattle	Schedule 3	Vulnerable
Andersonia gracilis	Slender Andersonia	Schedule 3	Endangered
Anigozanthos viridis subsp. *terraspectans*	Dwarf Green Kangaroo Paw	Schedule 3	Vulnerable
Anthocercis gracilis	Slender Tailflower	Schedule 3	Vulnerable

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act
Chamelaucium sp. Gingin (N.G. Marchant 6)	Gingin Wax	Schedule 3	Endangered
Eleocharis keigheryi	Keighery's Eleocharis	Schedule 3	Vulnerable
Calectasia elegans	Elegant Tinsel Lily	Priority 2	
Millotia tenuifolia var. *laevis*		Priority 2	
Pertusaria trachyspora		Priority 2	
Poranthera moorokatta		Priority 2	
Schoenus sp. Bullsbrook (J.J. Alford 915)		Priority 2	
Acacia oncinophylla subsp. *oncinophylla*		Priority 3	
Adenanthos cygnorum subsp. *chamaephyton*		Priority 3	
Beaufortia purpurea	Purple Beaufortia	Priority 3	
Chamaescilla gibsonii		Priority 3	
Cyathochaeta teretifolia		Priority 3	
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)		Priority 3	
Guichenotia tuberculata		Priority 3	
Haemodorum loratum		Priority 3	
Halgania corymbosa		Priority 3	
Lasiopetalum glutinosum subsp. *glutinosum*		Priority 3	
Meionectes tenuifolia		Priority 3	
Phlebocarya pilosissima subsp. *pilosissima*		Priority 3	
Pithocarpa corymbulosa		Priority 3	
Schoenus capillifolius		Priority 3	
Schoenus sp. Waroona (G.J. Keighery 12235)		Priority 3	
Stylidium asteroideum	Star Triggerplant	Priority 3	
Stylidium paludicola		Priority 3	
Stylidium trudgenii		Priority 3	
Styphelia filifolia		Priority 3	
Tetratheca pilifera		Priority 3	
Verticordia serrata var. linearis		Priority 3	
Anigozanthos humilis subsp. *chrysanthus*	Golden Cats Paw	Priority 4	
Cyanicula ixioides subsp. *ixioides*		Priority 4	
Darwinia pimelioides		Priority 4	

Scientific Name	Common Name	Conservation Status (WA)	Status under EPBC Act
Drosera occidentalis	Western Sundew	Priority 4	
Hydrocotyle lemnoides	Aquatic Pennywort	Priority 4	
Hypolaena robusta		Priority 4	
Persoonia sulcata		Priority 4	
Schoenus natans	Floating Bog-rush	Priority 4	
Stylidium longitubum	Jumping Jacks	Priority 4	
Verticordia lindleyi subsp. *lindleyi*		Priority 4	

Conservation Codes are shown in Appendix 4

Table 3: Likelihood of Identified Significant Flora Species Occurring on the Site

Scientific Name	Common Name	Habitat*	Likelihood to occur on the site
Caladenia huegelii	King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid	The Grand Spider-orchid prefers sand or clay loam. This species generally does not survive in disturbed areas.	Unlikely due to site disturbance
Drakaea elastica	Glossy-leafed Hammer Orchid	The Glossy-leafed Hammer Orchid prefers low-lying situations adjoining winter-wet swamps. This species does not survive in disturbed areas.	Unlikely due to site disturbance
Eucalyptus x balanites	Cadda Road Mallee	The Cadda Road Mallee prefers sandy soils with lateritic gravel.	No – not lateritic habitat
Grevillea curviloba subsp. *curviloba*	Narrow curved-leaf Grevillea	Narrow curved-leaf Grevillea occurs in grey sand. Winter-wet heath. There are 17 known populations in an area between Muchea and Badgingarra (Phillimore and English, 2000).	Previously recorded on the site
Synaphea sp. Fairbridge Farm (D Papenfus 696)	Selena's Synaphea	Selena's Synaphea occurs in sandy with lateritic pebbles near winter-wet flats, in low woodland with weedy grasses.	No – not lateritic habitat
Thelymitra dedmaniarum	Cinnamon Sun-orchid	Cinnamon sun orchid is known from only two locations in the Gidgegannup area. It is confined to open wandoo woodland on red-brown sandy loam associated with dolerite and granite outcropping (DEC, 2012).	No – not suitable habitat
Trithuria occidentalis (Hydatella dioica)	Swan Hydatella	Swan Hydatella grows partly submerged on the edge of shallow, winter-wet claypans in very open shrubland of Robin Redbreast Bush (*Melaleuca lateritica*) and numerous annual herbs.	Possible

Scientific Name	Common Name	Habitat*	Likelihood to occur on the site
Darwinia foetida	Muchea Bell	The Muchea Bell is found in grey-white sand on swampy, seasonally wet sites.	Possible
Diplolaena andrewsii	Native Wild Rose	The Native Wild Rose occurs on loam, clay in association with granite outcrops and hillsides.	No – not granite habitat
Diuris purdiei	Purdie's Donkey-orchid	Purdie's Donkey Orchid occurs in grey-black sand in moist winter-wet swamps.	Possible
Grevillea christineae	Christine's Grevillea	Christine's Grevillea prefers clay loam, sandy clay, often moist.	Unlikely - not clay habitat
Grevillea curviloba subsp. *incurva*	Narrow curved-leaf Grevillea	Narrow curved-leaf Grevillea prefers sand, sandy loam in winter-wet heath.	Possible
Lepidosperma rostratum	Beaked Lepidosperma	Beaked Lepidosperma is found in peaty sand, clay.	No – no peaty habitat
Thelymitra stellata	Star Sun-orchid	The Star Sun-orchid prefers sand, gravel or lateritic loam.	No – not lateritic habitat
Acacia anomala	Grass Wattle, Chittering Grass Wattle	The Grass Wattle prefers lateritic soils and slopes.	No – not lateritic habitat
Andersonia gracilis	Slender Andersonia	Slender Andersonia occurs in white/grey sand, sandy clay, gravelly loam in winter-wet areas, near swamps.	Possible
Anigozanthos viridis subsp. *terraspectans*	Dwarf Green Kangaroo Paw	The Dwarf Green Kangaroo Paw occurs on grey sand, clay loam in winter-wet depressions.	Possible
Anthocercis gracilis	Slender Tailflower	Slender Tailflower occurs in sandy or loamy soils near granite outcrops.	No – not granite habitat
Chamelaucium sp. Gingin (N.G. Marchant 6)	Gingin Wax	Gingin wax grows in white/yellow sand supporting open low woodland.	Unlikely
Eleocharis keigheryi	Keighery's Eleocharis	Keighery's Eleocharis occurs in clay, sandy loam and is emergent in freshwater: creeks, claypans.	Possible
Calectasia elegans	Elegant Tinsel Lily	Elegant Tinsel Lily occurs in deep grey quartz soils on gentle slopes, above damplands.	Possible
Millotia tenuifolia var. *laevis*		*Millotia tenuifolia* var. *laevis* grows in granite or laterite soils.	No – not lateritic or granite habitat

Scientific Name	Common Name	Habitat*	Likelihood to occur on the site
Pertusaria trachyspora		*Pertusaria trachyspora* is recorded from a wetland with bare-littered brown-grey sandy clay (Western Australian Herbarium, 2000).	Unlikely - not clay habitat
Poranthera moorokatta		*Poranthera moorokatta* grows in white silica sand	Possible
Schoenus sp. Bullsbrook (J.J. Alford 915)		*Schoenus* sp. Bullsbrook (J.J. Alford 915) grows in grey peaty sand on low-lying flats.	Possible
Acacia oncinophylla subsp. *oncinophylla*		*Acacia oncinophylla* subsp. *oncinophylla* occurs in granitic soils	No – not granite habitat
Adenanthos cygnorum subsp. *chamaephyton*		*Adenanthos cygnorum* subsp. *chamaephyton* occurs in grey sand, lateritic gravel.	Unlikely
Beaufortia purpurea	Purple Beaufortia	Purple Beaufortia occurs in lateritic or granitic soils on rocky slopes.	No – not lateritic or granite habitat
Chamaescilla gibsonii		*Chamaescilla gibsonii* grows in clay to sandy clay on winter-wet flats, shallow water-filled claypans.	Unlikely - not clay habitat
Cyathochaeta teretifolia		*Cyathochaeta teretifolia* occurs in grey sand, sandy clay on swamps, creek edges.	Possible
Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)		*Eryngium pinnatifidum* subsp. Palustre is recorded from a winter wet claypan, water to 20 cm deep in grey-brown clay (Western Australian Herbarium, 1989)	No – not claypan habitat
Guichenotia tuberculata		*Guichenotia tuberculata* grows in sand clay over laterite, sand.	No – not lateritic habitat
Haemodorum loratum		*Haemodorum loratum* prefers grey or yellow sand, gravel.	Unlikely
Halgania corymbosa		*Halgania corymbosa* prefers gravelly soils, soils over granite.	No – not suitable habitat
Lasiopetalum glutinosum subsp. *glutinosum*		*Lasiopetalum glutinosum* subsp. *glutinosum* occurs in lateritic and granitic soils.	No – not lateritic or granite habitat
Meionectes tenuifolia		*Meionectes tenuifolia* occurs on swamp margins (Western Australian Herbarium, 2011)	Possible

Scientific Name	Common Name	Habitat*	Likelihood to occur on the site
Phlebocarya pilosissima subsp. *pilosissima*		*Phlebocarya pilosissima* subsp. *pilosissima* grows in white or grey sand, lateritic gravel.	No – not lateritic habitat
Pithocarpa corymbulosa		*Pithocarpa corymbulosa* occurs in gravelly or sandy loam amongst granite outcrops.	No – not gravelly habitat
Schoenus capillifolius		*Schoenus capillifolius* grows in brown mud on claypans.	No – not claypan habitat
Schoenus sp. Waroona (G.J. Keighery 12235)		*Schoenus* sp. Waroona occurs in clay or sandy clay on winter-wet flats.	Unlikely - not clay habitat
Stylidium asteroideum	Star Triggerplant	The Star Triggerplant is recorded from shallow / flat drainage lines with damp sand / loam / clay (Western Australian Herbarium, 2013)	Unlikely
Stylidium paludicola		*Stylidium paludicola* prefers peaty sand over clay in winter wet habitats in Marri and Melaleuca woodland, Melaleuca shrubland.	No – not peaty habitat
Stylidium trudgenii		*Stylidium trudgenii* grows in grey sand, dark grey to black sandy peat on the margins of winter-wet swamps, depressions.	No – not peaty habitat
Styphelia filifolia		*Styphelia filifolia* occurs in sandy soils of the coastal plain (with one known occurrence from the northern Darling Scarp), usually in Banksia or Jarrah woodland and in low-lying situations (Hislop and Lelièvre, 2017).	Unlikely
Tetratheca pilifera		*Tetratheca pilifera* occurs in gravelly soils.	No – not gravelly soils
Verticordia serrata var. linearis		*Verticordia serrata* var. *linearis* grows in white sand, gravel in open woodland.	No – not gravelly soils
Anigozanthos humilis subsp. *chrysanthus*	Golden Cats Paw	Golden Cats Paw grows in grey or yellow sand.	Unlikely
Cyanicula ixioides subsp. *ixioides*		*Cyanicula ixioides* subsp. *ixioides* grows in laterite, gravel.	No – not lateritic habitat
Darwinia pimelioides		*Darwinia pimelioides* prefers loam, sandy loam on granite outcrops.	No – not granite habitat

Scientific Name	Common Name	Habitat*	Likelihood to occur on the site
Drosera occidentalis	Western Sundew	The Western Sundew occurs in sandy and clayey soils in swamps and wet depressions.	No – not clay habitat
Hydrocotyle lemnoides	Aquatic Pennywort	Aquatic Pennywort occurs in swamps	No – not permanent water
Hypolaena robusta		*Hypolaena robusta* grows in white sand on sandplains.	Possible
Persoonia sulcata		*Persoonia sulcata* occurs in lateritic or granitic soils.	No – not lateritic or granite habitat
Schoenus natans	Floating Bog-rush	Floating Bog-rush occurs in winter-wet depressions.	Possible
Stylidium longitubum	Jumping Jacks	Jumping Jacks prefer sandy clay, clay in seasonal wetlands.	No – not clayey soils
Verticordia lindleyi subsp. *lindleyi*		*Verticordia lindleyi* subsp. *lindleyi* prefers sand, sandy clay in winter-wet depressions.	Possible

* sourced from Florabase as well as the PaWS database searches unless otherwise denoted

4.2 TEC and PEC Desktop Search

A search of DBCA's Threatened (TEC) and Priority Ecological Communities (PEC) database was conducted within a radius of 5km around the site (01-0819EC). Six TECs and four Priority 3 PECs were identified in the database search. One additional TEC at the Commonwealth level was identified in the Protected Matters Search Tool Report (Appendix 5). The communities identified in the database searches are outlined in Table 4.

Table 4: Threatened and Priority Ecological Communities likely to occur within 5km of the Site

Ecological Community	Description	Conservation Status WA	Status under the EPBC Act
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	Critically Endangered	Endangered
SCP3c	*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain	Critically Endangered	Endangered
Muchea Limestone	Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	Endangered
SCP08	Herb rich shrublands in clay pans	Vulnerable	Critically Endangered
SCP15	Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	Vulnerable	
SCP18	Shrublands on calcareous silts of the Swan Coastal Plain	Vulnerable	
Banksia WL SCP	Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region	Priority 3	Endangered

Ecological Community	Description	Conservation Status WA	Status under the EPBC Act
Tuart WL SCP	Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community	Priority 3	Critically Endangered
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	Priority 3	Endangered as part of Banksia WL SCP
SCP22	*Banksia ilicifolia* woodlands	Priority 3	Endangered as part of Banksia WL SCP
SCP23b	Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands	Priority 3	Endangered as part of Banksia WL SCP

4.3 Flora

A total of 80 plant species were recorded during the 2019 flora survey (Appendix 6). The total consisted of 44 native species and 36 (45%) introduced species. The percentage of introduced species is relatively high and reflects the past disturbance on the site for rural purposes, and unfenced access to the areas of native vegetation by cattle grazing on the properties.

The plant Families with the highest representation of species were Poaceae (Grass family – 11 species, 1 native and 10 introduced), Asteraceae (Daisy family – 10 species, 2 native and 8 introduced), Myrtaceae (Myrtle family - 10 species, all native) and Fabaceae (Pea and Wattle family – 8 species, 4 native and 4 introduced).

The data from the quadrats sampled on the site are shown in Appendix 7.

Species richness in the quadrats ranged from 6-16. Overall the species richness is considered very low for the types of vegetation recorded on the site.

One Threatened (Declared Rare) species; *Grevillea curviloba* subsp. *curviloba* (Narrow Curved-leaf Grevillea) was recorded on the site in two locations about 50m apart. The location of each population is shown on Figure 3. The boundaries of the populations were recorded with a hand-held GPS with recordings about every 10m. Further information on the species is provided in Section 4.5.1.

Two species that are Declared Pests under Section 22 of the *Biosecurity and Agriculture Management Act 2007* (BAM Act) were recorded on the site, Cape Tulip (*Moraea flaccida*) and Arum Lily (*Zantedeschia aethiopica*). Cape Tulip was very abundant in the AsMr vegetation type on damp soils. Arum Lily was scarce and mostly recorded on the edge of the wetland at the northern end of Lot 30.

4.4 Vegetation

4.4.1 Vegetation Complex

Vegetation Complexes are a broad level of vegetation description which is based on the underlying geomorphology and rainfall (Heddle *et al*., 1980). The vegetation on the site is part of the Yanga Complex. The Yanga Complex is described as "Predominantly a closed scrub of *Melaleuca* spp. and low open forest of *Casuarina obesa* on the flats subject to inundation. On drier sites the vegetation reflects the adjacent vegetation complexes of Bassendean and Coonambidgee" (Heddle *et al*., 1980).

4.4.2 Vegetation Type

The vegetation complexes are a very broad mapping unit used to map the vegetation at the scale of the whole of Western Australia. For small scale sites, such as the survey area, vegetation mapping can be further refined by vegetation types, using the composition and structure of the dominant vegetation.

Nine vegetation types were described and mapped on the site (Figure 3). The vegetation types are described in Table 5.

Table 5: Vegetation Types on the Site

Vegetation Type	Description	Photograph
Cc *Corymbia calophylla* Low Woodland over weeds	Two stands of Marri trees occurred at the northern end of Lot 29. The trees were mostly young, up to 8m high and at a low density of around 20%. The understorey was almost completely weed species with Veldtgrass (*Ehrharta calycina*) and Lupin (*Lupinus cosentinii*) the most common. The soils were dry, grey sand. Quadrat MR1 is representative of this vegetation type.	
Mr *Melaleuca rhaphiophylla* Shrubland to Tall Open Scrub over weeds	Occurs on low-lying land on the southern edge of the wetland at the northern end of Lot 30 as well as at the western end of Lot 29. *Melaleuca rhaphiophylla* trees are 2-4m high and 25-40% cover. *Melaleuca teretifolia* is sometimes present as a smaller shrub. The understorey is herbaceous and varies depending on the degree of inundation. Wetter areas contain abundant *Cotula coronopifolia* while drier areas contain *Ehrharta calycina. Lotus subbiflorus* is a very common ground cover. The soils vary from dark grey sand to black peaty sand and can be inundated up to 5cm in winter/spring. Quadrats MR2 and 4 are representative of this vegetation type.	

Vegetation Type	Description	Photograph
MrMt *Melaleuca rhaphiophylla/M. teretifolia* Open Shrubland over weeds	This vegetation type occurred on the RE wetland at the northern end of Lot 30. *Melaleuca rhaphiophylla* and *M. teretifolia* shrubs were sparse and up to 2m high. Inundated areas contained the floating aquatic *Lemna disperma* and *Cotula coronopifolia*. *Lotus subbiflorus* and Couch Grass (*Cynodon dactylon*) are abundant on the edge of the water line. The soils are black, peaty sand with no evidence of near-surface clays. The area was inundated during both survey times on 24 July and 16 September 2019. Quadrat MR3 is representative of this vegetation type.	
AsMr *Acacia saligna/Melaleuca rhaphiophylla* Tall Open Scrub over weeds	Commonly occurs on low-lying land at the northern end of lot 29. *Acacia saligna* is up to 4m high and 20% cover over *Melaleuca rhaphiophylla* 2-3.5m high. *Melaleuca teretifolia* is a common smaller shrub. The understorey is low and sparse and mostly consists of weed species such as *Rumex pulcher, Cynodon dactylon, Arctotheca calendula* and *Lolium perenne.* Only a few Flooded Gums (*Eucalyptus rudis*) occur near the eastern end of the unit. The soils are dark peaty sand and damp in winter/spring. Quadrat MR5 is representative of this vegetation type.	

Vegetation Type	Description	Photograph
As *Acacia saligna* Tall Shrubland to Tall Open Scrub over weeds	Dense stands of *Acacia saligna* up to 4m high occurred at the southern end of the AsMr vegetation unit on Lot 29. The understorey was completely weeds with Veldtgrass the most common species, as well as Cape Tulip (*Moraea flaccida*), Ryegrass (*Lolium perenne*) and *Vulpia myuros*. The soils were dry, dark grey sand. Quadrats MR6 and 10 are representative of this vegetation type.	
Jf *Jacksonia furcellata* Tall Shrubland over *Alexgeorgea nitens* Closed Sedgeland	Occurred over most of the southern half of Lot 29 on land that had been previously cleared. *Jacksonia furcellata* has regrown up to 3m high and occurs in small stands as well as individual plants. The ground cover appears weedy but contains abundant low native species such as *Alexgeorgea nitens* and *Dasypogon bromeliifolius. Ursinia anthemoides* and *Ehrharta calycina* are common introduced species. The soils are dry grey sand. Quadrat MR7 is representative of this vegetation type.	

Vegetation Type	Description	Photograph
Gc *Grevillea curviloba* subsp. *curviloba* Open Heath over *Xanthorrhoea preissii* Low Shrubland	The two stands of the Threatened species *Grevillea curviloba* subsp. *curviloba* were large enough to be mapped as a vegetation type. The *Grevillea* plants were up to 1.6m high at a density of 50-60%. One of the stands contained many *Xanthorrhoea preissii* plants but the species was absent from the other. Most of the species in both stands were introduced weeds including Bridal Creeper (*Asparagus asparagoides*), Veldtgrass (*Ehrharta calycina*) and Ryegrass (*Lolium perenne*). The soil type was a light brown sand. Quadrats MR8 and 9 are representative of this vegetation type.	
BmBa *Banksia menziesii/B. attenuata* Low Open Woodland over *Alexgeorgea nitens/Dasypogon bromeliifolius*	A small stand of Banksia woodland occurred at the south-eastern end of Lot 29. The Banksia trees were up to 4m high and sparse over a low weedy understorey with common native species *Alexgeorgea nitens* and *Dasypogon bromeliifolius* and introduced species *Eragrostis curvula* (Lovegrass) and *Ehrharta calycina*. Some *Eucalyptus todtiana* trees were also present in low numbers. The soils were dry, whitish-grey sand.	

Vegetation Type	Description	Photograph
Rc *Regelia ciliata* Low Shrubland	A small area containing *Regelia ciliata* shrubs up to 1m occurred in the centre of Lot 30 on slightly higher ground than the broader As unit. *Acacia saligna* was sparsely present to 3m. The balance of the area contained grassy weeds. The soils were dry, whitish-grey sand.	

4.4.3 Floristic Community Types

Table 6 assesses the vegetation on the site against the TECs and PECs that have been recorded within 5km of the site.

None of the potential TECs or PECs are considered likely to occur on the site due to the degraded and completely degraded condition of most vegetation types which does not allow for accurate assessment of Floristic Community Types either by computer analysis or qualitatively using Table 12 of Gibson *et al.* (1994).

The *Melaleuca rhaphiophylla/M. teretifolia* Open Shrubland over weeds vegetation type that occurs in the wetland at the northern end of Lot 30 has potential to be the TEC SCP 15 'Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain' as it contains the two typical shrub species *Melaleuca rhaphiophylla* and *Melaleuca teretifolia* as well as some herbaceous species such as *Cotula coronopifolia*. The vegetation may represent a degraded example of SCP 15.

The wetland vegetation at the northern end of Lot 30 also has potential to be representative of the Claypans of the Swan Coastal Plain ecological community as the site is inundated for long periods and potentially contains unusual herbaceous species that emerge as the wetland dries out. However, the dominant shrub species *Melaleuca rhaphiophylla* and *M. teretifolia* are not characteristic of the TEC. In addition, the ground cover was mostly weeds, apart from *Cotula coronopifolia,* and no native ephemeral species appeared as the wetland water receded between July and September. The surface soils are peaty sand rather than clay.

The only area mapped as being in Good condition, the *Grevillea curviloba* subsp. *curviloba* vegetation type contained very few other species to enable an assessment of FCTs. While *Grevillea curviloba* subsp. *curviloba* is known to be associated with the Muchea Limestone ecological community its presence does not necessarily mean the vegetation is Muchea Limestone. The Muchea Limestone community contains a range of vegetation types that are influenced by the limestone substrates. No plant species that are typical or common in limestone substrates occur on the site. As a result of the absence of limestone in the soil and limestone indicator plant species, the presence of *Grevillea curviloba* subsp. *curviloba* does not in this instance indicate that the Muchea Limestone community occurs on the site. The highly disturbed nature of the vegetation in and around the areas of *Grevillea curviloba* subsp. *curviloba* vegetation make it extremely difficult to determine what the FCT would be if the vegetation were in better condition.

Table 6: Threatened and Priority Ecological Communities Assessment

Ecological Community	Description	Assessment
Mound Springs SCP	Communities of Tumulus Springs (Organic Mound Springs, Swan Coastal Plain)	Not on site – no springs or associated vegetation on site
SCP3c	*Corymbia calophylla - Xanthorrhoea preissii* woodlands and shrublands, Swan Coastal Plain	Not on site – Understorey of *Corymbia calophylla* (Marri) woodland completely degraded and does not contain *Xanthorrhoea preissii*
Muchea Limestone	Shrublands and woodlands on Muchea Limestone of the Swan Coastal Plain	Not on site – No limestone in the topsoil. No limestone indicator species on site.
SCP08	Herb rich shrublands in clay pans	Not on site – Wetland is not herb rich

Ecological Community	Description	Assessment
SCP15	Forests and woodlands of deep seasonal wetlands of the Swan Coastal Plain	Possible – MrMt vegetation in the wetland at the northern end of Lot 30 contains characteristic species but is in weedy condition.
SCP18	Shrublands on calcareous silts of the Swan Coastal Plain	Not on site – No calcareous silts on the site
Banksia WL SCP	Banksia Dominated Woodlands of the Swan Coastal Plain IBRA Region	Not on site - Small area containing *Banksia attenuata* and *B. menziesii* too degraded and not sufficient size to meet the criteria for the TEC
Tuart WL SCP	Tuart (*Eucalyptus gomphocephala*) Woodlands and Forests of the Swan Coastal Plain ecological community	Not on site – No Tuarts on site
SCP21c	Low lying *Banksia attenuata* woodlands or shrublands	Not on site – Small area of Banksia woodland not low-lying
SCP22	*Banksia ilicifolia* woodlands	Not on site - *Banksia ilicifolia* only present as individual trees in a parkland cleared setting
SCP23b	Swan Coastal Plain *Banksia attenuata* - *Banksia menziesii* woodlands	Not on site – Small area containing *Banksia attenuata* and *B. menziesii* too degraded to meet the definition of this community

4.4.4 Vegetation Condition

The condition of the vegetation was assessed according to the system of Keighery as described in Bush Forever (Government of Western Australia, 2000) (Table 7).

Table 7: Vegetation Condition Rating Scale

Condition	Description
Pristine	Pristine or nearly so, no obvious signs of disturbance.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good	Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate to it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

Condition	Description
Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

The condition of the vegetation is shown in Figure 4. The majority of the vegetation on the site is rated as Degraded to Completely Degraded due to the dominance of weeds in the understorey and significant alteration of the vegetation structure in other areas. No areas in Very Good condition or better were recorded on the site.

4.5 Conservation Significance of Flora and Vegetation

4.5.1 Flora

Two stands of the Threatened species *Grevillea curviloba* subsp. *curviloba* (Narrow curved-leaf Grevillea) were recorded on the site (Figure 3). The species had tentatively been identified on the site in a preliminary survey prepared for the landowners. PGV Environmental confirmed the identification of the species by lodging a specimen (under an Authorisation to take) at the Perth Herbarium. In addition, DBCA botanist Anne Harris confirmed the species on site on 23 October 2019.

Research on the genetic diversity of *Grevillea curviloba* by H. Nistelberger (2006) indicated that stands of the species may be clonal and represent one or a very few number of individuals. The two stands on the site, which have thousands of stems each, therefore may actually only be two individuals that have spread by underground runners.

Whatever the number of individuals occur in the two stands, the stands represent new populations for the Critically Endangered species and should be protected as far as possible from current and future land uses.

4.5.2 Vegetation

Vegetation Complex

The vegetation on the site is mapped as part of the Yanga vegetation Complex. According to the Perth Biodiversity Project (WALGA, 2013) the original extent of the Yanga Complex in the Perth and Peel Regions was 26,176.31ha. Of that, 4,645.77ha, or 17.75% which is less than the EPA's target for minimum 30% retention of vegetation complexes State-wide. There is 1.89% of the Yanga Complex with some formal protection. The percentage protection is below the 10% minimum criteria for vegetation complexes in the Perth and Peel Region Constrained Areas.

The vegetation is considered to be too degraded to be a significant remnant of the Yanga Complex.

Floristic Community Type

No Threatened Ecological Communities or Priority Ecological Communities based on FCTs occur on the site due to the degraded condition of all vegetation types.

The wetland vegetation at the northern end of Lot 30 has potential to be representative of a degraded example of FCT 15 which is a TEC at State level.

5 SUMMARY AND CONCLUSIONS

The 2019 Flora and Vegetation survey of Lots 29 and 30 Maralla Road resulted in the following findings:

- Most of the site has been cleared in the past for rural activity. Regrowth and remnant vegetation remains in scattered areas on the site;
- A total of 80 plant species were recorded during the flora survey. This total consisted of 44 native species and 36 (46%) introduced species;
- Two stands of the Threatened (Declared Rare) species *Grevillea curviloba* subsp. *curviloba* (Narrow curved-leaf Grevillea) were recorded on the site, with more than 1,000 stems in each stand. The population is a new record for this Critically Endangered species;
- No other conservation significant species were recorded;
- Two weed species, Cape Tulip (*Moraea flaccida*) and Arum Lily (*Solanum linnaeanum*) were recorded that are listed as Declared Pests under S22 of the BAM Act;
- Nine vegetation types were described and mapped on the site;
- The condition of the remnant vegetation was mostly Degraded or Completely Degraded with the only area in Good condition being where the *Grevillea curviloba* subsp. *curviloba* occurred;
- The remnant vegetation is part of the Yanga Vegetation Complex which has 55.4% of its original extent remaining and 17.75% with 1.89% protection which is less the 10% retention target in the Perth and Peel Regions Constrained Area and the EPA's general target for retention of at least 30% of all vegetation complexes in Western Australia however the vegetation is too degraded to be regionally significant at the Vegetation Complex level; and
- The vegetation types are considered too degraded to accurately assign to a FCT. As a result, no TECs or PECs are considered to occur on the site. The *Melaleuca rhaphiophylla/M. teretifolia* Open Shrubland over weeds vegetation type that occurs in the wetland at the northern end of Lot 30 has potential to be a degraded example of FCT 15 'Forests and woodlands of deep seasonal wetlands'.

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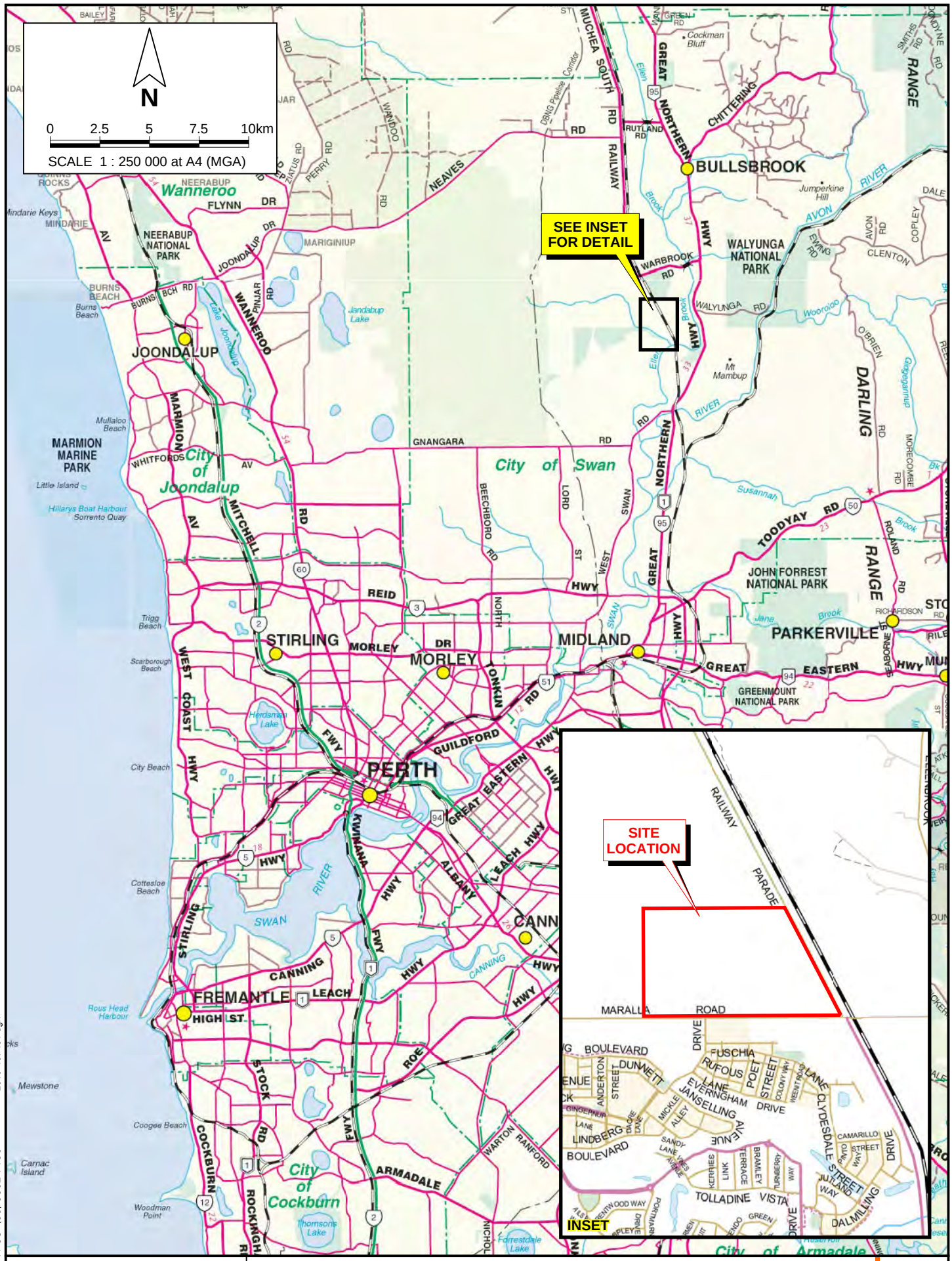
FIGURES



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pgv ENVIRONMENTAL

RPS Australia West Pty Ltd
FLORA AND VEGETATION SURVEY
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: P. van der Moezel	Date: 12 Nov 2019
Job: 10355 Rpt: 2019-467	Revision: A

SITE LOCATION

Figure 1

406 250mE
406 500mE
406 750mE
407 000mE
6 488 250mN
6 488 000mN
6 487 750mN
53
52
39
31
227
542
R 46875
543
R 46875
544
R 46875
9330
Lot 30
Lot 29
RAILWAY
RAILWAY
PARADE
MARALLA
ROAD

N

0 20 40 60 80 100m

SCALE 1 : 3 000 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary

CADASTRAL SOURCE: Landgate, August 2019.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown July 2019.

2019-467-f02.dgn

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pgv ENVIRONMENTAL

RPS Australia West Pty Ltd
FLORA AND VEGETATION SURVEY
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: P. van der Moezel | Date: 12 Nov 2019

Job: 10355 Rpt: 2019-467 | Revision: A

SITE BOUNDARY

Figure 2

406 250mE
406 500mE
406 750mE
407 000mE
6 488 250mN
6 488 000mN
6 487 750mN
53
52
31
MR03
MrMt
Mr
MR02
MR01
Cc
Cleared
AsMr
MR04
MR05
MR10
As
Gc
MR09
MR06
Rc
Jf
MR08
MR07
BmBa
Exotic
Lot 30
Lot 29
RAILWAY
PARADE
MARALLA
ROAD
227
9330
542
R 46875
543
R 46875
544
R 46875

Vegetation Types

Cc
Corymbia calophylla Low Woodland over weeds

Mr
Melaleuca rhaphiophylla Shrubland to Tall Open Scrub over weeds

MrMt
Melaleuca rhaphiophylla/M. teretifolia Open Shrubland over weeds

AsMr
Acacia saligna/Melaleuca rhaphiophylla Tall Open Scrub over weeds

As
Acacia saligna Tall Shrubland to Tall Open Scrub over weeds

Jf
Jacksonia furcellata Tall Shrubland over Alexgeorgea nitens Closed Sedgeland

Gc
Grevillea curviloba subsp. *curviloba* Open Heath over *Xanthorrhoea preissii* Low Shrubland

BmBa
Banksia menziesii/B. attenuata Low Open Woodland over *Alexgeorgea nitens/Dasypogon bromeliifolius*

Rc
Regelia ciliata Low Shrubland

N

0 20 40 60 80 100m

SCALE 1 : 3 000 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Quadrat
- Vegetation Type Boundary
- As Vegetation Type

CADASTRAL SOURCE: Landgate, August 2019.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown July 2019.

2019-467-f03.dgn

PINPOINT CARTOGRAPHICS (08) 9562 7136

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Job: 10355 Rpt: 2019-467 | Revision: A

RPS Australia West Pty Ltd
FLORA AND VEGETATION SURVEY
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

VEGETATION TYPES

Figure 3

406 250mE
406 500mE
406 750mE
407 000mE
53
52
6 488 250mN
6 488 000mN
6 487 750mN
31
39
D
CD
G
Lot 30
Lot 29
RAILWAY
PARADE
MARALLA
ROAD
9330
543
R 46875
544
R 46875

Vegetation Condition
(SOURCE: Bush Forever, Govt. of W.A., 2000)

P - Pristine
Pristine or nearly so, no obvious signs of disturbance.

Ex - Excellent
Vegetation structure intact, disturbance affecting individual species and weeds are non aggressive species.

VG - Very Good
Vegetation structure altered, obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.

G - Good
Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

D - Degraded
Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.

CD - Completely Degraded
The structure of the vegetation is no longer intact and the areas is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora composing weed or crop species with isolated native trees or shrubs.

Cl - Cleared
No native vegetation remaining.

N

0 20 40 60 80 100m

SCALE 1 : 3 000 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Vegetation Condition Boundary
- CD Vegetation Condition

CADASTRAL SOURCE: Landgate, August 2019.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown July 2019.

PINPOINT CARTOGRAPHICS (08) 9562 7136
2019-467-f04.dgn

pgv ENVIRONMENTAL

RPS Australia West Pty Ltd
FLORA AND VEGETATION SURVEY
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: P. van der Moezel | Date: 12 Nov 2019
Job: 10355 Rpt: 2019-467 | Revision: A

VEGETATION CONDITION

Figure 4

APPENDIX 1

DBCA Flora database Searches

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
283	723223	3219	Acacia anomala	T	Suffrutex caespitosus, 30 - 45 cm alt; fl. luteis.				Near Bullsbrook, Darling Range	MAN	3	/09/1966
284	723215	3219	Acacia anomala	T	Spindly plant 0.3; flowers yellow.	In Jarrah forest.			Smiths Road, 2 km NE of Bullsbrook	MAN	3	4/09/1981
289	723630	3219	Acacia anomala	T	Herb: 20 - 30 cm. Flowers bright yellow - styles turn brown and stamens (i.e. filaments).				East Bullsbrook	MAN	3	9/09/1980
291	723681	3219	Acacia anomala	T					0.3 miles along Smiths Road, Smiths Road is ca 3 km from Bullsbrook East along Chittering Road	MAN	3	17/08/1982
293	5551323	3219	Acacia anomala	T	Grass-like, 0.5 m high. Multiple stems of grass-like shrub.	Jarrah/Marri forest over scrub.			Jenkin's Road, Bullsbrook,	AUTO	3	//
3168	5082854	14129	Acacia oncinophylla subsp. oncinophylla	3		Eucalyptus calophylla Low Forest, over Acacia saligna Open Low Woodland, over Leptosperma erubescens, A. saligna Scrub, over Xanthorrhoea preissii Open Dwarf Scrub, over Hibbertia hypericoides, Phyllanthus calyinus Low Heath.			Walyunga National Park, in small gully 100 m E of railway line (c. 300m NE of major creekline) c. 2km ESE of Woodsome Hill. (Plot-WAYL09)	GPS	1	5/09/1996
3186	5124255	14129	Acacia oncinophylla subsp. oncinophylla	3		Grevillea endlicheriana Open Scrub, over Acacia spp., Melaleuca radula Heath, over Darwinia citriodora, Hibbertia subvaginata Low Heath, over Borya sphaerocephala, Conostylis androstemma Herbs.			Walyunga National Park, on N side of 4WD track c. 1.1 km NE of Wooroloo Creek crossing, c. 3 km SE of Woodsome Hill. (Plot-WAYL11)	GPS	1	6/09/1996
3188	7213182	14129	Acacia oncinophylla subsp. oncinophylla	3		Eucalyptus calophylla Low Forest, over Acacia saligna Open Low Woodland, over Leptosperma erubescens, A. saligna Scrub, over Xanthorrhoea preissii Open Dwarf Scrub, over Hibbertia hypericoides, Phyllanthus calyinus Low Heath.			Walyunga National Park, in small gully 100 m E of railway line (c. 300m NE of major creekline) c. 2km ESE of Woodsome Hill. (Plot-WAYL09)	GPS	1	5/09/1996
3192	6843697	14129	Acacia oncinophylla subsp. oncinophylla	3	Single stemmed shrub to 1.8 m senescent.	With Hakea lissocarpha, Casuarina humilis.			Susannah Brook, end of Padbury Road, Upper Swan	UNK	3	3/09/1980

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
4851	7132832	11336	Adenanthos cygnorum subsp. chamaephyton	3	Prostrate shrub 10 cm high x 1.5 m wide.	Low woodland. Banksia attenuata, B. menziesii, Eucalyptus marginata subsp. thalassica.	population of 30 plants.		Road verge on Jenkins Road opposite Lot 41, Bushplan Site 291	UNK	3	14/05/1999
6574	8772584	11957	Anigozanthos humilis subsp. chrysanthus	4	Perennial herb, 0.3 m high x 0.2 m wide. Flowers yellow.	Eucalyptus todtiana isolated mid mallee trees over Banksia attenuata, Banksia menziesii and Nuytsia floribunda sparse low woodland over Verticordia nitens, Beaufortia elegans, Jacksonia floribunda.	2 plants.		W of St Patrick Road, Ellenbrook	GPS	1	24/09/2014
10507	2290413	5390	Beaufortia purpurea	3		Open Wandoo woodland.			Walyunga National Park	AUTO	4	14/01/1988
10529	2290421	5390	Beaufortia purpurea	3	Shrub greater than 1.25 m high. Red-purplish flowers.	With Eucalyptus calophylla and Melaleuca radula woodland.	locally frequent.		Walyunga National Park	AUTO	4	10/02/1988
10533	7893949	5390	Beaufortia purpurea	3	Shrubs to 1 m high x 0.8 m diam., single-stemmed at base. Stamens bright dark crimson.	Marri - Wandoo - Jarrah forest.	frequent.		Wandoo Heights Nature Reserve, Millendon	GPS	1	7/12/2007
10535	9049576	5390	Beaufortia purpurea	3	Shrub.		50+ plants.		Top end of Loton Road, Millendon, well down scarp on road verge	TOPO	2	16/11/1985
12749	8008140	45757	Calectasia elegans	2	Small shrub.	Associated species: Adenanthos cygnorum subsp. cygnorum, Jacksonia floribunda to 2.5 m, 20% cover, Beaufortia elegans to 1.7 m, 15% cover, Eremaea pauciflora subsp. pauciflora, Leucopogon conostephoides, Nuytsia floribunda to 0.9 m, 10% cover.	uncommon.		Gnangara - Moore River State Forest, Melaleuca Block, 10 m W of Walton Road, 190 m N from intersection of corner of Warbrook and Walton Road, 10.3 km SW from Bullsbrook, GSS site PC1C	GPS	1	11/09/2008
12750	8008132	45757	Calectasia elegans	2	Small shrub.	Associated species: Banksia attenuata, Nuytsia floribunda to 5 m, 10% cover, Jacksonia floribunda, Adenanthos cygnorum subsp. cygnorum to 1.6 m, 5% cover, Verticordia nitens to 1.5 m, 2% cover.	uncommon.		Gnangara - Moore River State Forest, Melaleuca Block, 130 m E of St Patrick Road, 25 m S from intersection of corner of Warbook Road and St Patrick Road, 11 km SW of Bullsbrook, GSS site PC4A	GPS	1	11/09/2008
15908	256935	13826	Cyanicula ixioides subsp. ixioides	4					Upper Swan	MAN	3	/09/1913

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
15963	8122342	16245	Cyathochaeta teretifolia	3		Melaleuca preissania to 7.0 m, 10% cover, over Xanthorrhoea preissii, Banksia ilicifolia to 5.0 m, 20% cover, over Pultenaea reticulata, Astatea scoparia to 1.8 m, 10% cover, over Hypocalymma angustifolium to 0.7 m, 10% cover, over Mixed to 0.2 m, 10% co			Gnangara-Moore River State Forest, Melaleuca Block, 130 m W of a point 320 m N of intersection of Quicke Road and St Patrick Road, Bullsbrook, 13.8 km ENE of Wanneroo, GSS site 19B	GPS	1	26/10/2008
15978	6529887	16245	Cyathochaeta teretifolia	3	Sedge, 0.6-1.6 m.	Melaleuca preissiana, Banksia littoralis low open woodland over Melaleuca teretifolia high open shrubland over Melaleuca lateralis, Astartea aff. fascicularis shrubland to heath over Lepidosperma longitudinale, Baumea rubiginosa dense sedgeland. Dominant			Site ML29, N of Gnangara Road, NE section of Lot 47 Lexia Avenue, locality of Ellenbrook	GPS	1	21/08/1999
15982	6570240	16245	Cyathochaeta teretifolia	3	Tufted perennial herb to 1.5 m.	Associated species: Eucalyptus calophylla.			Cardinal Drive Bushland (Bush Forever Site 23) approx. 200 m N Bordeaux Road (adjacent to System 6 Update quadrat vines01) Ellenbrook Bushland	GPS	1	3/11/1995
15983	6527930	16245	Cyathochaeta teretifolia	3	Sedge.	Melaleuca preissiana, Banksia littoralis, low woodland to low open forest (patchy) over Pericalymma ellipticum var. ellipticum heath to closed heath over sedges.			Site ML36M ,N of Gnangara Road, SW side of Lot 47 Lexia Avenue, locality of Ellenbrook	GPS	1	6/09/1999
15985	6527914	16245	Cyathochaeta teretifolia	3	Sedge.	Corymbia calophylla over Agonis linearifolia high open shrubland over Xanthorrhoea preissii open shrubland. Zantedeschia aethiopica (young) established here.			Site ML44A, N of Gnangara Road, SE side of Lot 47 Lexia Avenue, locality of Ellenbrook	MAN	2	28/09/1999
16753	1026739	5523	Darwinia pimelioides	4	Frutex tenuis, usque 30 cm alt., involucrum viridio-rubrum.				Susannah Brook.	MAN	3	//1965
18756	2386372	3115	Drosera occidentalis	4					Rutland road and Great Northern Highway junction, Bullsbrook	AUTO	3	22/10/1987

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
19018	6512372	17605	Eleocharis keigheryi	T	Erect annually renewed sedge; flowers green.	Sedges.	abundant in deepest area of claypan, in mown area of airfield.		SW side of Pearce Airforce Base (System 6 Area M15, Bush Forever Site 294) opposite in town area to E of the boundary road	GPS	1	20/09/1994
19025	2266865	17605	Eleocharis keigheryi	T	Tufted perennial herb, flowers inconspicuous.		common.		Ellen Brook Tortoise Reserve, 21 miles N of Perth,	MAN	0	19/10/1978
19027	7782020	17605	Eleocharis keigheryi	T	Clumping grass-like sedge with height to 50 cm. Flowers green.	Transitions from open clay pans comprised excusively of of E. keigheryi to vegetated clay pans. Melaleuca spp., Verticordia sp. Chorizandra enodis, herbs, Avena fatua and Briza maxima.	frequent.	Plants are located in seasonally inundated claypans scattered throughout S portion of reserve.	Ellen Brook Nature Reserve, W side of the Great N Highway, Upper Swan	GPS	1	9/11/2007
19029	7782047	17605	Eleocharis keigheryi	T	Clumping grasslike sedge, green with yellow hairs. Height 20 - 30 cm.	Chorizandra enodis. Trees and shrubs 1-2 m.			Ellen Brook Nature Reserve, upper swan	GPS	1	12/10/2007
19030	7782039	17605	Eleocharis keigheryi	T	Clumping grass-like sedge to about 40 cm high. Green flowers with yellow hairs.	Cotula coronopifolia, Triglochin sp., sedges and weed spp.	abundant in deepest section of claypan.		RAAF Pearce Aerodrome, Bullsbrook, population located on SW side of the airforce base in an open clay pan	GPS	1	17/09/2007
20624	6512283	41801	Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)	3	Erect annually renewed herb; flowers green/white/purple.	Melaleuca shrubland.	locally common.		Wetland area to the N of quadrat Vines 01, W Vines residential area. Shire of Swan (Bush Forever Site 23)	GPS	1	3/11/1995
27313	7708602	1976	Grevillea christineae	T	Erect shrub multi branching from ground level, flowers white / cream, some styles aged to red. 1.8 m high x 2.4 m wide. Early - mid flowering stage.	Scattered Eucalyptus rudis with Grevillea enlicheriana, Calothamnus quadrifidus, Hakea erinacea, Labichea lanceolata, Darwinia citriodora, Petrophile biloba, Gastrolobium spinosum, weeds.	27 plants from area; 150 m EW x 50 m NS.		Bells Rapid Park, Cathedral ave, Upper Swan. On the S side of the footbridge between the Swan River and the EW railway line	GPS	1	9/07/2007

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
27360	8649707	14408	Grevillea curviloba subsp. curviloba	T	Perennial shrub, to 4 m high, to 10 m wide.	Eucalyptus rudis low forest over open scrub over very open low sedges. Corymbia calophylla, Melaleuca rhaphiophylla, Jacksonia furcellata, Xanthorrhoea preissii, Hakea prostrata, Hibbertia hypericoides, Lepidosperma longitudinale.	7 clumps, clonal.	Degraded habitat. New population.	Lot 9500 Maralla Road, The Vines. Plants occur in the riparian zone at the SE end of the property, c. 100 m N of Muirfield Way	GPS	1	30/06/2009
27361	8526656	14408	Grevillea curviloba subsp. curviloba	T	Erect shrub, 1.5 m tall with white cream flowers.	Associated species: Corymbia calophylla, Eucalyptus rudis, Xanthorrhoea preissii and Acacia saligna.	3 plants.	Vegetation condition: good.	Western bank of the Sawpit Gully Creek, Sawpit Gully Ellenbrook, c. 500 m N of the intersection of Roxburghe Drive and Tolladine Vista	GPS	1	16/09/2013
27365	2415887	14408	Grevillea curviloba subsp. curviloba	T					Bullsbrook, Swan River	AUTO	3	14/08/1900
27366	5414156	14408	Grevillea curviloba subsp. curviloba	T	Open, erect shrub 3+ m high x 2+ m wide. Old mature plants, appeared heavily grazed. No lower branches. No pods.	Open Scrub (very old). Associated species: Acacia saligna, Melaleuca rhaphiophylla, sedges, Xanthorrhoea preissii, Banksia menziesii.	common locally.		Maralla Road, Muchea, 7 km W from intersection with Railway Parade, S side of road,	TOPO	2	9/09/1998
27370	6512836	14408	Grevillea curviloba subsp. curviloba	T	Spreading shrub to 1 m.	Associated species: Eucalyptus calophylla.			Cardinal Drive Bushland (Bush Forever Site 23). c. 200 m N Bordeaux Road (adjacent to System 6 Update quadrat vines 01) Ellenbrook Bushland	GPS	1	3/11/1995
27374	5492963	14408	Grevillea curviloba subsp. curviloba	T	Woody shrub to 3 m high. Erect branches. Mid pale green leaves, cream flowers.	Shrubland/Sedgeland. Characteristic species: Hakea varia.			Ellenbrook,	MAN	0	15/02/2000
27375	8863768	14408	Grevillea curviloba subsp. curviloba	T	Spreading shrub to 1.6 m with pinnatifid leaves, in early flower bud stage. Juvenile growth prostrate with broader leaf lobes than the mature upright leaves.	Open Tall Shrubland of Acacia saligna over Open Shrubland of Xanthorrhoea preissii and Acacia ? cochlearis over African love grass, perennial Veldt grass and Cyathochaeta avenacea. Occasional Thysanotus ? patersonii and Hakea prostrata.	c. 120 plants in sometimes dense local patches, over a 230 m length.	Canker evident on many shrubs.	Rail reserve, E side, c. 210 m N of West Road rail crossing, Bullsbrook	GPS	1	6/09/2016

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
27376	8649723	14408	Grevillea curviloba subsp. curviloba	T	Perennial shrub, to 4 m high, to 10 m wide.	Eucalyptus rudis low forest over open scrub over very open low sedges. Corymbia calophylla, Melaleuca rhaphiophylla, Jacksonia furcellata, Xanthorrhoea preissii, Hakea prostrata, Hibbertia hypericoides, Lepidosperma longitudinale.	12 clumps, likely to be clonal.	Degraded habitat. New population.	Maralla Nature Reserve, The Vines (CR46874). Plants occur in riparian zone at the SE end of the reserve	GPS	1	30/06/2009
27377	8649715	14408	Grevillea curviloba subsp. curviloba	T	Perennial shrub, to 4 m high, to 10 m wide.	Eucalyptus rudis low forest over open scrub over very open low sedges. Corymbia calophylla, Melaleuca rhaphiophylla, Jacksonia furcellata, Xanthorrhoea preissii, Hakea prostrata, Hibbertia hypericoides, Lepidosperma longitudinale.	12 clumps, likely to be clonal.	Degraded habitat. New population.	Maralla Nature Reserve, The Vines (CR46874). Plants occur in riparian zone at the SE end of the reserve	GPS	1	30/06/2009
27379	9068759	14408	Grevillea curviloba subsp. curviloba	T	Very large shrub over 2 m. White flowers.	Occasional Xanthorrhoea preissii and weeds including Watsonia, Couch grass, love grass, veldt grass.	occasional - 1 adult and 3 juveniles in area.		In railway reserve, 360 m S of Strachen Road, E of Railway Parade and W of railway line, Bullsbrook	GPS	1	21/09/2011
27380	9068767	14408	Grevillea curviloba subsp. curviloba	T	Shrub with white flowers.	Tall open scrub of Acacia saligna and Jacksonia sp.; over open heath of Grevillea curviloba subsp. curviloba with occasional Xanthorrhoea preissii; over weeds of Eragrostis curvula, Watsona sp. and Poa sp.			Between Railway Parade and Almeria parade, E of the railway line, c. 230 m S of West Road railway crossing, Bullsbrook	GPS	1	30/08/2012
27381	9068775	14408	Grevillea curviloba subsp. curviloba	T	Shrub over 2 m high, in bud. Some plants prostrate.	Tall open scrub of Acacia saligna with occasional Banksia littoralis, B. sessilis, Hakea varia; over open heath of Stirlingia latifolia, Dianella revoluta and weeds of Eragrostis curvula, Oxalis sp. Babiana sp., Asparagoides.	locally frequent.		Between Almeria Parade and the railway line, c. 700 m S of Strachen Road railway crossing, Bullsbrook	GPS	1	17/08/2012

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
27382	9068813	14408	Grevillea curviloba subsp. curviloba	T	Large shrub to 2 m with white flowers.	Occasional Banksia menziesii; over shrubland of Grevillea curviloba subsp. curviloba, Xanthorrhoea preissii, Acacia saligna; over closed sedgeland of Schoenus subfascicularis; over weeds.	occasional.	Leaves similar to G. vestita in this population, but leaf lobes sparsely tomentose with white hairs, not villous with rust coloured hairs as in G. vestita. Floral bracts deciduous, not persistent as in G. vestita.	Unnamed nature reserve (Maralla Road Nature Reserve) R 46875, 60 m S of Maralla Road, 1000 m E of Sawpit Road	GPS	1	21/09/2011
27384	2415925	14408	Grevillea curviloba subsp. curviloba	T	Shrub 1.5 - 1.8 m with white flowers and pinnate leaves.				Bullsbrook	AUTO	3	5/10/1972
27422	8816433	14409	Grevillea curviloba subsp. incurva	T	Upright shrub, to 2 m high. Variable width. White flowers.	Occasional Acacia saligna over Shrubland of Grevillea curviloba and Xanthorrhoea preissii over Closed Grassland of mixed weed species dominated by Agrostis curvula and Ehrharta calycina. Associated species: Corynotheca micrantha, Burchardia congesta, Jac	ca 25 shrubs in one localised area.	Plants are in poor condition. Insects are having a secondary impact on the population which is stressed from weed competition and drying climate.	Ca 20 m S of Neaves Road along Railway Road, on the E side of the rail reserve, Bullsbrook	GPS	1	22/10/2015

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
27424	9068740	14409	Grevillea curviloba subsp. incurva	T	Shrub to 2 m. White flowers starting to emerge.	Open woodland of Melaleuca rhaphiophylla and M. preissiana; over Grevillea curviloba subsp. incurva and Macrozamia riedlei; over closed sedgeland of Schoenus subfascicularis (riparian zone) and weeds.	occasional - 1 plant only.		Maralla Road Nature Reserve (R46875), c. 75 m S of Maralla Road, c. 1 km E of Sawpit Road	GPS	1	17/08/2012
29693	2697246	16952	Guichenotia tuberculata	3					Near Bullsbrook, between New Norcia and Perth	AUTO	3	/09/1902
29891	1044567	1469	Haemodorum loratum	3	Bulbous herb. Inflorescence to 2 m, flowers green/brown, scented.	Wandoo woodland.			20 km ESE Muchea.	MAN	0	13/11/1981
30239	1111167	6686	Halgania corymbosa	3	Compact shrub to 40 cm high. Flowers blueish.				Susannah Brook, Millendon.	MAN	3	3/09/1980
31802	1137654	6233	Hydrocotyle lemnoides	4					Ellen Brook Nature Reserve	AUTO	3	22/08/1989
31805	1048104	6233	Hydrocotyle lemnoides	4	Corolla mauve. Leaves floating, stem rooted in clay.				15 km N of Midland on Great Northern Highway, Martyn Reserve	MAN	3	7/10/1976
31806	3401332	6233	Hydrocotyle lemnoides	4					21 mile peg Reserve Great Northern Highway [10 km S of Bullsbrook East]	AUTO	3	/09/1963
31808	1048112	6233	Hydrocotyle lemnoides	4					Short-necked Tortoise Reserve ca. 15 km N of Midland	MAN	4	13/09/1985
31822	1048139	6233	Hydrocotyle lemnoides	4	Leaves floating, stem rooted in clay. Corolla mauve.				15 km N of Midland on Great Northern Highway. Martyn Reserve	MAN	3	7/10/1976
32103	6528333	17622	Hypolaena robusta	4	Female. Rush, 40-65 cm.	Banksia attenuata, Banksia menziesii low woodland over scattered Adenanthos cygnorum ssp. cygnorum over Conospermum stoechadis, Jacksonia densiflora open shrubland over Eremaea pauciflora ssp. pauciflora, Stirlingia latifolia, Astroloma xerophyllum, Scho			Site ML35, N of Gnangara Road, S side of Lot 47 Lexia Avenue, locality of Ellenbrook	GPS	1	1/09/1999

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
32104	6528341	17622	Hypolaena robusta	4	Male. Rush, 40-65 cm.	Banksia attenuata, Banksia menziesii low woodland over scattered Adenanthos cygnorum ssp. cygnorum over Conospermum stoechadis, Jacksonia densiflora open shrubland over Eremaea pauciflora ssp. pauciflora, Stirlingia latifolia, Astroloma xerophyllum, Scho			Site ML35, N of Gnangara Road, S side of Lot 47 Lexia Avenue, locality of Ellenbrook	GPS	1	1/09/1999
33760	5117615	45081	Lasiopetalum glutinosum subsp. glutinosum	3		Petrophile biloba, Hakea undulata Low Scrub, over Dryandra armata, Calytrix glutinosa, Calothamnus sanguineus Heath, over Borya sphaerocephala Herbs.			Walyunga National Park, on N side of 4WD track c. 700m NE of Wooroloo Creek crossing, c. 3km SE of Woodsome Hill. (Plot-WAYL10)	GPS	1	5/09/1996
38058	8772630	14337	Millotia tenuifolia var. laevis	2	Annual herb, 0.05 m high x 0.01 m wide. Flowers yellow.	Banksia attenuata and Banksia menziesii low woodland over Eucalyptus todtiana sparse mid mallee woodland over Adenanthos cygnorum subsp. cygnorum sparse tall shrubland over Eremaea pauciflora var. pauciflora sparse mid shrubland over Hibbertia hypericoid			S of Maralla Road, Ellenbrook	GPS	1	24/09/2014
39532	5991714	2278	Persoonia sulcata	4	Decumbent shrub 0.2 m high with smooth, compact bark. Leaves spreading, slightly twisted, bright green.	Eucalypt woodland with low shrubby understory.	three plants seen.		Great Northern Highway, 102.6 km N of Perth GPO, 12.4 km N of turnoff to Toodyay,	MAN	3	18/12/1980
39981	6498841	11557	Phlebocarya pilosissima subsp. pilosissima	3	Herb 15 cm.	Banksia attenuata, Banksia ilicifolia low open woodland to low woodland over Regelia ciliata open scrub to closed scrub over Hypocalymma angustifolium open shrubland to open heath over scattered herbs and sedge of Dasypogon bromeliifolius and Hypolaena e		From site ML 18, Specimen ML18-12.	N of Gnangara Road, NE corner of Lot 46 Maralla Road, locality of Ellenbrook	GPS	1	20/08/1999

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
39982	6498868	11557	Phlebocarya pilosissima subsp. pilosissima	3	Herb, 15 cm.	Banksia attenuata, Banksia ilicifolia low open woodland to low woodland over Regelia ciliata open scrub to closed scrub over Hypocalymma angustifolium open shrubland to open heath over scattered herbs and sedge of Dasypogon bromeliifolius and Hypolaena e		From site ML 18, Specimen ML18-13.	N of Gnangara Road, NE corner of Lot 46 Maralla Road, locality of Ellenbrook	GPS	1	20/08/1999
40355	8017867	8163	Pithocarpa corymbulosa	3	Erect, annual herb 100 cm high x 75 cm wide. Flowers white.	Tall shrubland, Eucalyptus marginata, Xanthorrhoea preissii, Beaufortia purpurea, Verticordia acerosa, Hemigenia incana, Nuytsia floribunda, Allocasuarina humilis, Petrophile biloba, Hakea undulata, Hibbertia subvaginata.	2-5 plants.	Adult population. Percentage of population flowering 100%.	265 Boulonnais Drive, Brigadoon. Firebreak at NW end of block, near granite outcrop	TOPO	2	13/01/2009
40807	6350178	42022	Poranthera moorokatta	2	Erect annual herb, 1 cm.	Dominants: Melaleuca preissiana 4-13 +m 1-5% (varies); Calothamnus lateralis, Pericalymma ellipticum var. ellipticum 0.5-1 m >15%; Astartea aff. fascicularis 1-1.4 m <5%. Associated species: The more abundant species for this site were Phyllangium parado		Specimen ML48-8.	Site ML48, N of Gnangara Road, W part of Lot 47 Lexia Avenue, Locality of Ellenbrook	MAN	2	22/10/1999
40810	8772606	42022	Poranthera moorokatta	2	Annual herb, 0.05 m high x 0.05 m wide.	Melaleuca preissiana mid woodland over Banksia littoralis sparse low woodland over Xanthorrhoea preissii and Taxandria linearifolia open tall shrubland over Hypocalymma angustifolium sparse low shrubland.	1 plant.		N of Fewson Turn, Ellenbrook	GPS	1	17/09/2014
40811	8772622	42022	Poranthera moorokatta	2	Annual herb, 0.05 m high x 0.05 m wide.	Eucalyptus todtiana isolated mid mallee trees over Banksia attenuata, Banksia menziesii and Nuytsia floribunda sparse low woodland over Eremaea pauciflora var. pauciflora sparse mid shrubland over Hibbertia hypericoides, Hibbertia subvaginata and Scholtz	1 plant.		NW of Fewson Turn, Ellenbrook	GPS	1	19/09/2014

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
42675	6533388	980	Schoenus capillifolius	3	Annual herb, flowers brown.	Low Scrub B, Associated species: Kunzea littericola Ms, Verticordia densiflora.			Eastern side of Pearce Airforce Base near Singapore Airforce Training Centre, System 6 Area M15, in System 6 Update quadrat xpearce02	GPS	1	20/09/1994
42677	1278215	980	Schoenus capillifolius	3	Annual herb, in fruit.				J. Martyn Reserve, 13 km N Midland	AUTO	3	14/11/1980
42683	2239108	980	Schoenus capillifolius	3	Aquatic herb. Growing submerged or on edges.	With Glossostigma sp., Hydatella sp. and Trithuria sp. surrounded by regenerating heath B of Melaleuca lateritica.		Abundance: several hundred plants.	Ellen Brook Nature Reserve, Upper Swan	MAN	0	2/11/1990
42690	8893373	980	Schoenus capillifolius	3	Small aquatic herb.	Melaleuca lateritia, Viminaria juncea and Kunzea micrantha over herbs.		Vegetation condition: very good. Claypan TEC, communities 7 & 8.	Plot Ellen 03. Ellenbrook Nature Reserve	GPS	1	24/10/2012
42773	7514271	1003	Schoenus natans	4	Floating aquatic herb.	Melaleuca lateritia shrubland over Chorizandra enodis and aquatic herbs.	Common.		Ellenbrook Nature Reserve	GPS	1	7/10/2004
42854	4097610	16279	Schoenus sp. Bullsbrook (J.J. Alford 915)	2	Delicate herb 15 cm high, flowers brown and green.	Herbs and low shrubs.	common.		Twin Swamps Nature Reserve, 8 km S of Bullsbrook	MAN	0	31/10/1986
42908	4750411	17731	Schoenus sp. Waroona (G.J. Keighery 12235)	3	Annual 2-5 cm, flowers green.	Burnt low heath.	common.		J & B Martyn Reserve, 13 km N of Midland	MAN	3	31/10/1988
45073	1631098	7756	Stylidium longitubum	4	Annual herb, flowers pink, throat yellow.	Melaleuca lateritia shrubland; burnt.	abundant.		J. & R. Martyn Reserve, 13 km N Midland	AUTO	3	3/10/1988
45076	2694263	7756	Stylidium longitubum	4	Erect leafless herb with red succulent stems and pink flowers.				Twin Swamps Wildlife Sanctuary (Reserve No. A 27621) Ellen Brook - Bullsbrook area	TOPO	2	28/12/1971
45084	8161119	7756	Stylidium longitubum	4	Erect single stemmed plant with pink petals, darker pink with white at centres. Height 50 12 cm.	Jacksonia, Acacia, Asteraceae, Villarsia, weeds.	many plants but in an area of ca 25 m x 10 m.		Ellen Brook Nature Reserve, Great Northern Highway, West Swan	GPS	1	28/11/2008
45087	1643061	7756	Stylidium longitubum	4	Annual herb. Flowers pink, and laterally paired.	Under and around shrubs.			In a paddock on the W side of Railway Parade, 0.5 km N of Apple Road, Upper Swan	AUTO	3	12/11/1989

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
45092	3510042	7756	Stylidium longitubum	4					Ellenbrook area, west of Vines golf course	MAN	0	30/10/1992
45100	8893101	7756	Stylidium longitubum	4	Small annual herb.	Melaleuca lateritia, Viminaria juncea and Kunzea micrantha over herbs.		Vegetation condition: very good. Claypan TEC, communities 7 & 8.	Plot Ellen 03. Ellenbrook Nature Reserve	GPS	1	24/10/2012
45265	7855656	25800	Stylidium paludicola	3	Reed-like perennial herb 35-80 cm high, numerous scapes per plant; corolla lobes laterally-paired, bright pink, darker pink in bud; labellum pale pink with a pink terminal appendage; throat white, yellow to inside, glandular; anthers greenish-red fading	Open Melaleuca preissiana woodland with dense Myrtaceous shrubs.	localised patch		Maralla Rd, E of Sawpit Road, Maralla Nature Reserve, N of Perth	GPS	1	31/10/2006
45266	7282575	25800	Stylidium paludicola	3	Multi-stemmed erect plant with pink flowers, white throat. Height to 90 cm.	With Acacia sp., Melaleuca preissiana and Leptospermum sp.	ca 50 plants.		Maralla Nature Reserve, Maralla Road, The Vines, 200 m E of Sawpit Road then 100 m S of gate	GPS	1	14/11/2005
45831	6499171	20603	Stylidium trudgenii	3	Perennial herb, 4-5 cm	Melaleuca preissiana (1.8) 5-7 m 1-2%; Astartea aff. fascicularis 1-1.8 m +/- 30% (more out of 10 x 10 m; to > 70%); Pericalymma ellipticum var. ellipticum 0.7 m < 5%; Meeboldina scariosa (ML49-1)0.5-1 m < 5%. Associated species: Stylidium mimeticum, Iso		From site ML49, Specimen ML49-11.	N of Gnangara Road, SW section of Lot 46 Maralla Road, locality of Ellenbrook	GPS	1	22/10/1999
45833	6529690	20603	Stylidium trudgenii	3	Perennial herb.	Scattered Melaleuca preissiana, Banksia littoralis (shrubs), over Astartea aff. fascicularis heath. Associated species: Drosera pulchella, Drosera aff. pygmaea, Villarsia albiflora, Epiblema grandiflorum var. grandiflorum, Comesperma virgatum, patches of		Stylidium sp.Ellenbrook (M.Trudgen 49-11) in a localised patch about 5 m across of about 21 clumps.	Site ML50A, N of Gnangara Road, W part of Lot 47 Lexia Avenue, locality of Ellenbrook	GPS	1	1/12/1999

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
45834	6704832	20603	Stylidium trudgenii	3	Caespitose perennial herb. Flowers cerise laterally paired.			Specimens grown on in cultivation until anthesis then pressed for vouchers.	5 km N of Ellen Brook Estate	GPS	1	23/10/2000
45970	7337671	48297	Styphelia filifolia	3	Erect, well branched shrub to ca 50 cm high. White flowers. Mostly in bud.	Banksia ilicifolia, B. menziesii, Nuytsia floribunda, Melaleuca - paper bark trees and sandplain shrubs including Scholtzia involucrata.	10+ scattered plants.		Warbrook Road, Bullsbrook, ca 200 m S from Wise Road then 100 m W	GPS	1	25/02/2006
47793	1132857	4540	Tetratheca pilifera	3		Under Wandoo.			Walyunga National Park, behind Ranger's house	MAN	3	//
47805	6724884	4540	Tetratheca pilifera	3	Caespitose woody herb 10 cm x 15 cm. Sterile. Stems woody at base, pale green when young, covered with fine, long red hairs over erect short white hair. Leaves in whorls of three, glabrous, paler below. Leaves broadest at base with dentate margins-teeth	Corymbia calophylla, Eucalyptus wandoo woodland with Xanthorrhoea preissii and low shrub understorey including Acacia pulchella, Macrozamia riedlei, Trymalium ledifolium, Hibbertia hypericoides, Dryandra nivea, Hakea sp.	rare - 1 plant seen.		Hillslope behind Ranger's residence, Walyunga National Park	GPS	1	12/11/2003
47926	271993	13687	Thelymitra dedmaniarum	T					Susannah Creek, Red Hill	AUTO	3	27/10/1963
49563	2472635	32658	Trithuria occidentalis	T	Annual herb, leaves red, flowers red, anthers purple-red.		common.		J.R. & B. Martyn Reserve, Ellen Brook, 13 km N Midland	TOPO	3	27/10/1982
49567	2841886	32658	Trithuria occidentalis	T	Reddish annual herb.			Abundance: common	Warbrook Siding, Upper Swan	AUTO	3	18/10/1978
49570	2841851	32658	Trithuria occidentalis	T	Small annual, reddish colour.	Melaleuca laterite scrub.	common.		J.R. and B. Martyn Reserve, Ellen Brook, 13 km N Midland	MAN	3	27/10/1982

FID	Sheet	NameID	Taxon	Cons_Code	Plant_Desc	Vegetation	Frequency	Notes	Locality	Geo_Method	Precision	Date
49572	7855885	32658	Trithuria occidentalis	T		Open shrubland of Melaleuca lateritia to 1.5 m tall with open ground between shrubs, colourful with flowering herbs including Villarsia capitata, Gratiola pubescens, Rhodanthe pyrethrum, Stylidium sp., Utricularia inaequalis, Aphelia drummondii, Lachnagr	About 500 plants over an area 15 metres across.	Growing with Trithuria bibracteata and with Trithuria submersa about 50 metres away in a different depression.	Ellenbrook Nature Reserve (Reserve No A 27620), 15 km N of Midland	GPS	0	6/11/2007
49573	8640688	32658	Trithuria occidentalis	T	Tiny annual ca 2 cm tall.	Open shrubland. With Gratiola pubescens, Melaleucac lateritia, Rhodanthe sp., Stylidium sp., Villarsia capitata.	> 100.		Ellenbrook Nature Reserve (Reserve No. A 27620), 15 km N of Midland	GPS	1	19/10/2012
50799	5795672	14714	Verticordia lindleyi subsp. lindleyi	4	Erect shrub 0.5 m high.	Dense shrubs (tall) over sedges. Melaleuca rhaphiophylla, Hypocalymma angustifolium, Juncus pallidus, sedges.	occasional.		Saunders Street (W end), Aboriginal Community, Henley Brook	MAN	3	10/12/1996
51286	2033720	12460	Verticordia serrata var. linearis	3	80 cm high x 15 cm wide. Flowers golden yellow.	Growing in association with Adenanthos cygnorum.		This specimen was collected for painting.	N of Bullsbrook	AUTO	3	22/10/1987

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	PopStatus	Location	District	Vesting	Purpose1	Purpose2	CountDate	Method	MatureCoun	JuvenileCo	SeedlingCo	LiveTotal	PlantTypeC	AreaOccupi	inFlower	Population
1095	91851	14129	Acacia oncinophylla subsp. oncinophylla	3		10			Walyunga National Park (No.2065), on N side of 4WD track ca.1.1km NE of Wooroloo Creek crossing, ca.3km SE of Woodsome Hill (Plot-WAYL11).	PERTH HILLS	CC	NPK		6/09/1996 0:00		0			0			N	
1098	91854	14129	Acacia oncinophylla subsp. oncinophylla	3		13			Walyunga National Park (No. 2065), in small gully 100m E of railway line (ca.300m NE of major creekline) ca.2km ESE of Woodsome Hill (Plot-WAYL09)	PERTH HILLS	CC	NPK		5/09/1996 0:00		0			0			N	
1631	89659	11336	Adenanthos cygnorum subsp. chamaephyton	3		19			Road verge on Jenkins Rd opposite Lot.41, Bushplan Site 291.	SWAN COASTAL	LGA	VER		14/05/1999 0:00	UNKNOWN	0			30			N	
4607	84938	1596	Caladenia huegelii	T	CR	25			SE cnr of Lot 1452 Maralla Rd, Bullsbrook. ca 1.3km W from Sawpit/Maralla Rd T-jnc. N side of road.	SWAN COASTAL	PRI			15/10/1997 0:00	ESTMT	0			0			N	
4614	84940	1596	Caladenia huegelii	T	CR	32		U	## Orginal discovery was not definitely identified as C. huegelii ## NE corner of Nature Reserve 46875 along Maralla Road, The Vines.	SWAN COASTAL	CC	CFF		29/09/2004 0:00		0			0			N	
4615	84941	1596	Caladenia huegelii	T	CR	34		U	*Species identification not confirmed* N of Chardonnay Dr and Vines Ave junction, The Vines. East of Chardonnay Park.	SWAN COASTAL	PRI			29/09/2004 0:00	ACT_IND	0			0			N	
4616	84942	1596	Caladenia huegelii	T	CR	35		U	## Original population never properly identified## Nature Reserve 46875 south of Maralla Road and north of Barbera Lane, The Vines. Habitat appears unsuitable.	SWAN COASTAL	CC	CFF		29/09/2004 0:00	ACT_IND	0			0			N	
4680	110514	1596	Caladenia huegelii	T	CR	81			Lot 80 Maralla Road. Ellenbrook, Perth, WA. Bushland behind Rodsand Circuit, Ellenbrook (~40m).	SWAN COASTAL	PRI			24/09/2014 0:00	ESTMT	1			0	PLANTS		Y	HEALTHY

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	PopStatus	Location	District	Vesting	Purpose1	Purpose2	CountDate	Method	MatureCoun	JuvenileCo	SeedlingCo	LiveTotal	PlantTypeC	AreaOccupi	inFlower	Population
4684	114949	1596	Caladenia huegelii	T	CR	85			Lot 9508 Ellenbrook. Population is ca. 1km west of Sawpit Rd then ca. 2.5km south along the west edge of the clearing for the Perth to Darwin Highway, then ca. 825 m due west.	SWAN COASTAL	SPC	UNKNOWN		4/10/2017 0:00	ACT_IND	1			0	PLANTS	0.1	Y	HEALTHY
6258	93193	16245	Cyathochaeta teretifolia	3		1			Crown Reserve (49300). Sawpit Gully Conservation Area. 2 km S of the junction of Sawpit Rd and Maralla Rd, Bullsbrook. Swan.	SWAN COASTAL	CC	CFF		3/11/1995 0:00		0			0			N	
6270	93197	16245	Cyathochaeta teretifolia	3		13			Reserve (49300). Cardinal Drive Bushland (Bush Forever Site 23) ca.200m N Bordeaux. Swan.	SWAN COASTAL	CC	CFF		3/11/1995 0:00		0			0			N	
6277	93205	16245	Cyathochaeta teretifolia	3		20			Private Property. Lot 47 Lexia Ave. Site ML36M, N of Gnangara Rd, SW side.Ellenbrook. Swan.	SWAN COASTAL	PRI			6/09/1999 0:00		0			0			N	
6278	93206	16245	Cyathochaeta teretifolia	3		21			Private Property. Lot 47 Lexia Ave. Site ML29, N of Gnangara Rd, NE section.Ellenbrook. Swan.	SWAN COASTAL	PRI			21/08/1999 0:00		0			0			N	
6280	93208	16245	Cyathochaeta teretifolia	3		23			Private Property. Lot 47 Lexia Ave. Site ML44A, N of Gnangara Rd, SE side. Ellenbrook. Swan.	SWAN COASTAL	PRI			28/09/1999 0:00		0			0			N	
7547	93992	17605	Eleocharis keigheryi	T	VU	1			Ellen Brook NR (R 27620). W side of Gt Northern Hwy, Upper Swan. Pop located in seasonally inundated clay pans scattered throughout S portion of NR, within fenced area.	SWAN COASTAL	CC	CFA		9/11/2007 0:00	ESTMT	1000			1000			Y	
7553	94007	17605	Eleocharis keigheryi	T	VU	7			RAAF Base Pearce, located on W side of Gt Northern Hwy, Bullsbrook. Pop located on SW side of airforce base in an open claypan.	SWAN COASTAL	COM	AIR		17/09/2007 0:00	ESTMT	0			0			Y	

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	PopStatus	Location	District	Vesting	Purpose1	Purpose2	CountDate	Method	MatureCoun	JuvenileCo	SeedlingCo	LiveTotal	PlantTypeC	AreaOccupi	inFlower	Population
10133	85477	1976	Grevillea christineae	T	EN	9			Bells Rapids Park, via Cathedral Ave, Upper Swan. From E end of carpark for 200m E, from ca. 10m S of waterline for ca 100m upslope towards railwayline.	PERTH HILLS	LGA	OTH		25/07/2007 0:00	ACT_IND	33			33			Y	
10148	92200	14408	Grevillea curviloba subsp. curviloba	T	CR	2			Reserve 49300 â€œBordeaux Laneâ€ Nature Reserve, The Vines. From the SE corner of the Reserve the plants are 197m north along the track/drainage line of and 59-160m west into the bush. Bush Forever site 23.	SWAN COASTAL	CC	CFF		12/01/2017 0:00		0			0			N	
10149	92201	14408	Grevillea curviloba subsp. curviloba	T	CR	3			Unnamed (`Maralla Rd` NR) R 46875, 500m south of Maralla Road on the north-south track 220m East of Sawpit Road.	SWAN COASTAL	CC	NRE		26/05/2015 0:00		0			0			N	
10150	92202	14408	Grevillea curviloba subsp. curviloba	T	CR	4	A		Unnamed (`Maralla Rd NR`) R 46875. 18-60m S of Maralla Road, and 940-1030m E of Sawpit Rd just E of creekline.	SWAN COASTAL	CC	CFF		21/09/2011 0:00	ACT_CLMP	16			0	CLUMPS	230	Y	MODERATE
10151	92204	14408	Grevillea curviloba subsp. curviloba	T	CR	4	B		Maralla Road Nature Reserve (CR46875), Ellenbrook. Plants occur 100-230m NW of the Dunnett Road Bridge, in two distinct groups, one either side of Sawpit Gully, approximately 100m apart.	SWAN COASTAL	CC	CFF		26/10/2016 0:00	ACT_CLMP	29	3		0	CLUMPS		Y	MODERATE
10152	112129	14408	Grevillea curviloba subsp. curviloba	T	CR	4	C		Private Property. Lot 9007 on Plan 407385. 85m northwest of Dunnett Road Bridge, new subdivision on northern side of Maralla Road Nature Reserve, Ellenbrook. Access to this population is off Maralla and Dunnett Roads.	SWAN COASTAL	PRI			28/12/2016 0:00		0			1	PLANTS		N	HEALTHY

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	PopStatus	Location	District	Vesting	Purpose1	Purpose2	CountDate	Method	MatureCoun	JuvenileCo	SeedlingCo	LiveTotal	PlantTypeC	AreaOccupi	inFlower	Population
10153	102719	14408	Grevillea curviloba subsp. curviloba	T	CR	5	A		Railway Reserve. Railway Parade, Bullsbrook, eastern verge. 2 fenced areas, approx 70m south of West Road. Population extends along railway reserve for 100m from intersection southwards.	SWAN COASTAL	RAI	RRE		2/12/2015 0:00	ACT_IND	135			0	PLANTS		N	HEALTHY
10154	102720	14408	Grevillea curviloba subsp. curviloba	T	CR	5	B		Railway reserve along Railway Parade, E verge. 200m N of intersection with West Road, Bullsbrook.	SWAN COASTAL	RAI	RRE		2/12/2015 0:00	ACT_IND	198			0	PLANTS		N	HEALTHY
10155	102721	14408	Grevillea curviloba subsp. curviloba	T	CR	5	C		Railway Parade, E verge. Opposite Strachan Road, west side of the railway line, Bullsbrook.	SWAN COASTAL	LGA	VER		3/09/2004 0:00	ACT_IND	2		5	7			Y	
10156	102722	14408	Grevillea curviloba subsp. curviloba	T	CR	5	D		Railway reserve along Railway Parade, E verge. Opposite Strachan Road, west side of the railway line, Bullsbrook.	SWAN COASTAL	RAI	RRE		2/12/2015 0:00	ACT_IND	0			0			N	
10157	109315	14408	Grevillea curviloba subsp. curviloba	T	CR	5	E		Railway Reserve, between Railway Parade and Almeria Parade, Bullsbrook. Plants occur on the Eastern side of the line between 230-340m south of the West Road railway crossing.	SWAN COASTAL	RAI	RRE		30/08/2012 0:00	ESTMT	44			0	CLUMPS	1800	Y	HEALTHY
10158	109316	14408	Grevillea curviloba subsp. curviloba	T	CR	5	F		Railway Reserve, between Railway Parade and Almeria Parade, Bullsbrook. Plants occur 400m south of the Strachen Rd Railway crossing, W of the railway and 700-850m S of the crossing on the E of the railway.	SWAN COASTAL	RAI	RRE		3/12/2015 0:00	ACT_IND	165			0	PLANTS		N	HEALTHY

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	PopStatus	Location	District	Vesting	Purpose1	Purpose2	CountDate	Method	MatureCoun	JuvenileCo	SeedlingCo	LiveTotal	PlantTypeC	AreaOccupi	inFlower	Population
10159	109318	14408	Grevillea curviloba subsp. curviloba	T	CR	5	G		Shire Road Verge. Almeria Pde westerv verge, Bullsbrook. Plants occur 700-850m S of the Strachen Road Railway crossing on the drain embankment, opposite House 1138. [85m south from the intersection of Dean Head St and Almeria Pde]	SWAN COASTAL	LGA	VER		1/08/2012 0:00	ESTMT	10			0	CLUMPS	20	Y	HEALTHY
10162	102716	14408	Grevillea curviloba subsp. curviloba	T	CR	10	A		Maralla Nature Reserve (CR 46875), The Vines. Plants occur in riparian zone SE end of NR. City of Swan	SWAN COASTAL	CC	CFF	NRE	16/01/2018 0:00		0	1		0		1	N	MODERATE
10163	102717	14408	Grevillea curviloba subsp. curviloba	T	CR	10	B		PP Lot 9007 Janselling Ave, The Vines. Shire managed park at the E end of Janselling Ave, S of Maralla NR. City of Swan	SWAN COASTAL	PRI			16/01/2018 0:00		0			0			N	
10198	92209	14409	Grevillea curviloba subsp. incurva	T	EN	17			Nature Reserve (46875), Lot 12842. 1.1km east of Sawpit Road on Maralla Road, and 50m south. North of The Vines development. Just NE of the creekline in the riparian vegetation	SWAN COASTAL	CC	CFF		17/08/2012 0:00	ACT_CLMP	1			0	CLUMPS	6	Y	
10203	110229	14409	Grevillea curviloba subsp. incurva	T	EN	19	A		Almeria Parade unmade road reserve, Bullsbrook. ~20m south of Neaves Rd on the eastern side of the rail line. Access is via a boundary track that runs south from Rutland Rd.	SWAN COASTAL	LGA	VER		22/10/2015 0:00	ESTMT	0			10	PLANTS	150	Y	POOR
10204	110231	14409	Grevillea curviloba subsp. incurva	T	EN	19	B		Rail reserve, ~20m south of Neaves Rd on the eastern side of the rail line. Access is via a boundary track that runs south from Rutland Rd.	SWAN COASTAL	RAI	RRE		22/10/2015 0:00	ESTMT	0			15	PLANTS	350	Y	POOR
11166	84894	1469	Haemodorum loratum	3		2			20 km ESE of Muchea. Upper Swan.	SWAN COASTAL	UNKNOWN			13/11/1981 0:00		0			0			N	

FID	PopId	Nameid	Taxon	ConsStatus	WARank	PopNumber	SubPopCode	PopStatus	Location	District	Vesting	Purpose1	Purpose2	CountDate	Method	MatureCoun	JuvenileCo	SeedlingCo	LiveTotal	PlantTypeC	AreaOccupi	inFlower	Population
11334	100103	6686	Halgania corymbosa	3		4	A		At the eastern end of Padbury Avenue, Millendon, Perth. North east side of the road, for about 300 metres.	PERTH HILLS	LGA	VER		6/09/1978 0:00		0			0			Y	
11335	100104	6686	Halgania corymbosa	3		4	B		Susannah Brook, Millendon, Perth. About 50 metres north east of the eastern end of Padbury Avenue, on both sides of Susannah Brook, Lot 315.	PERTH HILLS	PRI			3/09/1980 0:00		0			0			Y	
11660	88387	6233	Hydrocotyle lemnoides	4		1			Ellen Brook N.Res. Fresh water pools in S part of res.	SWAN COASTAL	CC	CFA		2/11/1990 0:00	ESTMT	4000			4000			Y	
13240	96547	33638	Meionectes tenuifolia	3		4			Sawpit Conservation Area, Sawpit and Maralla Rd, Bullbrook. Lot 3 Lexia Ave.	SWAN COASTAL	PRI			3/11/1995 0:00		0			0			N	
15145	84517	980	Schoenus capillifolius	3		3			Ellen Brook Nature Reserve. Gt Northern Hwy 3.5 km N of Apple St Upper Swan.	SWAN COASTAL	CC	CFF		2/11/1990 0:00	ESTMT	0			100			Y	
15148	84520	980	Schoenus capillifolius	3		6			Pearce Airbase. 0.75 km W of Great Northern Hwy at 0.3 km S from the junction with Chittering Rd.	SWAN COASTAL	COM	AIR		20/09/1994 0:00		0			0			N	
15635	89291	7756	Stylidium longitubum	4		1			W side of Railway Parade. 0.5km N of Apple Rd. Upper Swan.	SWAN COASTAL	AGR	GVT		12/11/1989 0:00		0			0			Y	
15636	89302	7756	Stylidium longitubum	4		2			Twin Swamp Wildlife Sanctuary Ellen Brook.	SWAN COASTAL	CC	CFA		28/12/1971 0:00		0			0			N	
15637	89307	7756	Stylidium longitubum	4		3			Ellen Brook Nature Reserve. Lexia Ave.	SWAN COASTAL	CC	NRE		3/10/1988 0:00		0			0			N	
15638	89308	7756	Stylidium longitubum	4		4			West of Vines golf course. Ellenbrook area.	SWAN COASTAL	UNKNOWN			30/10/1992 0:00		0			0			N	
16241	87125	4540	Tetratheca pilifera	3		15			Walyunga National Park (ID: 2065), Hillslope behind Ranger's residence.	PERTH HILLS	CC	NPK		12/11/2003 0:00	ACT_IND	1			1			N	
16642	96349	32658	Trithuria occidentalis	T	CR	1			Ellenbrook Nature Reserve (R27620). On the central eastern side ~100m due west of Great Northern Hwy.	SWAN COASTAL	CC	CFA		23/10/2018 0:00	EXT_GRQD	0			421	PLANTS	47	N	HEALTHY

APPENDIX 2

Naturemap Report

NatureMap
Mapping Western Australia's biodiversity

NatureMap Species Report

Created By Guest user on 13/08/2019

Current Names Only Yes
Core Datasets Only Yes
Method 'By Circle'
Centre 116° 00' 50" E,31° 44' 22" S
Buffer 10km
Group By Conservation Status

Conservation Status	Species	Records
Non-conservation taxon	1354	10316
Other specially protected fauna	1	1
Priority 2	5	8
Priority 3	23	82
Priority 4	16	115
Protected under international agreement	1	2
Rare or likely to become extinct	21	1718
TOTAL	**1421**	**12242**

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
Rare or likely to become extinct					
1.	3219	*Acacia anomala (Grass Wattle)*		T	
2.	1596	*Caladenia huegelii (Grand Spider Orchid)*		T	
3.	24731	*Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black Cockatoo)*		T	
4.	24733	*Calyptorhynchus baudinii (Baudin's Cockatoo, White-tailed Long-billed Black Cockatoo)*		T	
5.	24734	*Calyptorhynchus latirostris (Carnaby's Cockatoo, White-tailed Short-billed Black Cockatoo)*		T	
6.	48400	*Calyptorhynchus sp. (white-tailed black cockatoo)*		T	
7.	24092	*Dasyurus geoffroii (Chuditch, Western Quoll)*		T	
8.	4452	*Diplolaena andrewsii*		T	
9.	17605	*Eleocharis keigheryi*		T	
10.	34027	*Galaxiella nigrostriata (Black-stripe Minnow, black-striped dwarf galaxias)*		T	
11.	1976	*Grevillea christineae*		T	
12.	14408	*Grevillea curviloba subsp. curviloba*		T	
13.	14409	*Grevillea curviloba subsp. incurva*		T	
14.	33983	*Leioproctus douglasiellus (a short-tongued bee)*		T	
15.	24168	*Macrotis lagotis (Bilby, Dalgyte, Ninu)*		T	
16.	24142	*Petrogale lateralis subsp. lateralis (Black-flanked Rock-wallaby, Black-footed Rock-wallaby)*		T	
17.	25345	*Pseudemydura umbrina (Western Swamp Tortoise, Western Swamp Turtle)*		T	
18.	48237	*Rostratula australis (Australian Painted Snipe)*		T	
19.	13687	*Thelymitra dedmaniarum (Cinnamon Sun Orchid, Bronze Orchid)*		T	
20.	32658	*Trithuria occidentalis (Swan Hydatella)*		T	
21.	34113	*Westralunio carteri (Carter's Freshwater Mussel)*		T	
Protected under international agreement					
22.	24843	*Plegadis falcinellus (Glossy Ibis)*		IA	
Other specially protected fauna					
23.	25624	*Falco peregrinus (Peregrine Falcon)*		S	
Priority 2					
24.	45757	*Calectasia elegans (Elegant Tinsel Lily)*		P2	
25.	14337	*Millotia tenuifolia var. laevis*		P2	
26.	20167	*Pertusaria trachyspora*		P2	
27.	42022	*Poranthera moorokatta*		P2	
28.	16279	*Schoenus sp. Bullsbrook (J.J. Alford 915)*		P2	Y
Priority 3					
29.	14129	*Acacia oncinophylla subsp. oncinophylla*		P3	
30.	11336	*Adenanthos cygnorum subsp. chamaephyton*		P3	
31.	5390	*Beaufortia purpurea (Purple Beaufortia)*		P3	
32.	19338	*Chamaescilla gibsonii*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
				P3	
33.	16245	*Cyathochaeta teretifolia*		P3	
34.	41801	*Eryngium pinnatifidum subsp. Palustre (G.J. Keighery 13459)*		P3	
35.	16952	*Guichenotia tuberculata*		P3	
36.	1469	*Haemodorum loratum*		P3	
37.	6686	*Halgania corymbosa*		P3	
38.	45081	*Lasiopetalum glutinosum subsp. glutinosum*		P3	
39.	33982	*Leioproctus contrarius (a short-tongued bee)*		P3	
40.	33638	*Meionectes tenuifolia*		P3	
41.	25249	*Neelaps calonotos (Black-striped Snake, black-striped burrowing snake)*		P3	
42.	11557	*Phlebocarya pilosissima subsp. pilosissima*		P3	
43.	8163	*Pithocarpa corymbulosa (Corymbose Pithocarpa)*		P3	
44.	980	*Schoenus capillifolius*		P3	
45.	17731	*Schoenus sp. Waroona (G.J. Keighery 12235)*		P3	
46.	12924	*Stylidium asteroideum (Star Triggerplant)*		P3	
47.	25800	*Stylidium paludicola*		P3	
48.	20603	*Stylidium trudgenii*		P3	
49.	48297	*Styphelia filifolia*		P3	
50.	4540	*Tetratheca pilifera*		P3	
51.	12460	*Verticordia serrata var. linearis*		P3	
Priority 4					
52.	11957	*Anigozanthos humilis subsp. chrysanthus (Golden Catspaw)*		P4	
53.	13826	*Cyanicula ixioides subsp. ixioides*		P4	
54.	5523	*Darwinia pimelioides*		P4	
55.	3115	*Drosera occidentalis (Western Sundew)*		P4	
56.	6233	*Hydrocotyle lemnoides (Aquatic Pennywort)*		P4	
57.	24215	*Hydromys chrysogaster (Water-rat, Rakali)*		P4	
58.	17622	*Hypolaena robusta*		P4	
59.	48588	*Isoodon fusciventer (Quenda, southwestern brown bandicoot)*		P4	
60.	48024	*Notamacropus eugenii subsp. derbianus (Tammar Wallaby, Tammar)*		P4	
61.	48022	*Notamacropus irma (Western Brush Wallaby)*		P4	
62.	24328	*Oxyura australis (Blue-billed Duck)*		P4	
63.	2278	*Persoonia sulcata*		P4	
64.	1003	*Schoenus natans (Floating Bog-rush)*		P4	
65.	7756	*Stylidium longitubum (Jumping Jacks)*		P4	
66.	33992	*Synemon gratiosa (Graceful Sunmoth)*		P4	
67.	14714	*Verticordia lindleyi subsp. lindleyi*		P4	
Non-conservation taxon					
68.	15466	*Acacia applanata*			
69.	3233	*Acacia barbinervis*			
70.	3254	*Acacia celastrifolia (Glowing Wattle)*			
71.	3324	*Acacia erinacea*			
72.	3374	*Acacia huegelii*			
73.	18217	*Acacia iteaphylla*	Y		
74.	3409	*Acacia lasiocarpa (Panjang)*			
75.	15721	*Acacia lasiocarpa var. sedifolia*			
76.	17861	*Acacia longifolia*	Y		
77.	3454	*Acacia nervosa (Rib Wattle)*			
78.	3502	*Acacia pulchella (Prickly Moses)*			
79.	15481	*Acacia pulchella var. glaberrima*			
80.	15483	*Acacia pulchella var. pulchella*			
81.	3515	*Acacia restiacea*			
82.	42600	*Acacia salicina*			
83.	3527	*Acacia saligna (Orange Wattle, Kudjong)*			
84.	30033	*Acacia saligna subsp. lindleyi*			
85.	30032	*Acacia saligna subsp. saligna*			
86.	3541	*Acacia sessilis*			
87.	3557	*Acacia stenoptera (Narrow Winged Wattle)*			
88.	3591	*Acacia urophylla*			
89.	3184	*Acaena echinata (Sheep's Burr)*			
90.	24260	*Acanthiza apicalis (Broad-tailed Thornbill, Inland Thornbill)*			
91.	24261	*Acanthiza chrysorrhoa (Yellow-rumped Thornbill)*			
92.	24262	*Acanthiza inornata (Western Thornbill)*			
93.	1205	*Acanthocarpus canaliculatus*			
94.	24560	*Acanthorhynchus superciliosus (Western Spinebill)*			
95.		*Acariformes sp.*			
96.	25535	*Accipiter cirrocephalus (Collared Sparrowhawk)*			
97.	25536	*Accipiter fasciatus (Brown Goshawk)*			
98.		*Acercella falcipes*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
99.	42368	*Acritoscincus trilineatus (Western Three-lined Skink)*			
100.	25755	*Acrocephalus australis (Australian Reed Warbler)*			
101.	12958	*Actinotus laxus*			
102.	6205	*Actinotus leucocephalus (Flannel Flower)*			
103.	1775	*Adenanthos cygnorum (Common Woollybush)*			
104.	11837	*Adenanthos cygnorum subsp. cygnorum (Common Woollybush)*			
105.	1779	*Adenanthos drummondii*			
106.	1791	*Adenanthos obovatus (Basket Flower)*			
107.	23474	*Agrostocrinum hirsutum*			
108.	1261	*Agrostocrinum scabrum (Blue Grass Lily)*			
109.	23501	*Agrostocrinum scabrum subsp. scabrum*			
110.	184	*Aira caryophyllea (Silvery Hairgrass)*	Y		
111.	185	*Aira cupaniana (Silvery Hairgrass)*	Y		
112.	187	*Aira praecox (Early Hairgrass)*	Y		
113.	1056	*Alexgeorgea nitens*			
114.	1375	*Allium neapolitanum (Naples Onion)*	Y		
115.	1728	*Allocasuarina fraseriana (Sheoak, Kondil)*			
116.	1732	*Allocasuarina humilis (Dwarf Sheoak)*			
117.	2652	*Alternanthera nodiflora (Common Joyweed)*			
118.	38756	*Amanita umbrinella*			
119.		*Amblyomma triguttatum*			
120.	13380	*Amphibromus nervosus*			
121.	199	*Amphipogon strictus (Greybeard Grass)*			
122.	200	*Amphipogon turbinatus*			
123.		*Amphisopodidae sp.*			
124.	2380	*Amyema miquelii (Stalked Mistletoe)*			
125.		*Aname mainae*			
126.	24312	*Anas gracilis (Grey Teal)*			
127.	24313	*Anas platyrhynchos (Mallard)*			
128.		*Anas platyrhynchos subsp. domesticus*			
129.	24315	*Anas rhynchotis (Australasian Shoveler)*			
130.	24316	*Anas superciliosa (Pacific Black Duck)*			
131.		*Ancylidae sp.*			
132.	6300	*Andersonia aristata (Rice Flower)*			
133.	6311	*Andersonia heterophylla*			
134.	6314	*Andersonia lehmanniana*			
135.	11471	*Andersonia lehmanniana subsp. lehmanniana*			
136.	47414	*Anhinga novaehollandiae (Australasian Darter)*			
137.	1406	*Anigozanthos bicolor (Little Kangaroo Paw)*			
138.	11470	*Anigozanthos bicolor subsp. bicolor*			
139.	1409	*Anigozanthos humilis (Catspaw)*			
140.	11434	*Anigozanthos humilis subsp. humilis*			
141.	1411	*Anigozanthos manglesii (Mangles Kangaroo Paw, Kurulbrang)*			
142.	11261	*Anigozanthos manglesii subsp. manglesii*			
143.	29436	*Anigozanthos viridis subsp. Cataby (S.D. Hopper 1786)*			
144.	11566	*Anigozanthos viridis subsp. viridis*			
145.	44629	*Anilios australis*			
146.	44650	*Anilios waitii*			
147.	25241	*Antaresia stimsoni subsp. stimsoni (Stimson's Python)*			
148.	6949	*Anthocercis littorea (Yellow Tailflower)*			
149.	24561	*Anthochaera carunculata (Red Wattlebird)*			
150.	24562	*Anthochaera lunulata (Western Little Wattlebird)*			
151.	12724	*Anthotium junciforme*			
152.	25670	*Anthus australis (Australian Pipit)*			
153.	24599	*Anthus australis subsp. australis (Australian Pipit)*			
154.	3686	*Aotus cordifolia*			
155.	3688	*Aotus gracillima*			
156.	3692	*Aotus procumbens*			
157.	1116	*Aphelia brizula*			
158.	1117	*Aphelia cyperoides*			
159.	1118	*Aphelia drummondii*			
160.	43548	*Aphelia sp. Albany (B.G. Briggs 596)*			
161.	24990	*Aprasia pulchella (Granite Worm-lizard)*			
162.	24991	*Aprasia repens (Sand-plain Worm-lizard)*			
163.	24285	*Aquila audax (Wedge-tailed Eagle)*			
164.		*Araneus cyphoxis*			
165.	7838	*Arctotheca calendula (Cape Weed, African Marigold)*	Y		
166.	41324	*Ardea modesta (great egret, white egret)*			
167.	24340	*Ardea novaehollandiae (White-faced Heron)*			
168.	24341	*Ardea pacifica (White-necked Heron)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
169.	207	*Aristida contorta (Bunched Kerosene Grass)*			
170.	1264	*Arnocrinum preissii*			
171.	25566	*Artamus cinereus (Black-faced Woodswallow)*			
172.	24353	*Artamus cyanopterus (Dusky Woodswallow)*			
173.	8779	*Asparagus asparagoides (Bridal Creeper)*	Y		
174.	20350	*Astartea affinis (West-coast Astartea)*			
175.	5330	*Astartea fascicularis (Recherche Astartea)*			
176.	20283	*Astartea scoparia (Common Astartea)*			
177.		*Asterella drummondii*			
178.	7851	*Asteridea pulverulenta (Common Bristle Daisy)*			
179.	6323	*Astroloma ciliatum (Candle Cranberry)*			
180.	6328	*Astroloma glaucescens*			
181.	6330	*Astroloma macrocalyx (Swan Berry)*			
182.	6334	*Astroloma pallidum (Kick Bush)*			
183.	6337	*Astroloma stomarrhena (Red Swamp Cranberry)*			
184.	6339	*Astroloma xerophyllum*			
185.		*Austracantha minax*			
186.		*Austrogomphus (Zephyrogomphus) lateralis*			
187.	47713	*Austronomus australis (White-striped Free-tailed Bat)*			
188.	42106	*Austroparmelina conlabrosa*			
189.	42109	*Austroparmelina endoleuca*			
190.	17233	*Austrostipa campylachne*			
191.	17234	*Austrostipa compressa*			
192.	17237	*Austrostipa elegantissima*			
193.	17240	*Austrostipa flavescens*			
194.	17241	*Austrostipa hemipogon*			
195.	17244	*Austrostipa macalpinei*			
196.		*Austrostipa sp. Ellen2 (no flowers)*			Y
197.	17254	*Austrostipa tenuifolia*			
198.	233	*Avena barbata (Bearded Oat)*	Y		
199.	234	*Avena fatua (Wild Oat)*	Y		
200.	235	*Avena sativa (Common Oat)*	Y		
201.	24318	*Aythya australis (Hardhead)*			
202.	36441	*Babingtonia camphorosmae (Camphor Myrtle)*			
203.		*Badumna insignis*			
204.	1382	*Baeometra uniflora*	Y		
205.		*Baetidae sp.*			
206.	32681	*Banksia armata (Prickly Dryandra)*			
207.	32682	*Banksia armata var. armata*			
208.	1800	*Banksia attenuata (Slender Banksia, Piara)*			
209.	32576	*Banksia dallanneyi (Couch Honeypot)*			
210.	32580	*Banksia dallanneyi subsp. dallanneyi var. dallanneyi*			
211.	32577	*Banksia dallanneyi subsp. dallanneyi var. mellicula*			
212.	32523	*Banksia fraseri var. fraseri*			
213.	1822	*Banksia ilicifolia (Holly-leaved Banksia)*			
214.	1830	*Banksia littoralis (Swamp Banksia, Pungura)*			
215.	1834	*Banksia menziesii (Firewood Banksia)*			
216.	1835	*Banksia micrantha*			
217.	32080	*Banksia sessilis var. sessilis*			
218.	32315	*Barbula calycina*			
219.		*Barnardius zonarius*			
220.	32323	*Bartramia pseudostricta*			
221.	740	*Baumea arthrophylla*			
222.	741	*Baumea articulata (Jointed Rush)*			
223.	743	*Baumea juncea (Bare Twigrush)*			
224.	748	*Baumea vaginalis (Sheath Twigrush)*			
225.	5382	*Beaufortia elegans (Elegant Beaufortia)*			
226.	5387	*Beaufortia macrostemon (Darling Range Beaufortia)*			
227.	7046	*Bellardia trixago (Bellardia)*	Y		
228.	48868	*Bellardia viscosa*	Y		
229.	3165	*Billardiera variifolia*			
230.	24319	*Biziura lobata (Musk Duck)*			
231.	1417	*Blancoa canescens (Winter Bell)*			
232.	7856	*Blennospora drummondii*			
233.	749	*Bolboschoenus caldwellii (Marsh Club-rush)*			
234.	4432	*Boronia ovata*			
235.	17665	*Boronia purdieana subsp. purdieana*			
236.	4438	*Boronia ramosa*			
237.	11381	*Boronia ramosa subsp. anethifolia*			
238.	11564	*Boronia ramosa subsp. ramosa*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
239.	1272	*Borya scirpoidea*			
240.	1273	*Borya sphaerocephala (Pincushions)*			
241.	24251	*Bos taurus (European Cattle)*	Y		
242.	3710	*Bossiaea eriocarpa (Common Brown Pea)*			
243.	3719	*Bossiaea spinescens*			
244.		*Bostockia porosa*			
245.	6341	*Brachyloma preissii (Globe Heath)*			
246.	8661	*Brachypodium distachyon (False Brome)*	Y		
247.	7878	*Brachyscome iberidifolia*			
248.	7882	*Brachyscome perpusilla*			
249.	42380	*Brachyurophis fasciolatus subsp. fasciolatus (Narrow-banded Shovel-nosed Snake)*			
250.	42381	*Brachyurophis semifasciatus (Southern Shovel-nosed Snake)*			
251.	244	*Briza maxima (Blowfly Grass)*	Y		
252.	245	*Briza minor (Shivery Grass)*	Y		
253.	249	*Bromus diandrus (Great Brome)*	Y		
254.	250	*Bromus hordeaceus (Soft Brome)*	Y		
255.	253	*Bromus rubens (Red Brome)*	Y		
256.	1383	*Burchardia bairdiae*			
257.	12770	*Burchardia congesta*			
258.	1385	*Burchardia multiflora (Dwarf Burchardia)*			
259.	25714	*Cacatua pastinator (Western Long-billed Corella)*			
260.	25715	*Cacatua roseicapilla (Galah)*			
261.	25716	*Cacatua sanguinea (Little Corella)*			
262.	24729	*Cacatua tenuirostris (Eastern Long-billed Corella)*	Y		
263.	25598	*Cacomantis flabelliformis (Fan-tailed Cuckoo)*			
264.	42307	*Cacomantis pallidus (Pallid Cuckoo)*			
265.		*Caenidae sp.*			
266.	1276	*Caesia micrantha (Pale Grass Lily)*			
267.	11136	*Caladenia denticulata*			
268.	1586	*Caladenia discoidea (Dancing Orchid)*			
269.	1592	*Caladenia flava (Cowslip Orchid)*			
270.	15348	*Caladenia flava subsp. flava*			
271.	15354	*Caladenia hirta subsp. hirta*			
272.	1599	*Caladenia latifolia (Pink Fairy Orchid)*			
273.	15365	*Caladenia longicauda subsp. longicauda*			
274.	1605	*Caladenia marginata (White Fairy Orchid)*			
275.	15503	*Caladenia paludosa*			
276.	15380	*Caladenia splendens*			
277.	18019	*Caladenia vulgata*			
278.	2856	*Calandrinia liniflora (Parakeelya)*			
279.	19309	*Calectasia narragara*			
280.	36600	*Callitris pyramidalis (Swamp Cypress)*			
281.	5415	*Calothamnus lateralis*			
282.	5426	*Calothamnus quadrifidus (One-sided Bottlebrush, Kwowdjard)*			
283.	35816	*Calothamnus quadrifidus subsp. quadrifidus*			
284.	5429	*Calothamnus sanguineus (Silky-leaved Blood flower, Pindak)*			
285.	25717	*Calyptorhynchus banksii (Red-tailed Black-Cockatoo)*			
286.	5439	*Calytrix angulata (Yellow Starflower)*			
287.	5458	*Calytrix flavescens (Summer Starflower)*			
288.	5460	*Calytrix fraseri (Pink Summer Calytrix)*			
289.	5461	*Calytrix glutinosa*			
290.	5476	*Calytrix sapphirina*			
291.	5481	*Calytrix sylvana*			
292.	32334	*Campylopus australis*			
293.	32335	*Campylopus bicolor*			
294.	32338	*Campylopus introflexus*	Y		
295.		*Carassius auratus*			
296.	2795	*Carpobrotus edulis (Hottentot Fig)*	Y		
297.	1162	*Cartonema philydroides*			
298.	2951	*Cassytha flava (Dodder Laurel)*			
299.	2952	*Cassytha glabella (Tangled Dodder Laurel)*			
300.	11211	*Cassytha glabella forma dispar*			
301.	2956	*Cassytha pomiformis (Dodder Laurel)*			
302.	11242	*Cassytha racemosa forma pilosa*			
303.	11799	*Cassytha racemosa forma racemosa*			
304.	1742	*Casuarina obesa (Swamp Sheoak, Kuli)*			
305.		*Ceinidae sp.*			
306.	41567	*Cenchrus macrourus (African Feather Grass)*	Y		
307.	41568	*Cenchrus setaceus (Fountain Grass)*	Y		
308.	7916	*Centaurea melitensis (Maltese Cockspur, Malta Thistle)*	Y		

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309.	6539	*Centaurium erythraea (Common Centaury)*	Y		
310.	6542	*Centaurium tenuiflorum*	Y		
311.	1120	*Centrolepis alepyroides*			
312.	1121	*Centrolepis aristata (Pointed Centrolepis)*			
313.	1123	*Centrolepis caespitosa*			
314.	1125	*Centrolepis drummondiana*			
315.	1129	*Centrolepis glabra (Smooth Centrolepis)*			
316.	1131	*Centrolepis inconspicua*			
317.	1132	*Centrolepis mutica*			
318.	1133	*Centrolepis pilosa*			
319.	1134	*Centrolepis polygyna (Wiry Centrolepis)*			
320.		*Ceratopogonidae sp.*			
321.	24086	*Cercartetus concinnus (Western Pygmy-possum, Mundarda)*			
322.		*Cercophonius sulcatus*			
323.	17685	*Chaetanthus aristatus*			
324.	24186	*Chalinolobus gouldii (Gould's Wattled Bat)*			
325.	1280	*Chamaescilla corymbosa (Blue Squill)*			
326.	11299	*Chamaescilla corymbosa var. corymbosa*			
327.	11878	*Chamaescilla corymbosa var. paradoxa*			
328.	8788	*Chamaescilla versicolor*			
329.	35598	*Chamelaucium sp. Winchester (C. Chapman s.n. PERTH 07879180)*			
330.	5498	*Chamelaucium uncinatum (Geraldton Wax)*			
331.	31	*Cheilanthes austrotenuifolia*			
332.	34	*Cheilanthes distans (Bristly Cloak Fern)*			
333.	3169	*Cheiranthera preissiana*			
334.	43380	*Chelodina colliei (South-western Snake-necked Turtle)*			
335.	24321	*Chenonetta jubata (Australian Wood Duck, Wood Duck)*			
336.	2491	*Chenopodium macrospermum*	Y		
337.	33939	*Cherax cainii (Marron)*			
338.		*Cherax quinquecarinatus*			
339.		*Cherax sp.*			
340.		*Chironominae sp.*			
341.	267	*Chloris gayana (Rhodes Grass)*	Y		
342.	17833	*Chordifex microcodon*			
343.	31112	*Chordifex sp. Ellenbrook (M. Trudgen MET 20790)*			Y
344.	763	*Chorizandra enodis (Black Bristlerush)*			
345.	24980	*Christinus marmoratus (Marbled Gecko)*			
346.	11900	*Chrysanthemoides monilifera subsp. monilifera*	Y		
347.	24431	*Chrysococcyx basalis (Horsfield's Bronze Cuckoo)*			
348.	24432	*Chrysococcyx lucidus subsp. plagosus (Shining Bronze Cuckoo)*			
349.	6543	*Cicendia filiformis (Slender Cicendia)*	Y		
350.	24288	*Circus approximans (Swamp Harrier)*			
351.	7937	*Cirsium vulgare (Spear Thistle, Scotch Thistle)*	Y		
352.	27663	*Cladia aggregata*			
353.	27668	*Cladia schizopora*			
354.		*Cladocera (unident.)*			
355.	27692	*Cladonia rigida*			
356.		*Clinohelea sp. 1 (SAP)*			
357.	25675	*Colluricincla harmonica (Grey Shrike-thrush)*			
358.	24399	*Columba livia (Domestic Pigeon)*	Y		
359.	4550	*Comesperma calymega (Blue-spike Milkwort)*			
360.	4551	*Comesperma ciliatum*			
361.	4554	*Comesperma flavum*			
362.	4564	*Comesperma virgatum (Milkwort)*			
363.	48634	*Commersonia corniculata*			
364.	15607	*Conospermum acerosum subsp. acerosum*			
365.	1864	*Conospermum crassinervium (Summer Smokebush)*			
366.	1875	*Conospermum huegelii (Slender Smokebush)*			
367.	1876	*Conospermum incurvum (Plume Smokebush)*			
368.	1880	*Conospermum polycephalum*			
369.	1882	*Conospermum stoechadis (Common Smokebush)*			
370.	15520	*Conospermum stoechadis subsp. sclerophyllum*			
371.	15611	*Conospermum stoechadis subsp. stoechadis (Common Smokebush)*			
372.	6347	*Conostephium minus (Pink-tipped Pearl flower)*			
373.	6348	*Conostephium pendulum (Pearl Flower)*			
374.	6349	*Conostephium preissii*			
375.	11826	*Conostylis aculeata subsp. aculeata*			
376.	11552	*Conostylis aculeata subsp. bromelioides*			
377.	11513	*Conostylis aculeata subsp. cygnorum*			
378.	1420	*Conostylis androstemma (Trumpets)*			

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379.	1423	*Conostylis aurea (Golden Conostylis)*			
380.	11438	*Conostylis candicans subsp. candicans*			
381.	1436	*Conostylis juncea*			
382.	1454	*Conostylis setigera (Bristly Cottonhead)*			
383.	11597	*Conostylis setigera subsp. setigera*			
384.	1455	*Conostylis setosa (White Cottonhead)*			
385.	25568	*Coracina novaehollandiae (Black-faced Cuckoo-shrike)*			
386.		*Corduliidae sp.*			
387.		*Corixidae sp.*			
388.		*Cormocephalus aurantiipes*			
389.		*Cormocephalus strigosus*			
390.		*Cormocephalus turneri*			
391.	2891	*Corrigiola litoralis (Strapwort)*	Y		
392.	25592	*Corvus coronoides (Australian Raven)*			
393.	24417	*Corvus coronoides subsp. perplexus (Australian Raven)*			
394.	17104	*Corymbia calophylla (Marri)*			
395.	11283	*Corynotheca micrantha var. micrantha*			
396.	7945	*Cotula coronopifolia (Waterbuttons)*	Y		
397.	7946	*Cotula cotuloides (Smooth Cotula)*			
398.	24420	*Cracticus nigrogularis (Pied Butcherbird)*			
399.	25595	*Cracticus tibicen (Australian Magpie)*			
400.	25596	*Cracticus torquatus (Grey Butcherbird)*			
401.	13354	*Craspedia variabilis*			
402.	17701	*Crassula closiana*			
403.	3137	*Crassula colorata (Dense Stonecrop)*			
404.	11563	*Crassula colorata var. colorata*			
405.	3142	*Crassula natans*	Y		
406.	15706	*Crassula natans var. minus*	Y		
407.	25456	*Crenadactylus ocellatus (Clawless Gecko)*			
408.	24918	*Crenadactylus ocellatus subsp. ocellatus (Clawless Gecko)*			
409.	7953	*Crepis foetida (Foetid Hawksbeard)*	Y		
410.	25398	*Crinia georgiana (Quacking Frog)*			
411.	25399	*Crinia glauerti (Clicking Frog)*			
412.	25400	*Crinia insignifera (Squelching Froglet)*			
413.	25401	*Crinia pseudinsignifera (Bleating Froglet)*			
414.	13527	*Croninia kingiana*			
415.	13470	*Cryptandra arbutiflora var. arbutiflora*			
416.	9076	*Cryptandra myriantha*			
417.	4804	*Cryptandra nutans*			
418.	4809	*Cryptandra pungens*			
419.	30893	*Cryptoblepharus buchananii*			
420.	25020	*Cryptoblepharus plagiocephalus*			
421.	30899	*Ctenophorus adelaidensis (Southern Heath Dragon, Western Heath Dragon)*			
422.	24883	*Ctenophorus ornatus (Ornate Crevice-Dragon)*			
423.	25027	*Ctenotus australis*			
424.	25039	*Ctenotus fallens*			
425.	25040	*Ctenotus gemmula (Jewelled South-west Ctenotus (Swan Coastal Plain subpop P3), skink)*			
426.	25047	*Ctenotus impar*			
427.		*Culicidae sp.*			
428.		*Curculionidae sp.*			
429.	6663	*Cuscuta epithymum (Lesser Dodder, Greater Dodder)*	Y		
430.	15114	*Cyanicula gemmata*			
431.	15404	*Cyanicula sericea*			
432.	768	*Cyathochaeta avenacea*			
433.	40661	*Cycnogeton lineare*			
434.	24322	*Cygnus atratus (Black Swan)*			
435.	283	*Cynodon dactylon (Couch)*	Y		
436.	783	*Cyperus congestus (Dense Flat-sedge)*	Y		
437.	794	*Cyperus gymnocaulos (Spiny Flat-sedge)*			
438.	806	*Cyperus polystachyos (Bunchy Sedge)*			
439.	815	*Cyperus tenellus (Tiny Flatsedge)*	Y		
440.	816	*Cyperus tenuiflorus (Scaly Sedge)*	Y		
441.		*Cyprinus carpio*			
442.	17692	*Cytogonidium leptocarpoides*			
443.	30901	*Dacelo novaeguineae (Laughing Kookaburra)*	Y		
444.	7428	*Dampiera coronata (Wedge-leaved Dampiera)*			
445.	7451	*Dampiera lavandulacea*			
446.	7454	*Dampiera linearis (Common Dampiera)*			
447.	7482	*Dampiera teres (Terete-leaved Dampiera)*			

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448.	25673	*Daphoenositta chrysoptera (Varied Sittella)*			
449.	5508	*Darwinia citriodora (Lemon-scented Darwinia)*			
450.	5524	*Darwinia pinifolia*			
451.	1218	*Dasypogon bromeliifolius (Pineapple Bush)*			
452.	6218	*Daucus glochidiatus (Australian Carrot)*			
453.	3793	*Daviesia angulata*			
454.	3805	*Daviesia decurrens (Prickly Bitter-pea)*			
455.	19747	*Daviesia decurrens subsp. decurrens*			
456.	18560	*Daviesia divaricata subsp. divaricata*			
457.	3815	*Daviesia horrida (Prickly Bitter-pea)*			
458.	3832	*Daviesia physodes*			
459.	3834	*Daviesia polyphylla*			
460.	3835	*Daviesia preissii*			
461.	3845	*Daviesia triflora*			
462.	25766	*Delma fraseri (Fraser's Legless Lizard)*			
463.	17663	*Desmocladus asper*			
464.	16595	*Desmocladus flexuosus*			
465.	39008	*Diachea leucopodia*			
466.	1259	*Dianella revoluta (Blueberry Lily)*			
467.	11636	*Dianella revoluta var. divaricata*			
468.	25607	*Dicaeum hirundinaceum (Mistletoebird)*			
469.	306	*Dichelachne crinita (Longhair Plumegrass)*			
470.	1287	*Dichopogon capillipes*			
471.	39018	*Didymium bahiense*			
472.	32345	*Didymodon australasiae*			
473.	32346	*Didymodon torquatus*			
474.	17838	*Dielsia stenostachya*			
475.	17736	*Digitaria aequiglumis*	Y		
476.	311	*Digitaria ciliaris (Summer Grass)*	Y		
477.	320	*Digitaria sanguinalis (Crab Grass)*	Y		
478.	20367	*Dillwynia laxiflora*			
479.		*Dingosa serrata*			
480.		*Dinocambala ingens*			
481.	1509	*Dioscorea hastifolia (Warrine, Wararn)*			
482.	25469	*Diplodactylus granariensis*			
483.	24929	*Diplodactylus granariensis subsp. granariensis*			
484.	44654	*Diplodactylus lateroides (Speckled Stone Gecko)*			
485.	4746	*Diplopeltis huegelii*			
486.	18541	*Diplopeltis huegelii subsp. huegelii*			
487.	18589	*Diplopeltis huegelii subsp. lehmannii*			
488.	3011	*Diplotaxis muralis (Wall Rocket)*	Y		
489.	19649	*Disa bracteata*	Y		
490.	7055	*Dischisma capitatum (Woolly-headed Dischisma)*	Y		
491.	7961	*Dittrichia graveolens (Stinkwort)*	Y		
492.	12943	*Diuris brumalis*			
493.	11049	*Diuris corymbosa*			
494.	42231	*Diuris decrementa*			
495.	1634	*Diuris laxiflora (Bee Orchid)*			
496.	11247	*Dodonaea viscosa subsp. angustissima*			
497.		*Dolichopodidae sp.*			
498.	24470	*Dromaius novaehollandiae (Emu)*			
499.	13204	*Drosera callistos*			
500.	48724	*Drosera collina*			
501.	48751	*Drosera drummondii*			
502.	3095	*Drosera erythrorhiza (Red Ink Sundew)*			
503.	3097	*Drosera gigantea (Giant Sundew)*			
504.	3098	*Drosera glanduligera (Pimpernel Sundew)*			
505.	13195	*Drosera helodes*			
506.	3101	*Drosera heterophylla (Swamp Rainbow)*			
507.	13197	*Drosera hyperostigma*			
508.	3106	*Drosera macrantha (Bridal Rainbow)*			
509.	3109	*Drosera menziesii (Pink Rainbow)*			
510.	48710	*Drosera micrantha*			
511.	48709	*Drosera minutiflora*			
512.	3113	*Drosera neesii (Jewel Rainbow)*			
513.	3114	*Drosera nitidula (Shining Sundew)*			
514.		*Drosera paleacea scps subsp. paleacea*			Y
515.	3118	*Drosera pallida (Pale Rainbow)*			
516.	3123	*Drosera platystigma (Black-eyed Sundew)*			
517.	3124	*Drosera pulchella (Pretty Sundew)*			

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518.	3125	*Drosera pycnoblasta (Pearly Sundew)*			
519.	8911	*Drosera rosulata*			
520.		*Drosera sp.*			
521.	49090	*Drosera sp. Branched styles (S.C. Coffey 193)*			
522.	13185	*Drosera spilos*			
523.	3131	*Drosera stolonifera (Leafy Sundew)*			
524.	3133	*Drosera subhirtella (Sunny Rainbow)*			
525.	13184	*Drosera walyunga*			
526.	13607	*Drosera x badgerupii*			Y
527.		*Dugesiidae sp.*			
528.		*Dytiscidae sp.*			
529.	25251	*Echiopsis curta (Bardick)*			
530.		*Ecnomina F group*			
531.		*Edelia vittata*			
532.	25096	*Egernia kingii (King's Skink)*			
533.	25100	*Egernia napoleonis*			
534.		*Egretta garzetta*			
535.		*Egretta novaehollandiae*			
536.	346	*Ehrharta brevifolia (Annual Veldt Grass)*	Y		
537.	347	*Ehrharta calycina (Perennial Veldt Grass)*	Y		
538.	349	*Ehrharta longiflora (Annual Veldt Grass)*	Y		
539.		*Elanus axillaris*			
540.	24290	*Elanus caeruleus subsp. axillaris (Australian Black-shouldered Kite)*			
541.	822	*Eleocharis acuta (Common Spikerush)*			
542.	353	*Eleusine indica (Crowsfoot Grass)*	Y		
543.	47937	*Elseyornis melanops (Black-fronted Dotterel)*			
544.	1643	*Elythranthera brunonis (Purple Enamel Orchid)*			
545.	1644	*Elythranthera emarginata (Pink Enamel Orchid)*			
546.		*Eolophus roseicapillus*			
547.	1645	*Epiblema grandiflorum (Babe-in-a-cradle)*			
548.	6131	*Epilobium billardiereanum (Glabrous Willow Herb)*			
549.	24567	*Epthianura albifrons (White-fronted Chat)*			
550.	24570	*Epthianura tricolor (Crimson Chat)*			
551.	24258	*Equus caballus (Horse)*	Y		
552.	374	*Eragrostis cilianensis (Stinkgrass)*	Y		
553.	376	*Eragrostis curvula (African Lovegrass)*	Y		
554.	378	*Eragrostis dielsii (Mallee Lovegrass)*			
555.	5541	*Eremaea pauciflora*			
556.	14104	*Eremaea pauciflora var. pauciflora*			
557.	5542	*Eremaea purpurea*			
558.	415	*Eriachne ovata*			
559.	1646	*Eriochilus dilatatus (White Bunny Orchid)*			
560.	15414	*Eriochilus helonomos*			
561.	4332	*Erodium botrys (Long Storksbill)*	Y		
562.	4335	*Erodium cygnorum (Blue Heronsbill)*			
563.	6219	*Eryngium pinnatifidum (Blue Devils)*			
564.	15446	*Eryngium pinnatifidum subsp. pinnatifidum*			
565.	24379	*Erythrogonys cinctus (Red-kneed Dotterel)*			
566.	5545	*Eucalyptus accedens (Powderbark Wandoo)*			
567.	5708	*Eucalyptus marginata (Jarrah, Djara)*			
568.	13547	*Eucalyptus marginata subsp. marginata (Jarrah)*			
569.	5739	*Eucalyptus patens (Swan River Blackbutt, Dwuda)*			
570.	5763	*Eucalyptus rudis (Flooded Gum, Kulurda)*			
571.	5767	*Eucalyptus salubris (Gimlet)*			
572.	5790	*Eucalyptus todtiana (Coastal Blackbutt)*			
573.	5797	*Eucalyptus wandoo (Wandoo, Wondu)*			
574.	12906	*Eucalyptus wandoo subsp. wandoo*			
575.	3872	*Euchilopsis linearis (Swamp Pea)*			
576.	15137	*Euchiton sphaericus*			
577.	4638	*Euphorbia peplus (Petty Spurge)*	Y		
578.	3880	*Eutaxia virgata*			
579.	25621	*Falco berigora (Brown Falcon)*			
580.	25622	*Falco cenchroides (Australian Kestrel, Nankeen Kestrel)*			
581.	24472	*Falco cenchroides subsp. cenchroides (Australian Kestrel, Nankeen Kestrel)*			
582.	25623	*Falco longipennis (Australian Hobby)*			
583.	24041	*Felis catus (Cat)*	Y		
584.	20216	*Ficinia nodosa (Knotted Club Rush)*			
585.	894	*Fimbristylis velata*			
586.	32367	*Fissidens megalotis*			
587.	27743	*Flavoparmelia diffractaica*			

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588.	27745	*Flavoparmelia haysomii*			
589.	27746	*Flavoparmelia marchantii*			
590.	27748	*Flavoparmelia rutidota*			
591.	25727	*Fulica atra (Eurasian Coot)*			
592.	24761	*Fulica atra subsp. australis (Eurasian Coot)*			
593.	39033	*Fuligo septica*			
594.	2969	*Fumaria capreolata (Whiteflower Fumitory)*	Y		
595.	32370	*Funaria hygrometrica*			
596.	900	*Gahnia aristata*			
597.	907	*Gahnia trifida (Coast Saw-sedge)*			
598.	34028	*Galaxias occidentalis (Western Minnow)*			
599.	7321	*Galium divaricatum*	Y		
600.	7323	*Galium murale (Small Goosegrass)*	Y		
601.	25729	*Gallinula tenebrosa (Dusky Moorhen)*			
602.	24763	*Gallinula tenebrosa subsp. tenebrosa (Dusky Moorhen)*			
603.		*Gambusia sp.*			
604.	20475	*Gastrolobium capitatum*			
605.	20505	*Gastrolobium celsianum*			
606.	20473	*Gastrolobium ebracteolatum*			
607.	20483	*Gastrolobium linearifolium*			
608.	20512	*Gastrolobium praemorsum*			
609.	3924	*Gastrolobium spinosum (Prickly Poison)*			
610.	42314	*Gavicalis virescens (Singing Honeyeater)*			
611.	24959	*Gehyra variegata*			
612.	32379	*Gemmabryum inaequale*			
613.	25530	*Gerygone fusca (Western Gerygone)*			
614.	1517	*Gladiolus alatus*	Y		
615.	1520	*Gladiolus caryophyllaceus (Wild Gladiolus)*	Y		
616.	1524	*Gladiolus undulatus (Wild Gladiolus)*	Y		
617.	2836	*Glinus oppositifolius*			
618.	6143	*Glischrocaryon aureum (Common Popflower)*			
619.		*Glossiphoniidae sp.*			
620.	7061	*Glossostigma drummondii (Mudmat)*			
621.	47962	*Glyciphila melanops (Tawny-crowned Honeyeater)*			
622.	7991	*Gnephosis drummondii*			
623.	10909	*Gompholobium confertum*			
624.	3950	*Gompholobium knightianum*			
625.	3951	*Gompholobium marginatum*			
626.	3954	*Gompholobium polymorphum*			
627.	3957	*Gompholobium tomentosum (Hairy Yellow Pea)*			
628.	6149	*Gonocarpus cordiger*			
629.	6159	*Gonocarpus nodulosus*			
630.	6161	*Gonocarpus pithyoides*			
631.	8614	*Goodenia claytoniacea*			
632.	29362	*Goodenia coerulea*			
633.	12551	*Goodenia micrantha*			
634.	7538	*Goodenia pulchella*			
635.	24443	*Grallina cyanoleuca (Magpie-lark)*			
636.	7394	*Grammatotheca bergiana*	Y		
637.	14282	*Gratiola pubescens*			
638.	19628	*Grevillea bipinnatifida subsp. bipinnatifida*			
639.	1997	*Grevillea endlicheriana (Spindly Grevillea)*			
640.	13450	*Grevillea manglesii subsp. manglesii*			
641.	2066	*Grevillea pilulifera (Woolly-flowered Grevillea)*			
642.	2080	*Grevillea quercifolia (Oak-leaf Grevillea)*			
643.	14421	*Grevillea synapheae subsp. synapheae*			
644.	2122	*Grevillea wilsonii (Native Fuchsia)*			
645.	32473	*Grimmia pulvinata var. africana*			
646.		*Gripopterygidae sp.*			
647.	5014	*Guichenotia sarotes*			
648.		*Gyrinidae sp.*			
649.	1465	*Haemodorum discolor*			
650.	1468	*Haemodorum laxum*			
651.	1470	*Haemodorum paniculatum (Mardja)*			
652.	1472	*Haemodorum simplex*			
653.	1475	*Haemodorum spicatum (Mardja)*			
654.	2131	*Hakea auriculata*			
655.	2136	*Hakea candolleana*			
656.	2149	*Hakea cristata (Snail Hakea)*			
657.	2158	*Hakea erinacea (Hedge-hog Hakea)*			

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658.	2166	*Hakea incrassata (Marble Hakea)*			
659.	2175	*Hakea lissocarpha (Honey Bush)*			
660.	2185	*Hakea myrtoides (Myrtle Hakea)*			
661.	2197	*Hakea prostrata (Harsh Hakea)*			
662.	2215	*Hakea undulata (Wavy-leaved Hakea)*			
663.	2216	*Hakea varia (Variable-leaved Hakea)*			
664.	24295	*Haliastur sphenurus (Whistling Kite)*			
665.	24296	*Hamirostra isura (Square-tailed Kite)*			
666.	3961	*Hardenbergia comptoniana (Native Wisteria)*			
667.		*Harpacticoida sp*			
668.		*Hebridae sp.*			
669.	25408	*Heleioporus albopunctatus (Western Spotted Frog)*			
670.	25409	*Heleioporus barycragus (Hooting Frog)*			
671.	25410	*Heleioporus eyrei (Moaning Frog)*			
672.	25411	*Heleioporus inornatus (Whooping Frog)*			
673.	3016	*Heliophila pusilla*	Y		
674.	11451	*Hemarthria uncinata var. uncinata*			
675.	6838	*Hemiandra linearis (Speckled Snakebush)*			
676.	6839	*Hemiandra pungens (Snakebush)*			
677.		*Hemicordulia tau*			
678.		*Hemicorduliidae sp.*			
679.	25474	*Hemiergis initialis*			
680.	25115	*Hemiergis initialis subsp. initialis*			
681.	25475	*Hemiergis peronii*			
682.	25119	*Hemiergis quadrilineata*			
683.	6842	*Hemigenia barbata*			
684.		*Henicops dentatus*			
685.	1293	*Hensmania turbinata*			
686.	1526	*Hesperantha falcata*	Y		
687.	42408	*Hesperoedura reticulata*			
688.	5108	*Hibbertia acerosa (Needle Leaved Guinea Flower)*			
689.	5112	*Hibbertia aurea*			
690.	5114	*Hibbertia commutata*			
691.	5118	*Hibbertia cunninghamii*			
692.	20051	*Hibbertia diamesogenos*			
693.	5134	*Hibbertia huegelii*			
694.	5135	*Hibbertia hypericoides (Yellow Buttercups)*			
695.	45534	*Hibbertia hypericoides subsp. hypericoides*			
696.	5139	*Hibbertia lasiopus (Large Hibbertia)*			
697.	5154	*Hibbertia perfoliata*			
698.	5162	*Hibbertia racemosa (Stalked Guinea Flower)*			
699.	43280	*Hibbertia sericosepala*			
700.	5171	*Hibbertia spicata*			
701.	5172	*Hibbertia stellaris (Orange Stars)*			
702.	48381	*Hibbertia striata*			
703.	5173	*Hibbertia subvaginata*			
704.	47965	*Hieraaetus morphnoides (Little Eagle)*			
705.	25734	*Himantopus himantopus (Black-winged Stilt)*			
706.	24491	*Hirundo neoxena (Welcome Swallow)*			
707.		*Hogna crispipes*			
708.		*Holconia westralia*			
709.	445	*Holcus setiger (Annual Fog)*	Y		
710.	6222	*Homalosciadium homalocarpum*			
711.	17575	*Hordeum distichon*	Y		
712.	3966	*Hovea pungens (Devil's Pins, Puyenak)*			
713.	3968	*Hovea trisperma (Common Hovea)*			
714.	12859	*Hovea trisperma var. trisperma*			
715.	18296	*Humulus lupulus*	Y		
716.	12741	*Hyalosperma cotula*			
717.	5216	*Hybanthus calycinus (Wild Violet)*			
718.		*Hydridae sp.*			
719.	6223	*Hydrocotyle alata*			
720.	6226	*Hydrocotyle callicarpa (Small Pennywort)*			
721.	6229	*Hydrocotyle diantha*			
722.		*Hydrophilidae sp.*			
723.		*Hydroptilidae sp.*			
724.	5817	*Hypocalymma angustifolium (White Myrtle, Kudjid)*			
725.	35074	*Hypocalymma angustifolium subsp. Dandaragan plateau (S. Patrick 702A)*			
726.	35070	*Hypocalymma angustifolium subsp. Swan Coastal Plain (G.J. Keighery 16777)*			
727.	5825	*Hypocalymma robustum (Swan River Myrtle)*			

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728.	27782	*Hypocenomyce scalaris*			
729.	8086	*Hypochaeris glabra (Smooth Catsear)*	Y		
730.	9352	*Hypochaeris radicata (Flat Weed, Cats-ear)*	Y		
731.	28219	*Hypogymnia subphysodes var. subphysodes*			
732.	1070	*Hypolaena exsulca*			
733.		*Idiommata blackwalli*			
734.	48545	*Inocybe sabulosa*			
735.	11	*Isoetes drummondii (Quillwort)*			
736.	910	*Isolepis cernua (Nodding Club-rush)*			
737.	14540	*Isolepis hystrix*	Y		
738.	917	*Isolepis marginata (Coarse Club-rush)*			
739.	919	*Isolepis oldfieldiana*			
740.	921	*Isolepis producta*			
741.	924	*Isolepis stellata (Star Club-rush)*			
742.	2221	*Isopogon asper*			
743.	2227	*Isopogon divergens (Spreading Coneflower)*			
744.	2229	*Isopogon dubius (Pincushion Coneflower)*			
745.	2237	*Isopogon sphaerocephalus (Drumstick Isopogon)*			
746.	7396	*Isotoma hypocrateriformis (Woodbridge Poison)*			
747.	7398	*Isotoma pusilla (Small Isotome)*			
748.	3992	*Isotropis cuneifolia (Granny Bonnets)*			
749.	1532	*Ixia maculata (Yellow Ixia)*	Y		
750.	8092	*Ixiolaena viscosa (Sticky Ixiolaena)*			
751.	3997	*Jacksonia alata*			
752.	14783	*Jacksonia calcicola*			
753.	4010	*Jacksonia floribunda (Holly Pea)*			
754.	4012	*Jacksonia furcellata (Grey Stinkwood)*			
755.	4029	*Jacksonia sternbergiana (Stinkwood, Kapur)*			
756.	1295	*Johnsonia acaulis*			
757.	1298	*Johnsonia pubescens (Pipe Lily)*			
758.	19632	*Johnsonia pubescens subsp. pubescens*			
759.	1175	*Juncus acutus (Spiny Rush)*	Y		
760.	1178	*Juncus bufonius (Toad Rush)*	Y		
761.	1180	*Juncus capitatus (Capitate Rush)*	Y		
762.	1188	*Juncus pallidus (Pale Rush)*			
763.	1190	*Juncus planifolius (Broadleaf Rush)*			
764.	1195	*Juncus subsecundus (Finger Rush)*			
765.		*Karaops ellenae*			
766.	4042	*Kennedia nigricans (Black Kennedia)*			
767.	4044	*Kennedia prostrata (Scarlet Runner)*			
768.	4045	*Kennedia stirlingii (Bushy Kennedia)*			
769.	11898	*Kickxia elatine subsp. elatine*	Y		
770.	5831	*Kunzea baxteri (Baxter's Kunzea)*			
771.	15498	*Kunzea glabrescens (Spearwood)*			
772.	5835	*Kunzea micrantha*			
773.	17461	*Kunzea micrantha subsp. micrantha*			
774.	17505	*Kunzea praestans*			
775.	5840	*Kunzea pulchella (Granite Kunzea, Silky Kunzea)*			
776.	5841	*Kunzea recurva*			
777.	3667	*Labichea lanceolata (Tall Labichea)*			
778.	11289	*Labichea lanceolata subsp. lanceolata*			
779.	4046	*Lablab purpureus (Lablab Bean)*	Y		
780.	20019	*Lachnagrostis filiformis*			
781.	19955	*Lachnagrostis plebeia*			
782.	29046	*Lactuca serriola forma serriola*	Y		
783.	18585	*Lagenophora huegelii*			
784.	468	*Lamarckia aurea (Goldentop)*	Y		
785.	14083	*Lambertia multiflora var. darlingensis*			
786.	24511	*Larus novaehollandiae subsp. novaehollandiae (Silver Gull)*			
787.	5034	*Lasiopetalum glabratum*			
788.	45082	*Lasiopetalum glutinosum subsp. latifolium*			
789.	4052	*Latrobea tenella*			
790.		*Latrodectus hasseltii*			
791.	13284	*Lawrencella rosea*			
792.	4959	*Lawrencia squamata*			
793.	1303	*Laxmannia grandiflora*			
794.	11815	*Laxmannia grandiflora subsp. grandiflora*			
795.	11911	*Laxmannia ramosa subsp. ramosa*			
796.	1308	*Laxmannia sessiliflora (Nodding Lily)*			
797.	11464	*Laxmannia sessiliflora subsp. australis*			

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798.	1309	*Laxmannia squarrosa*			
799.	7574	*Lechenaultia floribunda (Free-flowering Leschenaultia)*			
800.	1051	*Lemna disperma (Duckweed)*			
801.	44490	*Leontodon rhagadioloides*	Y		
802.	1075	*Lepidobolus preissianus*			
803.	18074	*Lepidobolus preissianus subsp. preissianus*			
804.		*Lepidoptera sp.*			
805.	925	*Lepidosperma angustatum*			
806.	42741	*Lepidosperma apricola*			
807.	41620	*Lepidosperma asperatum*			
808.	42742	*Lepidosperma calcicola*			
809.	930	*Lepidosperma costale*			
810.		*Lepidosperma eastern terete scps (BJK&NG 232)*			
811.	936	*Lepidosperma leptostachyum*			
812.	937	*Lepidosperma longitudinale (Pithy Sword-sedge)*			
813.	940	*Lepidosperma pubisquameum*			
814.	944	*Lepidosperma scabrum*			
815.		*Lepidosperma sp.*			
816.	945	*Lepidosperma squamatum*			
817.	946	*Lepidosperma striatum*			
818.	1653	*Leporella fimbriata (Hare Orchid)*			
819.	1077	*Leptocarpus canus (Hoary Twine-rush)*			
820.	1078	*Leptocarpus coangustatus*			
821.	46375	*Leptocarpus decipiens*			
822.	1080	*Leptocarpus scariosus*			
823.	46383	*Leptocarpus tephrinus*			
824.		*Leptoceridae sp.*			
825.	2344	*Leptomeria empetriformis*			
826.	2350	*Leptomeria pauciflora (Sparse-flowered Currant Bush)*			
827.		*Leptophlebiidae sp.*			
828.	5847	*Leptospermum erubescens (Roadside Teatree)*			
829.	5850	*Leptospermum laevigatum (Coast Teatree)*	Y		
830.	1088	*Lepyrodia macra (Large Scale Rush)*			
831.	25128	*Lerista christinae*			
832.	25133	*Lerista elegans*			
833.	25148	*Lerista lineopunctulata*			
834.	25165	*Lerista praepedita*			
835.		*Lethocolea pansa*			
836.	6360	*Leucopogon australis (Spiked Beard-heath)*			
837.	6374	*Leucopogon conostephioides*			
838.	6397	*Leucopogon glaucifolius*			
839.	6416	*Leucopogon nutans (Drooping Leucopogon)*			
840.	6420	*Leucopogon oldfieldii*			
841.	6425	*Leucopogon oxycedrus*			
842.	6434	*Leucopogon polymorphus*			
843.	6436	*Leucopogon propinquus*			
844.	6439	*Leucopogon pulchellus (Beard-heath)*			
845.	40803	*Leucopogon squarrosus subsp. squarrosus*			
846.	6451	*Leucopogon tenuis*			
847.	7676	*Levenhookia pusilla (Midget Stylewort)*			
848.	7677	*Levenhookia stipitata (Common Stylewort)*			
849.	25005	*Lialis burtonis*			
850.		*Libellulidae sp.*			
851.	25661	*Lichmera indistincta (Brown Honeyeater)*			
852.	25415	*Limnodynastes dorsalis (Western Banjo Frog)*			
853.	4363	*Linum trigynum (French Flax)*	Y		
854.	36160	*Liparophyllum capitatum*			
855.	25378	*Litoria adelaidensis (Slender Tree Frog)*			
856.	25388	*Litoria moorei (Motorbike Frog)*			
857.	9289	*Lobelia anceps (Angled Lobelia)*			
858.	7407	*Lobelia rhytidosperma (Wrinkled-seeded Lobelia)*			
859.	7408	*Lobelia tenuior (Slender Lobelia)*			
860.	476	*Lolium perenne (Perennial Ryegrass)*	Y		
861.	478	*Lolium rigidum (Wimmera Ryegrass)*	Y		
862.		*Lolium sp.*			
863.	1222	*Lomandra brittanii*			
864.	1223	*Lomandra caespitosa (Tufted Mat Rush)*			
865.	1227	*Lomandra hastilis*			
866.	1228	*Lomandra hermaphrodita*			
867.	1229	*Lomandra integra*			

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868.	1232	*Lomandra micrantha (Small-flower Mat-rush)*			
869.	14542	*Lomandra micrantha subsp. micrantha*			
870.	1234	*Lomandra nigricans*			
871.	1239	*Lomandra preissii*			
872.	1243	*Lomandra sericea (Silky Mat Rush)*			
873.		*Lomandra sp.*			
874.	1245	*Lomandra spartea*			
875.	1246	*Lomandra suaveolens*			
876.		*Lophoictinia isura*			
877.	4059	*Lotus angustissimus (Narrowleaf Trefoil)*	Y		
878.	8564	*Lotus subbiflorus*	Y		
879.	4065	*Lupinus angustifolius (Narrowleaf Lupin)*	Y		
880.	12783	*Lycopodiella serpentina*			
881.	1097	*Lyginia barbata*			
882.	18049	*Lyginia imberbis*			
883.		*Lymnaeidae sp.*			
884.	36375	*Lysimachia arvensis (Pimpernel)*	Y		
885.	36373	*Lysimachia minima*	Y		
886.	6456	*Lysinema ciliatum (Curry Flower)*			
887.	6458	*Lysinema elegans*			
888.	34736	*Lysinema pentapetalum*			
889.	5281	*Lythrum hyssopifolia (Lesser Loosestrife)*	Y		
890.	2838	*Macarthuria apetala*			
891.	2839	*Macarthuria australis*			
892.	1477	*Macropidia fuliginosa (Black Kangaroo Paw)*			
893.	24132	*Macropus fuliginosus (Western Grey Kangaroo)*			
894.	85	*Macrozamia riedlei (Zamia, Djiridji)*			
895.	24326	*Malacorhynchus membranaceus (Pink-eared Duck)*			
896.	25651	*Malurus lamberti (Variegated Fairy-wren)*			
897.	25652	*Malurus leucopterus (White-winged Fairy-wren)*			
898.	24551	*Malurus pulcherrimus (Blue-breasted Fairy-wren)*			
899.	25654	*Malurus splendens (Splendid Fairy-wren)*			
900.	24583	*Manorina flavigula (Yellow-throated Miner)*			
901.	17637	*Marianthus candidus (White Marianthus)*			
902.	17636	*Marianthus coeruleopunctatus (Blue-spotted Marianthus)*			
903.	34676	*Meionectes brownii (Swamp Raspwort)*			
904.	5926	*Melaleuca lateritia (Robin Redbreast Bush)*			
905.	18394	*Melaleuca parviceps*			
906.	5952	*Melaleuca preissiana (Moonah)*			
907.	5958	*Melaleuca radula (Graceful Honeymyrtle)*			
908.	5959	*Melaleuca rhaphiophylla (Swamp Paperbark)*			
909.	19365	*Melaleuca ryeae*			
910.	5964	*Melaleuca seriata*			
911.	5978	*Melaleuca teretifolia (Banbar)*			
912.	5983	*Melaleuca trichophylla*			
913.	5984	*Melaleuca uncinata (Broom Bush, Kwidjard)*			
914.	5987	*Melaleuca viminea (Mohan)*			
915.	13280	*Melaleuca viminea subsp. viminea*			
916.	47997	*Melanodryas cucullata (Hooded Robin)*			
917.	4085	*Melilotus indicus*	Y		
918.	14985	*Melinis repens*	Y		
919.	25663	*Melithreptus brevirostris (Brown-headed Honeyeater)*			
920.	25184	*Menetia greyii*			
921.	24598	*Merops ornatus (Rainbow Bee-eater)*			
922.		*Mesamphisopodidae sp.*			
923.	953	*Mesomelaena graciliceps*			
924.	955	*Mesomelaena pseudostygia*			
925.	957	*Mesomelaena tetragona (Semaphore Sedge)*			
926.		*Microcarbo melanoleucos*			
927.	6897	*Microcorys longifolia*			
928.	25693	*Microeca fascinans (Jacky Winter)*			
929.	485	*Microlaena stipoides (Weeping Grass)*			
930.	10954	*Microtis media (Tall Mignonette Orchid)*			
931.	12761	*Microtis media subsp. densiflora*			
932.	15419	*Microtis media subsp. media*			
933.		*Microvelia sp.*			
934.	8105	*Millotia myosotidifolia*			
935.	8106	*Millotia tenuifolia (Soft Millotia)*			
936.	4100	*Mirbelia spinosa*			
937.	7085	*Misopates orontium (Lesser Snapdragon)*	Y		

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938.		*Missulena granulosa*			
939.	29418	*Monoculus monstrosus*	Y		
940.		*Monohelea sp. 4 (SAP)*			
941.	7410	*Monopsis debilis*	Y		
942.	37440	*Monopsis debilis var. depressa*	Y		
943.	4666	*Monotaxis occidentalis*			
944.	19179	*Moraea flaccida (One-leaf Cape Tulip)*	Y		
945.	19180	*Moraea miniata (Two-leaf Cape Tulip)*	Y		
946.	25240	*Morelia spilota subsp. imbricata (Carpet Python)*			
947.	25191	*Morethia lineoocellata*			
948.	25192	*Morethia obscura*			
949.	2412	*Muehlenbeckia adpressa (Climbing Lignum)*			
950.	24223	*Mus musculus (House Mouse)*	Y		
951.	25610	*Myiagra inquieta (Restless Flycatcher)*			
952.	25420	*Myobatrachus gouldii (Turtle Frog)*			
953.	8114	*Myriocephalus appendiculatus (White-tip Myriocephalus)*			
954.	8116	*Myriocephalus guerinae*			
955.	8117	*Myriocephalus helichrysoides*			
956.	14187	*Myriocephalus occidentalis*			
957.	6185	*Myriophyllum aquaticum (Brazilian Water Milfoil)*	Y		
958.	6189	*Myriophyllum crispatum*			
959.	6192	*Myriophyllum drummondii*			
960.	25248	*Neelaps bimaculatus (Black-naped Snake)*			
961.		*Nematoda sp.*			
962.	25426	*Neobatrachus pelobatoides (Humming Frog)*			
963.	24738	*Neophema elegans (Elegant Parrot)*			
964.		*Nephila edulis*			
965.	492	*Neurachne alopecuroidea (Foxtail Mulga Grass)*			
966.	25252	*Notechis scutatus (Tiger Snake)*			
967.		*Notiasemus glauerti*			
968.		*Notonectidae sp.*			
969.	2401	*Nuytsia floribunda (Christmas Tree, Mudja)*			
970.	25564	*Nycticorax caledonicus (Rufous Night Heron)*			
971.	2922	*Nymphaea mexicana (Yellow Waterlily)*	Y		
972.	27881	*Ochrolechia pallescens*			
973.	27883	*Ochrolechia subathallina*			
974.	24407	*Ocyphaps lophotes (Crested Pigeon)*			
975.		*Oecobius navus*			
976.	8143	*Olearia paucidentata (Autumn Scrub Daisy)*			
977.		*Oligochaeta sp.*			
978.		*Oniscidae sp.*			
979.	18255	*Opercularia vaginata (Dog Weed)*			
980.	17	*Ophioglossum lusitanicum (Adders Tongue)*			
981.	36177	*Ornduffia albiflora*			
982.	4114	*Ornithopus pinnatus (Slender Serradella)*	Y		
983.	7122	*Orobanche minor (Lesser Broomrape)*	Y		
984.		*Orthocladiinae SO3 sp. A (SAP)*			
985.		*Orthocladiinae sp.*			
986.	11749	*Orthrosanthus laxus var. laxus (Morning Iris)*			
987.	24085	*Oryctolagus cuniculus (Rabbit)*	Y		
988.		*Ostracoda (unident.)*			
989.	4355	*Oxalis perennans*			
990.	4356	*Oxalis pes-caprae (Soursob)*	Y		
991.	4358	*Oxalis purpurea (Largeflower Wood Sorrel)*	Y		
992.		*Oxyethira sp.*			
993.	25680	*Pachycephala rufiventris (Rufous Whistler)*			
994.		*Palaemonidae sp.*			
995.	23500	*Paracaleana hortiorum*			
996.	1667	*Paracaleana nigrita (Flying Duck Orchid)*			
997.		*Paracyclops sp.*			
998.		*Paralimnophyes pullulus (V42)*			
999.		*Paramelitidae sp.*			
1000.	516	*Parapholis incurva (Coast Barbgrass)*	Y		
1001.	25253	*Parasuta gouldii*			
1002.	25681	*Pardalotus punctatus (Spotted Pardalote)*			
1003.	25682	*Pardalotus striatus (Striated Pardalote)*			
1004.	7089	*Parentucellia latifolia (Common Bartsia)*	Y		
1005.	44083	*Parmotrema norsticticatum*			
1006.	30458	*Parmotrema reticulatum*			
1007.	519	*Paspalidium constrictum (Knottybutt Grass)*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1008.	1546	*Patersonia juncea (Rush Leaved Patersonia)*			
1009.	1550	*Patersonia occidentalis (Purple Flag, Koma)*			
1010.	30471	*Patersonia occidentalis var. angustifolia*			
1011.	14433	*Patersonia rudis subsp. rudis*			
1012.	43760	*Pauridia occidentalis*			
1013.	43761	*Pauridia occidentalis var. occidentalis*			
1014.		*Pedidromus velox*			Y
1015.	4343	*Pelargonium capitatum (Rose Pelargonium)*	Y		
1016.	24648	*Pelecanus conspicillatus (Australian Pelican)*			
1017.	40424	*Pentameris airoides subsp. airoides*	Y		
1018.	40422	*Pentameris pallida*	Y		
1019.	48805	*Pentameris patula*	Y		
1020.	11109	*Pericalymma crassipes*			
1021.	6006	*Pericalymma ellipticum (Swamp Teatree)*			
1022.	16477	*Pericalymma ellipticum var. ellipticum*			
1023.	16478	*Pericalymma ellipticum var. floridum*			
1024.	13911	*Persicaria decipiens*			
1025.	2273	*Persoonia saccata (Snottygobble)*			
1026.	48061	*Petrochelidon nigricans (Tree Martin)*			
1027.	48066	*Petroica boodang (Scarlet Robin)*			
1028.	24659	*Petroica goodenovii (Red-capped Robin)*			
1029.	2284	*Petrophile biloba (Granite Petrophile)*			
1030.	20391	*Petrophile juncifolia*			
1031.	2299	*Petrophile linearis (Pixie Mops)*			
1032.	2308	*Petrophile seminuda*			
1033.	2312	*Petrophile striata*			
1034.	19825	*Petrorhagia dubia*	Y		
1035.	25697	*Phalacrocorax carbo (Great Cormorant)*			
1036.	25698	*Phalacrocorax melanoleucos (Little Pied Cormorant)*			
1037.	24667	*Phalacrocorax sulcirostris (Little Black Cormorant)*			
1038.	25699	*Phalacrocorax varius (Pied Cormorant)*			
1039.	551	*Phalaris minor (Lesser Canary Grass)*	Y		
1040.	24409	*Phaps chalcoptera (Common Bronzewing)*			
1041.	18529	*Philotheca spicata (Pepper and Salt)*			
1042.	1172	*Philydrella drummondii*			
1043.	1173	*Philydrella pygmaea (Butterfly Flowers)*			
1044.	1478	*Phlebocarya ciliata*			
1045.	48071	*Phylidonyris niger (White-cheeked Honeyeater)*			
1046.	24596	*Phylidonyris novaehollandiae (New Holland Honeyeater)*			
1047.	16177	*Phyllangium paradoxum*			
1048.	4675	*Phyllanthus calycinus (False Boronia)*			
1049.	39078	*Physarum vernum*			
1050.		*Physidae sp.*			
1051.	2793	*Phytolacca octandra (Red Ink Plant)*	Y		
1052.		*Phytophthora cinnamomi*			
1053.	78	*Pilularia novae-hollandiae (Austral Pillwort)*			
1054.	5232	*Pimelea argentea (Silvery Leaved Pimelea)*			
1055.	11404	*Pimelea imbricata var. major*			
1056.	11402	*Pimelea imbricata var. piligera*			
1057.	12041	*Pimelea suaveolens subsp. suaveolens*			
1058.	5268	*Pimelea sulphurea (Yellow Banjine)*			
1059.		*Piona murleyi*			
1060.		*Pisum sativum*			
1061.	8165	*Pithocarpa pulchella (Beautiful Pithocarpa)*			
1062.	18353	*Pithocarpa pulchella var. pulchella*			
1063.		*Planorbidae sp.*			
1064.	24841	*Platalea flavipes (Yellow-billed Spoonbill)*			
1065.	25720	*Platycercus icterotis (Western Rosella)*			
1066.	24747	*Platycercus spurius (Red-capped Parrot)*			
1067.	25721	*Platycercus zonarius (Australian Ringneck, Ring-necked Parrot)*			
1068.	24750	*Platycercus zonarius subsp. semitorquatus (Twenty-eight Parrot)*			
1069.	24751	*Platycercus zonarius subsp. zonarius (Port Lincoln Parrot)*			
1070.	6255	*Platysace juncea*			
1071.	4524	*Platytheca galioides*			
1072.	25509	*Pletholax gracilis (Keeled Legless Lizard)*			
1073.	25007	*Pletholax gracilis subsp. gracilis (Keeled Legless Lizard)*			
1074.	32413	*Pleuridium ecklonii*			
1075.	571	*Poa annua (Winter Grass)*	Y		
1076.	25703	*Podargus strigoides (Tawny Frogmouth)*			
1077.	8175	*Podolepis gracilis (Slender Podolepis)*			

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1078.	8177	*Podolepis lessonii*			
1079.	8179	*Podolepis nutans (Nodding Podolepis)*			
1080.	8182	*Podotheca angustifolia (Sticky Longheads)*			
1081.	8183	*Podotheca chrysantha (Yellow Podotheca)*			
1082.	8184	*Podotheca gnaphalioides (Golden Long-heads)*			
1083.	25510	*Pogona minor (Dwarf Bearded Dragon)*			
1084.	24907	*Pogona minor subsp. minor (Dwarf Bearded Dragon)*			
1085.	8188	*Pogonolepis stricta*			
1086.	24681	*Poliocephalus poliocephalus (Hoary-headed Grebe)*			
1087.	582	*Polypogon monspeliensis (Annual Beardgrass)*	Y		
1088.	583	*Polypogon tenellus*			
1089.		*Polypompholyx tenella scps*			
1090.	30854	*Polytelis anthopeplus subsp. westralis (Regent Parrot)*			
1091.	24683	*Pomatostomus superciliosus (White-browed Babbler)*			
1092.	4689	*Poranthera ericoides (Heath Poranthera)*			
1093.	4691	*Poranthera microphylla (Small Poranthera)*			
1094.	25731	*Porphyrio porphyrio (Purple Swamphen)*			
1095.	2884	*Portulaca oleracea (Purslane, Wakati)*			
1096.	1671	*Prasophyllum elatum (Tall Leek Orchid)*			
1097.	1672	*Prasophyllum fimbria (Fringed Leek Orchid)*			
1098.	1680	*Prasophyllum parvifolium (Autumn Leek Orchid)*			
1099.		*Procladius paludicola*			
1100.	25261	*Pseudechis australis (Mulga Snake)*			
1101.	36137	*Pseudocrossidium crinitum*			
1102.	25511	*Pseudonaja affinis (Dugite)*			
1103.	25259	*Pseudonaja affinis subsp. affinis (Dugite)*			
1104.	42416	*Pseudonaja mengdeni (Western Brown Snake)*			
1105.	25433	*Pseudophryne guentheri (Crawling Toadlet)*			
1106.	41651	*Pteridium esculentum subsp. esculentum*			
1107.	13255	*Pterochaeta paniculata*			
1108.		*Pterostylis aff. nana*			
1109.	1686	*Pterostylis barbata (Bird Orchid)*			
1110.	48677	*Pterostylis ectypha*			
1111.	44723	*Pterostylis glebosa*			
1112.	1693	*Pterostylis recurva (Jug Orchid)*			
1113.	12217	*Pterostylis sanguinea*			
1114.		*Pterostylis sp.*			
1115.	1698	*Pterostylis vittata (Banded Greenhood)*			
1116.	2716	*Ptilotus declinatus (Curved Mulla Mulla)*			
1117.	11260	*Ptilotus drummondii var. drummondii (Pussytail)*			
1118.	2720	*Ptilotus esquamatus*			
1119.	2742	*Ptilotus manglesii (Pom Poms, Mulamula)*			
1120.	2751	*Ptilotus polystachyus (Prince of Wales Feather)*			
1121.	4181	*Pultenaea reticulata*			
1122.		*Punctelia borreri*			
1123.	28006	*Punctelia pseudocoralloidea*			
1124.	42344	*Purnella albifrons (White-fronted Honeyeater)*			
1125.		*Purpureicephalus spurius*			
1126.	48835	*Pycnoporus coccineus*			
1127.	25008	*Pygopus lepidopodus (Common Scaly Foot)*			
1128.	16367	*Pyrorchis nigricans (Red beaks, Elephants ears)*			
1129.	8195	*Quinetia urvillei*			
1130.	32480	*Racopilum cuspidigerum var. convolutaceum*			
1131.	2932	*Ranunculus colonorum (Common Buttercup)*			
1132.	2933	*Ranunculus muricatus (Sharp Buttercup)*	Y		
1133.	2937	*Ranunculus sessiliflorus (Smallflower Buttercup)*			
1134.	11927	*Ranunculus sessiliflorus var. sessiliflorus*			
1135.	3061	*Raphanus raphanistrum (Wild Radish)*	Y		
1136.	24245	*Rattus rattus (Black Rat)*	Y		
1137.	6012	*Regelia ciliata*			
1138.	6014	*Regelia inops*			
1139.	48096	*Rhipidura albiscapa (Grey Fantail)*			
1140.	25614	*Rhipidura leucophrys (Willie Wagtail)*			
1141.	38834	*Rhizopogon roseolus*			
1142.	13300	*Rhodanthe citrina*			
1143.	15035	*Rhodanthe corymbosa*			
1144.	13312	*Rhodanthe pyrethrum*			
1145.		*Richardsonianidae sp.*			
1146.	4705	*Ricinus communis (Castor Oil Plant)*	Y		
1147.	1556	*Romulea rosea (Guildford Grass)*	Y		

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1148.	11544	*Romulea rosea var. australis (Guildford Grass)*	Y		
1149.	14924	*Romulea rosea var. communis*	Y		
1150.	32426	*Rosulabryum campylothecium*			
1151.		*Rotifera sp.*			
1152.	2429	*Rumex acetosella (Sorrel)*	Y		
1153.	2433	*Rumex crispus (Curled Dock)*	Y		
1154.	46434	*Rumex hypogaeus*	Y		
1155.	40425	*Rytidosperma caespitosum*			
1156.	40426	*Rytidosperma occidentale*			
1157.	40430	*Rytidosperma pilosum*			
1158.	40427	*Rytidosperma setaceum*			
1159.	48433	*Salicornia blackiana*			
1160.	6483	*Samolus junceus*			
1161.	2356	*Santalum acuminatum (Quandong, Warnga)*			
1162.	7603	*Scaevola canescens (Grey Scaevola)*			
1163.	7613	*Scaevola glandulifera (Viscid Hand-flower)*			
1164.	12585	*Scaevola repens*			
1165.	13182	*Scaevola repens var. repens*			
1166.	41660	*Schenkia australis*			
1167.	968	*Schoenoplectus pungens (Sharpleaf Rush)*			
1168.		*Schoenus aff. brevisetis (Mud2, #135)*			
1169.	972	*Schoenus armeria*			
1170.	975	*Schoenus bifidus*			
1171.	978	*Schoenus brevisetis*			
1172.	982	*Schoenus clandestinus*			
1173.	984	*Schoenus curvifolius*			
1174.	985	*Schoenus discifer*			
1175.	986	*Schoenus efoliatus*			
1176.	991	*Schoenus grammatophyllus*			
1177.	994	*Schoenus humilis*			
1178.	8312	*Schoenus maschalinus*			
1179.	1002	*Schoenus nanus (Tiny Bog Rush)*			
1180.	1006	*Schoenus odontocarpus*			
1181.	1007	*Schoenus pedicellatus*			
1182.	17614	*Schoenus plumosus*			
1183.	1011	*Schoenus rigens*			
1184.	1013	*Schoenus sculptus (Gimlet Bog-rush)*			
1185.	18164	*Schoenus sp. smooth culms (K.R. Newbey 7823)*			
1186.	1017	*Schoenus subbulbosus*			
1187.	1018	*Schoenus subfascicularis*			
1188.	1023	*Schoenus tenellus*			
1189.	1026	*Schoenus unispiculatus*			
1190.	17409	*Schoenus variicellae*			
1191.	6033	*Scholtzia involucrata (Spiked Scholtzia)*			
1192.		*Scirtidae sp.*			
1193.		*Scolopendra laeta*			
1194.	6	*Selaginella gracillima (Tiny Clubmoss)*			
1195.	32433	*Sematophyllum homomallum*			
1196.	20663	*Senecio multicaulis subsp. multicaulis*			
1197.	25534	*Sericornis frontalis (White-browed Scrubwren)*			
1198.	2909	*Silene gallica (French Catchfly)*	Y		
1199.	15972	*Silene gallica var. gallica*	Y		
1200.	11803	*Silene gallica var. quinquevulnera*	Y		
1201.	8224	*Siloxerus filifolius*			
1202.	8225	*Siloxerus humifusus (Procumbent Siloxerus)*			
1203.	14583	*Siloxerus multiflorus*			
1204.	25266	*Simoselaps bertholdi (Jan's Banded Snake)*			
1205.		*Simuliidae sp.*			
1206.	30948	*Smicrornis brevirostris (Weebill)*			
1207.	24111	*Sminthopsis gilberti (Gilbert's Dunnart)*			
1208.	6988	*Solanum americanum (Glossy Nightshade)*	Y		
1209.	7013	*Solanum hoplopetalum (Thorny Solanum)*			
1210.	7022	*Solanum nigrum (Black Berry Nightshade)*	Y		
1211.	8230	*Sonchus asper (Rough Sowthistle)*	Y		
1212.	8231	*Sonchus oleraceus (Common Sowthistle)*	Y		
1213.	617	*Sorghum halepense (Johnson Grass)*	Y		
1214.	1312	*Sowerbaea laxiflora (Purple Tassels)*			
1215.	623	*Spartochloa scirpoidea*			
1216.	2912	*Spergula arvensis (Corn Spurry)*	Y		
1217.	4211	*Sphaerolobium vimineum (Leafless Globe Pea)*			

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1218.	635	*Sporobolus virginicus (Marine Couch)*			
1219.	6930	*Stachys arvensis (Staggerweed)*	Y		
1220.	4713	*Stachystemon axillaris (Leafy Stachystemon)*			
1221.	4733	*Stackhousia monogyna*			
1222.	24645	*Stagonopleura oculata (Red-eared Firetail)*			
1223.		*Steatoda capensis*			
1224.	2918	*Stellaria media (Chickweed)*	Y		
1225.	16197	*Stenanthemum emarginatum*			
1226.		*Sternopriscus sp.*			
1227.	12856	*Stirlingia abrotanoides*			
1228.	2316	*Stirlingia latifolia (Blueboy)*			
1229.		*Stratiomyidae sp.*			
1230.	25597	*Strepera versicolor (Grey Currawong)*			
1231.	25589	*Streptopelia chinensis (Spotted Turtle-Dove)*	Y		
1232.	25590	*Streptopelia senegalensis (Laughing Turtle-Dove)*	Y		
1233.	25518	*Strophurus spinigerus*			
1234.	24943	*Strophurus spinigerus subsp. inornatus*			
1235.	24942	*Strophurus spinigerus subsp. spinigerus*			
1236.	7681	*Stylidium affine (Queen Triggerplant)*			
1237.	7684	*Stylidium amoenum (Lovely Triggerplant)*			
1238.	30278	*Stylidium androsaceum*			
1239.	25831	*Stylidium araeophyllum (Stilt Walker)*			
1240.	48457	*Stylidium bindoon*			
1241.	7693	*Stylidium brunonianum (Pink Fountain Triggerplant)*			
1242.	7694	*Stylidium bulbiferum (Circus Triggerplant)*			
1243.	7696	*Stylidium calcaratum (Book Triggerplant)*			
1244.	7698	*Stylidium caricifolium (Milkmaids)*			
1245.	7699	*Stylidium carnosum (Fleshy-leaved Triggerplant)*			
1246.	7702	*Stylidium ciliatum (Golden Triggerplant)*			
1247.	7709	*Stylidium crossocephalum (Posy Triggerplant)*			
1248.	7712	*Stylidium despectum (Dwarf Triggerplant)*			
1249.	7713	*Stylidium dichotomum (Pins-and-needles)*			
1250.	7716	*Stylidium diuroides (Donkey Triggerplant)*			
1251.	7717	*Stylidium divaricatum (Daddy-long-legs)*			
1252.	7719	*Stylidium ecorne (Foot Triggerplant)*			
1253.	7734	*Stylidium guttatum (Dotted Triggerplant)*			
1254.	7736	*Stylidium hispidum (White Butterfly Triggerplant)*			
1255.	7742	*Stylidium inundatum (Hundreds and Thousands)*			
1256.	7745	*Stylidium junceum (Reed Triggerplant)*			
1257.	25829	*Stylidium neurophyllum (Coastal Plain Triggerplant)*			
1258.	7768	*Stylidium obtusatum (Pinafore Triggerplant)*			
1259.	7773	*Stylidium petiolare (Horn Triggerplant)*			
1260.	7774	*Stylidium piliferum (Common Butterfly Triggerplant)*			
1261.	7781	*Stylidium pubigerum (Yellow Butterfly Triggerplant)*			
1262.	25837	*Stylidium purpureum (Purple Fountain Triggerplant)*			
1263.	33106	*Stylidium recurvum*			
1264.	7785	*Stylidium repens (Matted Triggerplant)*			
1265.	20521	*Stylidium rigidulum*			
1266.	7790	*Stylidium roseoalatum (Pink-wing Triggerplant)*			
1267.	25806	*Stylidium scariosum*			
1268.	7798	*Stylidium schoenoides (Cow Kicks)*			
1269.	45594	*Stylidium tenue subsp. majusculum (Showy Fountain Triggerplant)*			
1270.	23511	*Stylidium thesioides (Delicate Triggerplant)*			
1271.	7806	*Stylidium utricularioides (Pink Fan Triggerplant)*			
1272.	3181	*Stylobasium australe*			
1273.	1260	*Stypandra glauca (Blind Grass)*			
1274.	6476	*Styphelia tenuiflora (Common Pinheath)*			
1275.	2321	*Synaphea acutiloba (Granite Synaphea)*			
1276.	2323	*Synaphea gracillima*			
1277.	2325	*Synaphea pinnata (Helena Synaphea)*			
1278.	2329	*Synaphea spinulosa*			
1279.	15532	*Synaphea spinulosa subsp. spinulosa*			
1280.	32438	*Syntrichia pagorum*			
1281.		*Tabanidae sp.*			
1282.	25705	*Tachybaptus novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
1283.	24682	*Tachybaptus novaehollandiae subsp. novaehollandiae (Australasian Grebe, Black-throated Grebe)*			
1284.	24207	*Tachyglossus aculeatus (Short-beaked Echidna)*			
1285.	24331	*Tadorna tadornoides (Australian Shelduck, Mountain Duck)*			
1286.		*Tanypodinae sp.*			

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1287.		*Tanytarsus barbitarsis*			
1288.	24167	*Tarsipes rostratus (Honey Possum, Noolbenger)*			
1289.		*Tasmanicosa leuckartii*			
1290.	20135	*Taxandria linearifolia*			
1291.	4251	*Templetonia drummondii*			
1292.	1034	*Tetraria capillaris (Hair Sedge)*			
1293.	1036	*Tetraria octandra*			
1294.	667	*Tetrarrhena laevis (Forest Ricegrass)*			
1295.	4537	*Tetratheca nuda*			
1296.		*Thelymitra aff. pauciflora*			
1297.	1701	*Thelymitra antennifera (Vanilla Orchid)*			
1298.	10856	*Thelymitra benthamiana (Leopard Orchid)*			
1299.	1702	*Thelymitra campanulata (Shirt Orchid)*			
1300.	1705	*Thelymitra crinita (Blue Lady Orchid)*			
1301.	1707	*Thelymitra flexuosa (Twisted Sun Orchid)*			
1302.	20731	*Thelymitra vulgaris*			
1303.	673	*Themeda triandra*			
1304.	5080	*Thomasia foliosa*			
1305.	24845	*Threskiornis spinicollis (Straw-necked Ibis)*			
1306.	37661	*Thysanothecium hookeri subsp. xanthonicum*			
1307.	28071	*Thysanothecium scutellatum*			
1308.	48804	*Thysanothecium sorediatum*			
1309.	1318	*Thysanotus arbuscula*			
1310.	1319	*Thysanotus arenarius*			
1311.	1328	*Thysanotus dichotomus (Branching Fringe Lily)*			
1312.	1338	*Thysanotus manglesianus (Fringed Lily)*			
1313.		*Thysanotus manglesianus/patersonii complex*			
1314.	1339	*Thysanotus multiflorus (Many-flowered Fringe Lily)*			
1315.	1343	*Thysanotus patersonii*			
1316.	1348	*Thysanotus rectantherus*			
1317.	1350	*Thysanotus scaber*			
1318.	1351	*Thysanotus sparteus*			
1319.	1354	*Thysanotus tenellus*			
1320.	1357	*Thysanotus thyrsoideus*			
1321.	1358	*Thysanotus triandrus*			
1322.	25203	*Tiliqua occipitalis (Western Bluetongue)*			
1323.	25519	*Tiliqua rugosa*			
1324.	25204	*Tiliqua rugosa subsp. aspera*			
1325.	25207	*Tiliqua rugosa subsp. rugosa*			
1326.		*Tipulidae sp.*			
1327.	25549	*Todiramphus sanctus (Sacred Kingfisher)*			
1328.	8248	*Tolpis barbata (Yellow Hawkweed)*	Y		
1329.	6280	*Trachymene pilosa (Native Parsnip)*			
1330.	1481	*Tribonanthes australis (Southern Tiurndin)*			
1331.	1482	*Tribonanthes brachypetala (Nodding Tiurndin)*			
1332.	1483	*Tribonanthes longipetala (Branching Tiurndin)*			
1333.	8798	*Tribonanthes uniflora (Woolly Tiurndin)*			
1334.	4383	*Tribulus terrestris (Caltrop)*	Y		
1335.	8251	*Trichocline spathulata (Native Gerbera)*			
1336.		*Trichoglossus chlorolepidotus*			
1337.	25723	*Trichoglossus haematodus (Rainbow Lorikeet)*			
1338.	24755	*Trichoglossus haematodus subsp. moluccanus (Rainbow Lorikeet)*	Y		
1339.	25521	*Trichosurus vulpecula (Common Brushtail Possum)*			
1340.	1361	*Tricoryne elatior (Yellow Autumn Lily)*			
1341.	1363	*Tricoryne tenella*			
1342.	4289	*Trifolium angustifolium (Narrowleaf Clover)*	Y		
1343.	17145	*Trifolium angustifolium var. angustifolium*	Y		
1344.	17542	*Trifolium arvense var. arvense*	Y		
1345.	17763	*Trifolium campestre var. campestre (Hop Clover)*	Y		
1346.	4293	*Trifolium cernuum (Drooping Flower Clover)*	Y		
1347.	4295	*Trifolium dubium (Suckling Clover)*	Y		
1348.	4313	*Trifolium subterraneum (Subterranean Clover)*	Y		
1349.	19039	*Triglochin bulbosa*	Y		
1350.	33676	*Triglochin calcitrapa*			
1351.	147	*Triglochin mucronata*			
1352.	148	*Triglochin muelleri*			
1353.	18587	*Triglochin nana*			
1354.	4737	*Tripterococcus brunonis (Winged Stackhousia)*			
1355.	1139	*Trithuria bibracteata*			
1356.	1141	*Trithuria submersa*			

	Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area
1357.	708	*Triticum aestivum (Wheat)*	Y		
1358.	4839	*Trymalium angustifolium*			
1359.	13479	*Trymalium ledifolium var. rosmarinifolium*			
1360.	33418	*Trymalium odoratissimum subsp. odoratissimum*			
1361.	48147	*Turnix varius (Painted Button-quail)*			
1362.	24851	*Turnix velox (Little Button-quail)*			
1363.	24852	*Tyto alba subsp. delicatula (Barn Owl)*			
1364.	24983	*Underwoodisaurus milii (Barking Gecko)*			
1365.		*Urodacus novaehollandiae*			
1366.	8255	*Ursinia anthemoides (Ursinia)*	Y		
1367.	38388	*Ursinia anthemoides subsp. anthemoides*	Y		
1368.	28087	*Usnea inermis*			
1369.	28092	*Usnea scabrida*			
1370.	7131	*Utricularia dichotoma (Fairy Aprons)*			
1371.	7138	*Utricularia inaequalis*			
1372.	7148	*Utricularia multifida*			
1373.	7153	*Utricularia tenella*			
1374.	7157	*Utricularia violacea (Violet Bladderwort)*			
1375.	34772	*Vachellia karroo*	Y		
1376.	24386	*Vanellus tricolor (Banded Lapwing)*			
1377.	25218	*Varanus gouldii (Bungarra or Sand Monitor)*			
1378.	25526	*Varanus tristis (Racehorse Monitor)*			
1379.	8257	*Vellereophyton dealbatum (White Cudweed)*	Y		
1380.	15431	*Verticordia acerosa var. acerosa*			
1381.	12388	*Verticordia acerosa var. preissii*			
1382.	6076	*Verticordia densiflora (Compacted Featherflower)*			
1383.	15432	*Verticordia densiflora var. densiflora*			
1384.	6077	*Verticordia drummondii (Drummond's Featherflower)*			
1385.	6088	*Verticordia huegelii (Variegated Featherflower)*			
1386.	15433	*Verticordia huegelii var. huegelii*			
1387.	15434	*Verticordia insignis subsp. insignis*			
1388.	6101	*Verticordia nitens (Morrison Featherflower, Kodjeningara)*			
1389.	6103	*Verticordia ovalifolia*			
1390.	6107	*Verticordia pennigera*			
1391.	6109	*Verticordia picta (Painted Featherflower)*			
1392.	12449	*Verticordia plumosa var. brachyphylla*			
1393.	15618	*Verticordia plumosa var. plumosa*			
1394.	24206	*Vespadelus regulus (Southern Forest Bat)*			
1395.	4322	*Vicia sativa (Common Vetch)*	Y		
1396.	4325	*Viminaria juncea (Swishbush, Koweda)*			
1397.	17042	*Vitis vinifera*	Y		
1398.	24040	*Vulpes vulpes (Red Fox)*	Y		
1399.	722	*Vulpia bromoides (Squirrel Tail Fescue)*	Y		
1400.	11018	*Vulpia muralis*	Y		
1401.	724	*Vulpia myuros (Rat's Tail Fescue)*	Y		
1402.	12052	*Vulpia myuros forma megalura*	Y		
1403.	33101	*Vulpia myuros forma myuros*	Y		
1404.		*Vulpia sp. Ellen4*			Y
1405.	7384	*Wahlenbergia capensis (Cape Bluebell)*	Y		
1406.	7389	*Wahlenbergia preissii*			
1407.	8282	*Waitzia suaveolens (Fragrant Waitzia)*			
1408.	18118	*Watsonia meriana var. meriana*	Y		
1409.		*Watsonia sp. Ellen4*			Y
1410.	32455	*Weissia controversa*			
1411.	1394	*Wurmbea dioica (Early Nancy)*			
1412.	12072	*Wurmbea dioica subsp. alba*			
1413.	1249	*Xanthorrhoea acanthostachya*			
1414.	1253	*Xanthorrhoea gracilis (Graceful Grass Tree, Mimidi)*			
1415.	1256	*Xanthorrhoea preissii (Grass tree, Palga)*			
1416.	6283	*Xanthosia atkinsoniana*			
1417.	6284	*Xanthosia candida*			
1418.	6285	*Xanthosia ciliata*			
1419.	6287	*Xanthosia fruticulosa*			
1420.	6289	*Xanthosia huegelii*			
1421.	25765	*Zosterops lateralis (Grey-breasted White-eye, Silvereye)*			

Conservation Codes
T - Rare or likely to become extinct
X - Presumed extinct
IA - Protected under international agreement
S - Other specially protected fauna
1 - Priority 1

Name ID	Species Name	Naturalised	Conservation Code	[1]Endemic To Query Area

2 - Priority 2
3 - Priority 3
4 - Priority 4
5 - Priority 5

[1] For NatureMap's purposes, species flagged as endemic are those whose records are wholely contained within the search area. Note that only those records complying with the search criterion are included in the calculation. For example, if you limit records to those from a specific datasource, only records from that datasource are used to determine if a species is restricted to the query area.

APPENDIX 3

Protected Matters Search Tool Report

EPBC Act Protected Matters Report

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

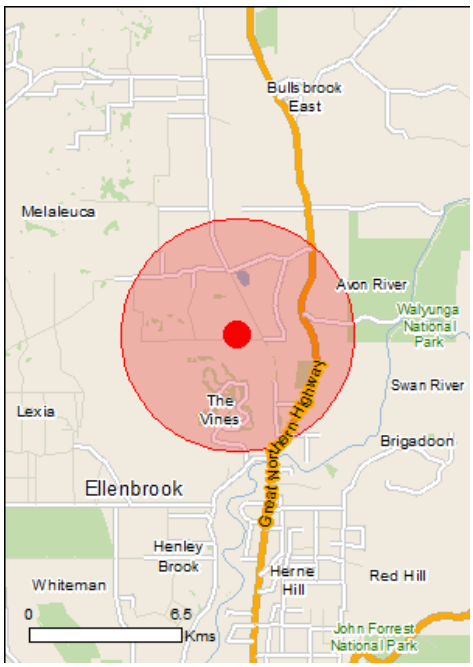
Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 13/08/19 12:26:14

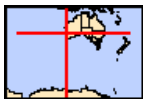
Summary
Details
- Matters of NES
- Other Matters Protected by the EPBC Act
- Extra Information

Caveat
Acknowledgements



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 5.0Km



Summary

Matters of National Environmental Significance

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

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	6
Listed Threatened Species:	32
Listed Migratory Species:	9

Other Matters Protected by the EPBC Act

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

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

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

Commonwealth Land:	1
Commonwealth Heritage Places:	None
Listed Marine Species:	15
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

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

State and Territory Reserves:	6
Regional Forest Agreements:	1
Invasive Species:	36
Nationally Important Wetlands:	1
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Listed Threatened Ecological Communities [Resource Information]

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

Name	Status	Type of Presence
	Critically Endangered	Community likely to occur within area
	Endangered	Community likely to occur within area
	Endangered	Community known to occur within area
Corymbia calophylla - Xanthorrhoea preissii woodlands and shrublands of the Swan Coastal Plain	Endangered	Community known to occur within area
Shrublands and Woodlands on Muchea Limestone of the Swan Coastal Plain	Endangered	Community known to occur within area
Tuart (Eucalyptus gomphocephala) Woodlands and Forests of the Swan Coastal Plain ecological community	Critically Endangered	Community may occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calyptorhynchus banksii naso Forest Red-tailed Black-Cockatoo, Karrak [67034]	Vulnerable	Species or species habitat known to occur within area
Calyptorhynchus baudinii Baudin's Cockatoo, Long-billed Black-Cockatoo [769]	Endangered	Species or species habitat likely to occur within area
Calyptorhynchus latirostris Carnaby's Cockatoo, Short-billed Black-Cockatoo [59523]	Endangered	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Fish		
Galaxiella nigrostriata Blackstriped Dwarf Galaxias, Black-stripe Minnow [88677]	Endangered	Species or species habitat likely to occur within area
Insects		
Hesperocolletes douglasi Douglas' Broad-headed Bee, Rottnest Bee [66734]	Critically Endangered	Species or species habitat may occur within area
Mammals		
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Translocated population known to occur within area
Other		
Westralunio carteri Carter's Freshwater Mussel, Freshwater Mussel [86266]	Vulnerable	Species or species habitat may occur within area
Plants		
Andersonia gracilis Slender Andersonia [14470]	Endangered	Species or species habitat likely to occur within area
Anigozanthos viridis subsp. terraspectans Dwarf Green Kangaroo Paw [3435]	Vulnerable	Species or species habitat may occur within area
Anthocercis gracilis Slender Tailflower [11103]	Vulnerable	Species or species habitat may occur within area
Caladenia huegelii King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid [7309]	Endangered	Species or species habitat known to occur within area
Chamelaucium sp. Gingin (N.G.Marchant 6) Gingin Wax [88881]	Endangered	Species or species habitat may occur within area
Darwinia foetida Muchea Bell [83190]	Critically Endangered	Species or species habitat may occur within area
Diplolaena andrewsii [6601]	Endangered	Species or species habitat likely to occur within area
Diuris purdiei Purdie's Donkey-orchid [12950]	Endangered	Species or species habitat may occur within area
Drakaea elastica Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid [16753]	Endangered	Species or species habitat likely to occur within area
Eleocharis keigheryi Keighery's Eleocharis [64893]	Vulnerable	Species or species habitat known to occur within area
Eucalyptus x balanites Cadda Road Mallee, Cadda Mallee [87816]	Endangered	Species or species habitat may occur within area

Name	Status	Type of Presence
Grevillea christineae Christine's Grevillea [64520]	Endangered	Species or species habitat likely to occur within area
Grevillea curviloba subsp. curviloba Curved-leaf Grevillea [64908]	Endangered	Species or species habitat known to occur within area
Grevillea curviloba subsp. incurva Narrow curved-leaf Grevillea [64909]	Endangered	Species or species habitat known to occur within area
Lepidosperma rostratum Beaked Lepidosperma [14152]	Endangered	Species or species habitat likely to occur within area
Synaphea sp. Fairbridge Farm (D. Papenfus 696) Selena's Synaphea [82881]	Critically Endangered	Species or species habitat likely to occur within area
Thelymitra dedmaniarum Cinnamon Sun Orchid [65105]	Endangered	Species or species habitat likely to occur within area
Thelymitra stellata Star Sun-orchid [7060]	Endangered	Species or species habitat likely to occur within area
Reptiles		
Pseudemydura umbrina Western Swamp Tortoise [1760]	Critically Endangered	Translocated population known to occur within area

Listed Migratory Species [Resource Information]

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

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area

Name	Threatened	Type of Presence
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Land [Resource Information]

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

Name
Commonwealth Land -

Listed Marine Species [Resource Information]

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

Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba Great Egret, White Egret [59541]		Species or species habitat likely to occur within area
Ardea ibis Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pandion haliaetus Osprey [952]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat likely to occur within area
Thinornis rubricollis Hooded Plover [59510]		Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat likely to occur within area

Extra Information

State and Territory Reserves [Resource Information]

Name	State
Ellen Brook	WA
Twin Swamps	WA
Unnamed WA46875	WA
Unnamed WA46919	WA
Unnamed WA49300	WA
Walyunga	WA

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

Name	State
South West WA RFA	Western Australia

Invasive Species [Resource Information]

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

Name	Status	Type of Presence
Birds		
Acridotheres tristis Common Myna, Indian Myna [387]		Species or species habitat likely to occur within area
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Carduelis carduelis European Goldfinch [403]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area

Name	Status	Type of Presence
Passer montanus Eurasian Tree Sparrow [406]		Species or species habitat likely to occur within area
Streptopelia chinensis Spotted Turtle-Dove [780]		Species or species habitat likely to occur within area
Streptopelia senegalensis Laughing Turtle-dove, Laughing Dove [781]		Species or species habitat likely to occur within area
Sturnus vulgaris Common Starling [389]		Species or species habitat likely to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Funambulus pennantii Northern Palm Squirrel, Five-striped Palm Squirrel [129]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Rattus norvegicus Brown Rat, Norway Rat [83]		Species or species habitat likely to occur within area
Rattus rattus Black Rat, Ship Rat [84]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Asparagus asparagoides Bridal Creeper, Bridal Veil Creeper, Smilax, Florist's Smilax, Smilax Asparagus [22473]		Species or species habitat likely to occur within area
Brachiaria mutica Para Grass [5879]		Species or species habitat may occur within

Name	Status	Type of Presence
		area
Cenchrus ciliaris Buffel-grass, Black Buffel-grass [20213]		Species or species habitat may occur within area
Chrysanthemoides monilifera Bitou Bush, Boneseed [18983]		Species or species habitat may occur within area
Chrysanthemoides monilifera subsp. monilifera Boneseed [16905]		Species or species habitat likely to occur within area
Genista sp. X Genista monspessulana Broom [67538]		Species or species habitat may occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Lycium ferocissimum African Boxthorn, Boxthorn [19235]		Species or species habitat likely to occur within area
Olea europaea Olive, Common Olive [9160]		Species or species habitat may occur within area
Pinus radiata Radiata Pine Monterey Pine, Insignis Pine, Wilding Pine [20780]		Species or species habitat may occur within area
Rubus fruticosus aggregate Blackberry, European Blackberry [68406]		Species or species habitat likely to occur within area
Salix spp. except S.babylonica, S.x calodendron & S.x reichardtii Willows except Weeping Willow, Pussy Willow and Sterile Pussy Willow [68497]		Species or species habitat likely to occur within area
Salvinia molesta Salvinia, Giant Salvinia, Aquarium Watermoss, Kariba Weed [13665]		Species or species habitat likely to occur within area
Tamarix aphylla Athel Pine, Athel Tree, Tamarisk, Athel Tamarisk, Athel Tamarix, Desert Tamarisk, Flowering Cypress, Salt Cedar [16018]		Species or species habitat likely to occur within area
Reptiles		
Hemidactylus frenatus Asian House Gecko [1708]		Species or species habitat likely to occur within area

Nationally Important Wetlands [Resource Information]

Name	State
Ellen Brook Swamps System	WA

Caveat

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

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

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

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

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

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

- migratory and
- marine

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

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

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

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

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

Coordinates

-31.73971 116.00958

Acknowledgements

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

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
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-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

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

Please feel free to provide feedback via the Contact Us page.

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Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

APPENDIX 4

Conservation Codes

APPENDIX 5

TEC and PEC Database Searches

Conservation Codes for Western Australian Flora and Fauna

Specially protected fauna or flora are species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

Categories of specially protected fauna and flora are:

T Threatened species – Schedules 1-4

Published as Specially Protected under the *Wildlife Conservation Act 1950,* and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

- ***Threatened fauna*** is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.
- ***Threatened flora*** is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species – Schedule 1

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN Endangered species – Schedule 2

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU Vulnerable species - Schedule 3

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX Presumed extinct species - Schedule 4

Species which have been adequately searched for and there is no reasonable doubt that the last individual has died. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA Migratory birds protected under an international agreement - Schedule 5

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna - Schedule 6

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna - Schedule 7

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950,* in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare: Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened: Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

A list of the current rankings can be downloaded from the Parks and Wildlife Threatened Species and Communities webpage at http://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities

Commonwealth of Australia Conservation Codes

Threatened fauna and flora may be listed under Section 178 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in any one of the following six categories:

Extinct

A native species is eligible to be included in the extinct category at a particular time if, at that time, there is no reasonable doubt that the last member of the species has died.

Extinct in the wild

A native species is eligible to be included in the extinct in the wild category at a particular time if, at that time:

a) it is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; or
b) it has not been recorded in its known and/or expected habitat, at appropriate seasons, anywhere in its past range, despite exhaustive surveys over a time frame appropriate to its life cycle and form.

Critically endangered

A taxon is Critically Endangered when the best available evidence indicates that it meets any of the five criteria for the category identified in Part 7.01 of the EPBC Regulations, and it is therefore considered to be facing an extremely high risk of extinction in the wild.

Endangered

A taxon is Endangered when the best available evidence indicates that it meets any of the five criteria for the category identified in Part 7.01 of the EPBC Regulations, and it is therefore considered to be facing a very high risk of extinction in the wild.

Vulnerable

A taxon is Vulnerable when the best available evidence indicates that it meets any of the five criteria for the category identified in Part 7.01 of the EPBC Regulations, and it is therefore considered to be facing a high risk of extinction in the wild.

Conservation dependent

A native species is eligible to be included in the conservation dependent category at a particular time if, at that time:

a) the species is the focus of a specific conservation program the cessation of which would result in the species becoming vulnerable, endangered or critically endangered; or
b) the following subparagraphs are satisfied:
    i. the species is a species of fish;

ii. the species is the focus of a plan of management that provides for management actions necessary to stop the decline of, and support the recovery of, the species so that its chances of long term survival in nature are maximised;
iii. the plan of management is in force under a law of the Commonwealth or of a State or Territory;
iv. cessation of the plan of management would adversely affect the conservation status of the species.

The EPBC Act does not provide for listing in a data deficient category. Where sufficient data (evidence) is unavailable to allow assessment by the Threatened Species Scientific Committee against the criteria for listing, the species are found to be ineligible. A recommendation is made to the Minister to not include the species in any category under the EPBC Act. For reasons of transparency and to inform future research, the Threatened Species Scientific Committee publishes the names of those species found to be data deficient. As data deficient is not a listing category under the EPBC Act, this has no statutory implications and the species is not considered to be listed under the EPBC Act.

APPENDIX 6

Species List

Lots 29 and 30 Maralla Road Species List

GYMNOSPERMS

CYCADACEAE
Macrozamia riedlei

MONOCOTYLEDONS

ANARTHRIACEAE
Lyginia imberbis

ARACEAE
Lemna disperma
**Zantedeschia aethiopica*

ASPARAGACEAE
**Asparagus asparagoides*
Laxmannia squarrosa

COLCHICACEAE
Burchardia congesta

CYPERACEAE
Baumea juncea
Gahnia trifida

DASYPOGONACEAE
Dasypogon bromeliifolius

HAEMODORACEAE
Haemodorum spicatum

IRIDACEAE
**Gladiolus caryophyllaceus*
**Moraea flaccida*
Patersonia occidentalis
**Romulea rosea*
**Watsonia bulbillifera*

JUNCACEAE
Juncus pallidus

ORCHIDACEAE
Caladenia flava
Microtis media subsp. *media*

POACEAE
**Avena fatua*
**Briza maxima*
**Bromus diandrus*
**Cenchrus clandestinus*
**Cortaderia selloana*
**Cynodon dactylon*
**Ehrharta calycina*
**Eragrostis curvula*
**Lolium perenne*
Poa drummondiana
**Vulpia myuros*

RESTIONACEAE
Alexgeorgea nitens
Desmocladus flexuosus
Lepyrodia muirii

TYPHACEAE
Typha orientalis

XANTHORRHOEACEAE
Xanthorrhoea preissii

DICOTYLEDONS

AMARANTHACEAE
Ptilotus polystachyus

ASTERACEAE
**Arctotheca calendula*
**Conyza bonariensis*
**Cotula coronopifolia*
**Hypochaeris glabra*
**Monoculus monstrosus*
Podotheca angustifolia
Podotheca gnaphalioides
**Pseudognaphalium luteoalbum*
**Taraxacum officinale*
**Ursinia anthemoides*

BRASSICACEAE
**Brassica tournefortii*
**Raphanus raphanistrum*

CARYOPHYLLACEAE
**Petrorhagia dubia*

COMMELINACEAE
Cartonema philydroides

CRASSULACEAE
Crassula colorata

FABACEAE
Acacia huegelii
Acacia saligna
Jacksonia furcellata
Kennedia prostrata
**Lotus subbiflorus*
**Lupinus cosentinii*
**Ornithopus compressus*
**Trifolium campestre*

GERANIACEAE
**Pelargonium capitatum*

GOODENIACEAE
Dampiera linearis

MYRTACEAE
Beaufortia squarrosa
Corymbia calophylla
Eucalyptus rudis
Eucalyptus todtiana
Melaleuca sp.
Melaleuca preissiana
Melaleuca rhaphiophylla
Melaleuca teretifolia
Regelia ciliata
Scholtzia involucrata

POLGONACEAE
**Rumex acetosella*
**Rumex pulcher*

PROTEACEAE
Banksia attenuata
Banksia ilicifolia
Banksia menziesii
Grevillea curviloba subsp. *curviloba* **T**

RUTACEAE
Philotheca spicata

SCROPHULARIACEAE
**Dischisma arenarium*

SOLANACEAE
**Solanum nigrum*

APPENDIX 7

Quadrat Data

QUADRAT MR01

50 406758 E 6488245 N

Vegetation: *Corymbia calophylla* Low Woodland over weeds
Condition: Completely Degraded
Soil Type: Grey sand
Landform: Flat

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Corymbia calophylla	8	20
Xanthorrhoea preissii	1	5
**Ehrharta calycina*	0.4	20
**Lupinus cosentinii*	0.4	10
**Moraea flaccida*	0.4	<1
**Romulea rosea*	0.2	<1

* introduced species

QUADRAT MR02

50 406354 E 6488229 N

Vegetation: *Melaleuca rhaphiophylla* Tall Open Scrub over weeds
Condition: Completely Degraded
Soil Type: Dark grey sand
Landform: Gentle slope down to the north towards waterbody

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Melaleuca rhaphiophylla	4	40
Melaleuca teretifolia	0.4	1
**Moraea flaccida*	0.4	1
**Ehrharta calycina*	0.2	60
**Lolium perenne*	0.2	1
**Romulea rosea*	0.1	5
**Bromus diandrus*	0.1	2
**Vulpia myuros*	0.1	2
**Cenchrus clandestinus*	0.1	1
**Trifolium campestre*	0.1	1
**Cynodon dactylon*	0.1	<1
**Lotus subbiflorus*	<0.1	2
Crassula colorata	<0.1	<1

* introduced species

QUADRAT MR03

50 406305 E 6488270 N

Vegetation: *Melaleuca rhaphiophylla/M. teretifolia* Open Shrubland over weeds
Condition: Completely Degraded
Soil Type: Black peaty sand
Landform: Flat, inundated to 20cm in NE half of quadrat

July 2019 **September 2019**

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Melaleuca rhaphiophylla	1.6	2
Melaleuca teretifolia	1.4	2
**Lolium perenne*	0.3	1
Cotula coronopifolia	0.2	60
**Cenchrus clandestinus*	0.2	<1
**Ehrharta calycina*	0.2	<1
**Cynodon dactylon*	0.1	30
Hydrocotyle callicarpa	0.1	20
**Lotus subbiflorus*	<0.1	10
**Rumex acetosella*	<0.1	<1
**Arctotheca calendula*	Flat	1

* introduced species

QUADRAT MR04

50 406596 E 6488163 N

Vegetation: *Melaleuca rhaphiophylla* Shrubland over weeds
Condition: Completely Degraded
Soil Type: Black peaty sand
Landform: Flat, 10cm water in whole of quadrat

July 2019

September 2019

QUADRAT (10 x 10m) **wooden pegs in SE and NE corners**

SPECIES	HEIGHT (m)	COVER (%)
Melaleuca rhaphiophylla	2	25
Melaleuca teretifolia	1.8	<1
**Eragrostis curvula*	0.9	<1
**Moraea flaccida*	0.4	<1
Cotula coronopifolia	0.2	5
**Lolium perenne*	0.2	2
**Cynodon dactylon*	0.2	1
**Lotus subbiflorus*	0.1	80
Hydrocotyle callicarpa	0.1	5
**Ehrharta longifolia*	0.1	<1
**Arctotheca calendula*	0.1	<1
**Rumex acetosella*	0.1	<1

* introduced species

QUADRAT MR05

50 406741 E 6488157 N

Vegetation: *Acacia saligna/Melaleuca rhaphiophylla* Tall Open Scrub over weeds
Condition: Degraded
Soil Type: Dark peaty sand, damp
Landform: Flat

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Acacia saligna	4	20
Melaleuca rhaphiophylla	3.5	40
Eucalyptus rudis	3	1
Melaleuca teretifolia	2.5	5
Baumea juncea	0.7	<1
**Moraea flaccida*	0.6	<1
**Lolium perenne*	0.4	1
**Echium plantagineum*	0.3	1
**Ehrharta longifolia*	0.3	<1
**Rumex pulcher*	0.2	5
**Cynodon dactylon*	0.1	2
**Arctotheca calendula*	0.1	1
**Rumex acetosella*	0.1	<1
**Lotus subbiflorus*	<0.1	<1
**Hypochaeris glabra*	Flat	<1

* introduced species

QUADRAT MR06

50 406877 E 6488032 N

Vegetation: *Acacia saligna* Tall Open Scrub over weeds
Condition: Completely Degraded
Soil Type: Dark grey sand
Landform: Flat

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Acacia saligna	4	60
**Eragrostis curvula*	1.1	2
**Ehrharta calycina*	0.5	80
**Moraea flaccida*	0.4	5
**Lolium perenne*	0.4	5
**Ursinia anthemoides*	0.3	2
**Vulpia myuros*	0.2	10
**Arctotheca calendula*	0.2	2
**Romulea rosea*	0.2	2
**Lotus subbiflorus*	0.1	5
**Ornithopus compressus*	0.1	<1
**Hypochaeris glabra*	Flat	1

* introduced species

QUADRAT MR07

50 406948 E 6487885 N

Vegetation: *Jacksonia furcellata* Tall Shrubland over *Alexgeorgea nitens* Closed Sedgeland
Condition: Completely Degraded
Soil Type: Grey sand
Landform: Flat

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Jacksonia furcellata	3	20
Macrozamia riedlei	1	1
Dasypogon bromeliifolius	0.5	1
**Ehrharta calycina*	0.3	20
**Ursinia anthemoides*	0.3	10
**Monoculus monstrosus*	0.3	1
**Podotheca angustifolia*	0.3	1
**Gladiolus caryophyllaceus*	0.3	1
**Raphanus raphanistrum*	0.3	<1
**Gladiolus caryophyllaceus*	0.3	<1
Alexgeorgea nitens	0.2	80
**Briza maxima*	0.2	1
**Arctotheca calendula*	0.1	<1
**Petrorhagia dubia*	0.1	<1
Crassula colorata	<0.1	<1
**Hypochaeris glabra*	Flat	1

* introduced species

QUADRAT MR08

50 406812 E 6487933 N

Vegetation: *Grevillea curviloba* subsp. *curviloba* Open Heath
Condition: Good
Soil Type: Grey-brown sand
Landform: Flat

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Grevillea curviloba subsp. *curviloba*	1.6	60
**Ehrharta calycina*	0.5	1
**Conyza bonariensis*	0.5	<1
**Lupinus cosentinii*	0.5	<1
**Ehrharta calycina*	0.4	50
**Moraea flaccida*	0.4	<1
**Lolium perenne*	0.3	10
**Romulea rosea*	0.1	5
**Asparagus asparagoides*	Climber	5

* introduced species

QUADRAT MR09

50 406747 E 6488035 N

Vegetation: *Grevillea curviloba* subsp. *curviloba* Open Heath over *Xanthorrhoea preissii* Low Shrubland
Condition: Good
Soil Type: Light grey-brown sand
Landform: Flat

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Grevillea curviloba subsp. *curviloba*	1.6	50
Xanthorrhoea preissii	1	10
**Eragrostis curvula*	1	<1
Regelia ciliata	0.5	<1
**Ehrharta calycina*	0.5	10
**Ursinia anthemoides*	0.4	<1
**Moraea flaccida*	0.4	<1
**Lolium perenne*	0.3	<1
Kennedia prostrata	0.1	<1
**Monoculus monstrosus*	0.1	<1
**Hypochaeris glabra*	Flat	<1
**Asparagus asparagoides*	Climber	<1

* introduced species

QUADRAT MR10

50 406667 E 6488110 N

Vegetation: *Acacia saligna* Tall Shrubland over weeds
Condition: Completely Degraded
Soil Type: Grey sand
Landform: Gentle slope down to the north

QUADRAT (10 x 10m) wooden pegs in SE and SW corners

SPECIES	HEIGHT (m)	COVER (%)
Acacia saligna	4	25
**Ehrharta calycina*	0.4	80
**Ehrharta longifolia*	0.4	5
**Moraea flaccida*	0.4	5
**Lolium perenne*	0.3	1
**Arctotheca calendula*	0.1	<1
**Romulea rosea*	0.1	<1
**Hypochaeris glabra*	Flat	<1
**Asparagus asparagoides*	Climber	<1

* introduced species

Appendix B

Black Cockatoo Habitat Assessment (PGV Environmental 2019)

LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

BLACK COCKATOO HABITAT ASSESSMENT

Prepared for:	RPS Australia West Pty Ltd
Report Date:	15 November 2019
Version:	2
Report No.	2019-458

pgv ENVIRONMENTAL

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Table 2: Bush Forever Sites within 12km containing habitat for Black Cockatoos

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Figure 2: Site Boundary

Figure 3: Foraging Habitat

Figure 4: Significant Trees

Figure 5: Context Plan

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Appendix 1: Significant Tree Survey Results

Appendix 2: Significant Tree Photos

1 INTRODUCTION

1.1 Background

Lots 29 and 30 Maralla Road, North Ellenbrook (the site) are located in the City of Swan, approximately 28km north-east of the Perth Central Business District (Figure 1). The site is approximately 48ha and is bounded by Maralla Road to the south and Railway parade to the east. The remainder of the site is surrounded by large rural lots (Figure 2).

Surveys on the site have identified habitat that may be suitable for three species of Black Cockatoo listed under both Western Australian and Federal legislation being:

- Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*) (Endangered);
- Baudin's Black Cockatoo (*Calyptorhynchus baudinii*) (Endangered); and
- Forest Red-tailed Black-Cockatoo (*Calyptorhynchus banksii naso*) (Vulnerable).

1.2 Scope of Works

PGV Environmental was commissioned by RPS Australia West Pty Ltd to undertake a Black Cockatoo Habitat Assessment of the site. The assessment included a survey of the potential foraging, roosting and breeding habitat on the site.

2 BLACK COCKATOOS

2.1 Carnaby's Black Cockatoo (*Calyptorhynchus latirostris*)

Carnaby's Black Cockatoo is found in the south-west of Australia from Kalbarri through to Ravensthorpe. It has a preference for feeding on the seeds of *Banksia, Hakea, Eucalyptus, Grevillea, Pinus* and *Allocasuarina* spp. It is nomadic, often moving toward the coast after breeding. It breeds in tree hollows that are 2.5 – 12m above the ground and have an entrance of 23-30cm with a depth of 1-2.5m. Nesting mostly occurs in smooth-barked trees (e.g. Salmon Gum, Wandoo, Red Morrell). Eggs are laid from July to October, with incubation lasting 29 days (DoE, 2014).

The site is inside the boundary of the modelled distribution and breeding range for Carnaby's Black Cockatoos (SEWPaC, 2012).

2.2 Baudin's Black Cockatoo (*Calyptorhynchus baudinii*)

Baudin's Black Cockatoo is most common in the far south-west of Western Australia. It is known to breed from the southern forests north to Collie and east to near Kojonup. Baudin's Black Cockatoo is typically found in vagrant flocks and utilises the taller, more open Jarrah (*Eucalyptus marginata*) and Marri (*Corymbia calophylla*) woodlands where it feeds mainly on Marri seeds and various Proteaceous species (Johnstone and Kirkby, 2011).

The site is outside the modelled distribution for Baudin's Black Cockatoos (SEWPaC, 2012). Baudin's Black Cockatoo predominantly lives in the south-west, Darling Range and Scarp.

2.3 Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*)

Forest Red-tailed Black Cockatoos are endemic to the humid to sub-humid south-west of Western Australia (SEWPaC, 2012). The range of Forest Red-tailed Black Cockatoos is bound by Gingin in the north to Mt Helena, Christmas Tree Well, West Dale, North Bannister, Mt Saddleback, Kojonup, Rocky Gully, upper King River and Green Range (east of Albany) (SEWPaC, 2012; DoE, 2014). It nests in tree hollows with a depth of 1-5m, that are predominately Marri, Jarrah and Karri (*E. diversicolor*) and it feeds primarily on the seeds of Marri and Jarrah (Johnstone and Kirkby, 2011).

The site is inside the modelled distribution for Forest Red-tailed Black Cockatoos (SEWPaC, 2012).

3 BLACK COCKATOO HABITAT

3.1 Habitat Survey

PGV Environmental undertook a Black Cockatoo habitat assessment on site on 30 July 2019. The assessment was undertaken in accordance with the *EPBC Act referral guidelines for three threatened Black Cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii Forest red-tailed Black Cockatoo (vulnerable) Calyptorhynchus banksii naso* (SEWPaC, 2012) (Black Cockatoo Referral Guidelines) and the methodology outlined in the SPRAT Database for each of the Black Cockatoo species for Black Cockatoo Habitat Assessments.

The site was traversed on foot and information on Black Cockatoo foraging, roosting and breeding habitat was recorded. The extent, type and quality of the vegetation present, including the presence and extent of plants known to be used by Black Cockatoos was investigated.

3.2 Foraging Habitat

A flora and vegetation survey of the site was undertaken by PGV Environmental in 2019 (PGV Environmental, 2019). The survey recorded five plant species on the site that are known to be used by Black Cockatoos for foraging (Table 1) (Valentine and Stock, 2008; Groom, 2011).

Table1: Foraging Species for Black Cockatoos on 29 and 30 Maralla Road

Scientific Name	Common Name
Banksia attenuata	Candlestick Banksia
Banksia menziesii	Firewood Banksia
Corymbia calophylla	Marri
Eucalyptus todtiana	Blackbutt
Xanthorhoea preissii	Grass Tree

The total area containing foraging habitat is approximately 2.9ha and consists primarily of two stands of Marri trees at the northern end of Lot 29. The Banksia and Blackbutt trees are scarce and restricted to the south-east boundary of Lot 29. *Xanthorrhoea preissii* is also present mostly on Lot 29 (Figure 3).

The Black Cockatoo Referral Guidelines refer to the quality of the foraging habitat as an important characteristic in determining the significance of the impact. However, there is no guidance as to how the quality is determined in the Black Cockatoo Referral Guidelines other than specifying that 'quality' foraging habitat refers to the use of the habitat by Black Cockatoos rather than the overall quality of the vegetation which would normally be described using understorey as well as tree canopy.

Marri and Banksia trees are considered to be a High Resource for Black Cockatoos and therefore the scattered foraging habitat on the site is considered to be 'quality' foraging. The *Xanthorrhoea preissii* and *Eucalyptus todtiana* plants on the site are considered low value foraging habitat.

There was evidence of foraging on Marris by Carnaby's Black Cockatoo with the Marri nuts showing narrow scars from the species' smaller lower mandible (Fleming, 2011) (Plate 1). Foraging by Black Cockatoos on Banksia cones was also observed (Plate 2).

Plate 1: Carnaby's Black Cockatoo Foraging on Marri Nuts

Plate 2: Black Cockatoo Foraging on Banksia Cones

3.3 Roosting Habitat

There are no confirmed or unconfirmed roost sites for Carnaby's Black Cockatoos on the site (National Map, 2019). The nearest confirmed roost site for Carnaby's Black Cockatoos is located approximately 8km to the south-west in the Gnangara Pine Plantation (National Map, 2019). National Map does not map the roosting habitat for Forest Red-tailed Black Cockatoos.

No roosting by Carnaby's or Forest Red-tailed Black Cockatoos has been recorded on the site during the Great Cocky Count (Peck *et al.*, 2018).

The survey did not observe any evidence of roosting by Carnaby's or Forest Red-tailed Black Cockatoos on the site.

3.4 Breeding Habitat

Black Cockatoos are known to breed in hollows of large eucalypts. The site is not known as a breeding site for Black Cockatoos (DoP, 2011;National Map, 2019). The nearest confirmed breeding site for Carnaby's Black Cockatoos is approximately 15km to the north near Muchea and 16km to the south-east in the Darling Scarp. National Map does not map the breeding habitat for Forest Red-tailed Black Cockatoos.

No survey did not observe any evidence of current or past breeding by Black Cockatoos on the site.

The Black Cockatoo Referral Guidelines define trees of certain species with a diameter at breast height (DBH) of 500mm or greater as breeding habitat regardless of the presence or not of hollows. The theory behind this definition is the concept that while the trees may not currently contain hollows, they are mature enough that in the next 50 years or so a hollow might form and be of use to Black Cockatoos for the purposes of breeding.

The species on the site that are relevant to the definition of breeding habitat are Marri (*Corymbia calophylla*) and Flooded Gum (*Eucalyptus rudis*).

The Black Cockatoo habitat assessment recorded the location, DBH, height and overall health of all Marri and Flooded Gum trees on the site with a DBH greater than 500mm. The trees were also photographed and assessed for the presence of hollows or spouts.

A total of 44 potential breeding habitat trees were recorded on the site. The total included 38 Marris, three Flooded Gums and three Standing Dead Trees (Appendix 1). The trees ranged in DBH from 500mm up to 1240mm (Appendix 1). Two trees had a DBH greater than 1000mm. The details of the potential breeding habitat trees on the site are contained in Appendix 1 and Appendix 2 and the locations are shown on Figure 4.

Two trees were recorded as containing a potential hollow or spout. These were recorded from the ground and their suitability as Black Cockatoo breeding habitat was not able to be determined. There were no obvious chew marks on the rim of the hollows that indicate recent or past use by Black Cockatoos. Other hollows may be present that are not visible from the ground.

3.5 Regional Context

To assist in determining the significance of any impact on Black Cockatoo habitat on the site an assessment of Black Cockatoo habitat within the vicinity of the site was undertaken.

Table 2 and Figure 5 show that there are large areas of protected bushland in Bush Forever Sites and National Parks within 12km of the site. All of these site contain habitat for Black Cockatoos. The total area of reserved bushland that contains habitat for Black Cockatoos within 12km of the site is greater than 7,600ha.

Table 2: Bush Forever Sites within 12km containing habitat for Black Cockatoos

Bush Forever Site No.	Name	Approximate Habitat Area (ha)
300	Maralla Road Bushland, Ellenbrook/Upper Swan	419
399	Melaleuca Park and adjacent bushland, Bullsbrook/Lexia	3,900
304	Whiteman Park, Whiteman/West Swan	1,200
301	Ellenbrook Nature Reserve and adjacent bushland, Upper Swan	25
200	Caversham Airbase Bushland, West Swan/Whiteman	97
294	Pearce Aerodrome and adjacent bushland, Bullsbrook	135
86	Burley park and adjacent bushland, Bullsbrook	65
	Walyunga National Park	1,800
	Total	**7,649**

4 BLACK COCKATOO REFERRAL GUIDELINES

The *EPBC Act referral guidelines for three threatened Black Cockatoo species: Carnaby's cockatoo (endangered) Calyptorhynchus latirostris Baudin's cockatoo (vulnerable) Calyptorhynchus baudinii Forest red-tailed Black Cockatoo (vulnerable) Calyptorhynchus banksii naso* (SEWPaC, 2012) (Black Cockatoo Referral Guidelines) contain several steps to determine whether or not a referral is required. These steps are:

1. The definition of habitat (breeding, roosting and foraging – Table 1 in the Black Cockatoo Referral Guidelines);
2. A description of the type of action that may have a high or low risk of being a significant impact and therefore require referral (Table 3 in the Black Cockatoo Referral Guidelines);
3. Formulation of a mitigation strategy to reduce the scale of impact; and
4. A flowchart to assist in decision making on whether or not an action should be referred.

Step 1 Black Cockatoo Habitat

The Black Cockatoo Habitat assessment identified approximately 2.9ha of native vegetation containing foraging habitat for Carnaby's Black Cockatoos and Forest Red-tailed Black Cockatoos as well as 44 trees that are considered to be potential breeding trees under the definition provided by the DoEE. There was no actual roosting or breeding recorded on the site.

Step 2 Level of Impact

Foraging

In accordance with the Referral Guidelines clearing greater than 1ha of quality foraging habitat may constitute a significant impact. Therefore, any development of the site that will exceed this guideline may be considered a significant impact.

Roosting

The Black Cockatoo Referral Guidelines consider the clearing of a known roosting site as a high risk of being a significant impact. The site does not contain a known roosting site. Therefore, development of the site would not lead to a significant impact on any roosting habitat.

Breeding

According to Table 3 in the Black Cockatoo Referral Guidelines the clearing of any known nesting tree has a high risk of being a significant impact. A known nesting tree is defined in the Black Cockatoo Referral Guidelines as any existing tree in which breeding has been recorded or suspected. There are no known nesting trees that occur on the site and therefore there is no risk of a significant impact on known breeding habitat of Black Cockatoos.

The Black Cockatoo Referral Guidelines also consider that the clearing or degradation of any part of a vegetation community known to contain breeding habitat is likely to have a high risk of a significant impact. In Table 1 of the Black Cockatoo Referral Guidelines breeding habitat is defined as woodlands,

forests or isolated trees that contain or consist of live or dead trees of certain species with either a DBH of or greater than 500mm or the presence of suitable nest hollows.

The site contains 44 Marri, Flooded Gum and Standing Dead Trees with a DBH of or greater than 500mm that are considered to be potential breeding habitat.

The Black Cockatoo Referral Guidelines state that breeding habitat predominantly applies to those areas within the breeding range of the Black Cockatoo species as shown in the maps attached to the Black Cockatoo Referral Guidelines. The site is within the breeding range of Carnaby's Black Cockatoos. The breeding range of Forest Red-tailed Black Cockatoos is not specified within the map attached to the Black Cockatoo Referral Guidelines however the site is within the mapped distribution range. Clearing any of the potential breeding habitat trees may be considered a significant impact according to the Black Cockatoo Referral Guidelines.

Step 3 Mitigation

If a future development of the site has the potential to have a significant impact on foraging and potential breeding habitat mitigation strategies such as planting Black Cockatoo habitat plant species in the development site may need to be explored.

Step 4 Referral Advice

The Black Cockatoo Referral Guidelines have a Decision-Making flowchart that can be applied to determine whether a proposed development is likely to have a significant impact or not, and whether a Referral under the EPBC Act is recommended.

The Decision Making flowchart has the following question:

1. Could the impacts of your action occur within the modelled distribution of the black cockatoos?
2. Could the impacts of your action affect any black cockatoo habitat or individuals?
3. Have you surveyed for black cockatoo habitat using the recommended methods?
4. Could your action have an impact on black cockatoos or their habitat?
5. Is your impact mitigation best practice so that it may reduce the significance of your impacts on black cockatoos? Prioritise impact avoidance over impact minimisation

If the answer to question 4 is Yes then there is a high risk of a significant impact referral would be recommended. Clearing more than 1ha of foraging habitat and more than one potential breeding habitat tree would give a Yes answer to question 4.

Avoiding the clearing of more than 1ha of foraging habitat and any potential breeding habitat trees would mean a referral would not be required.

5 SUMMARY AND CONCLUSION

Lots 29 and 30 Maralla Road, North Ellenbrook contains habitat for Carnaby's Black Cockatoos and Forest Red-tailed Black Cockatoos. The site contains around 2.9ha of foraging habitat, consisting mostly of two stands of Marri trees at the northern end of Lot 29 and some scattered Banksia trees on Lot 29 close to Railway Parade. *Xanthorrhoea preissii* plants were also present on the site and are considered low value foraging habitat.

No evidence of recent roosting at the site was observed on site or has previously been recorded on the site.

No evidence of breeding was observed on the site or has been recorded previously. The site contains a total of 44 trees with a diameter at breast height of 500mm or greater that are considered potential breeding habitat. The total includes 38 Marri (*Corymbia calophylla*), three Flooded Gum (*Eucalyptus rudis*) and three Standing Dead Trees.

The clearing of more than 1ha of quality foraging habitat and more than one potential breeding habitat tree may be considered a significant impact and require a referral under the EPBC Act. Avoiding the clearing of more than 1ha of foraging habitat and any potential breeding habitat trees would not require a referral.

If a proposal to clear habitat were referred under the EPBC Act, the significance of the impact would need to consider the regional context. The total area of reserved bushland that contains habitat for Black Cockatoos within 12km of the site is greater than 7,600ha.

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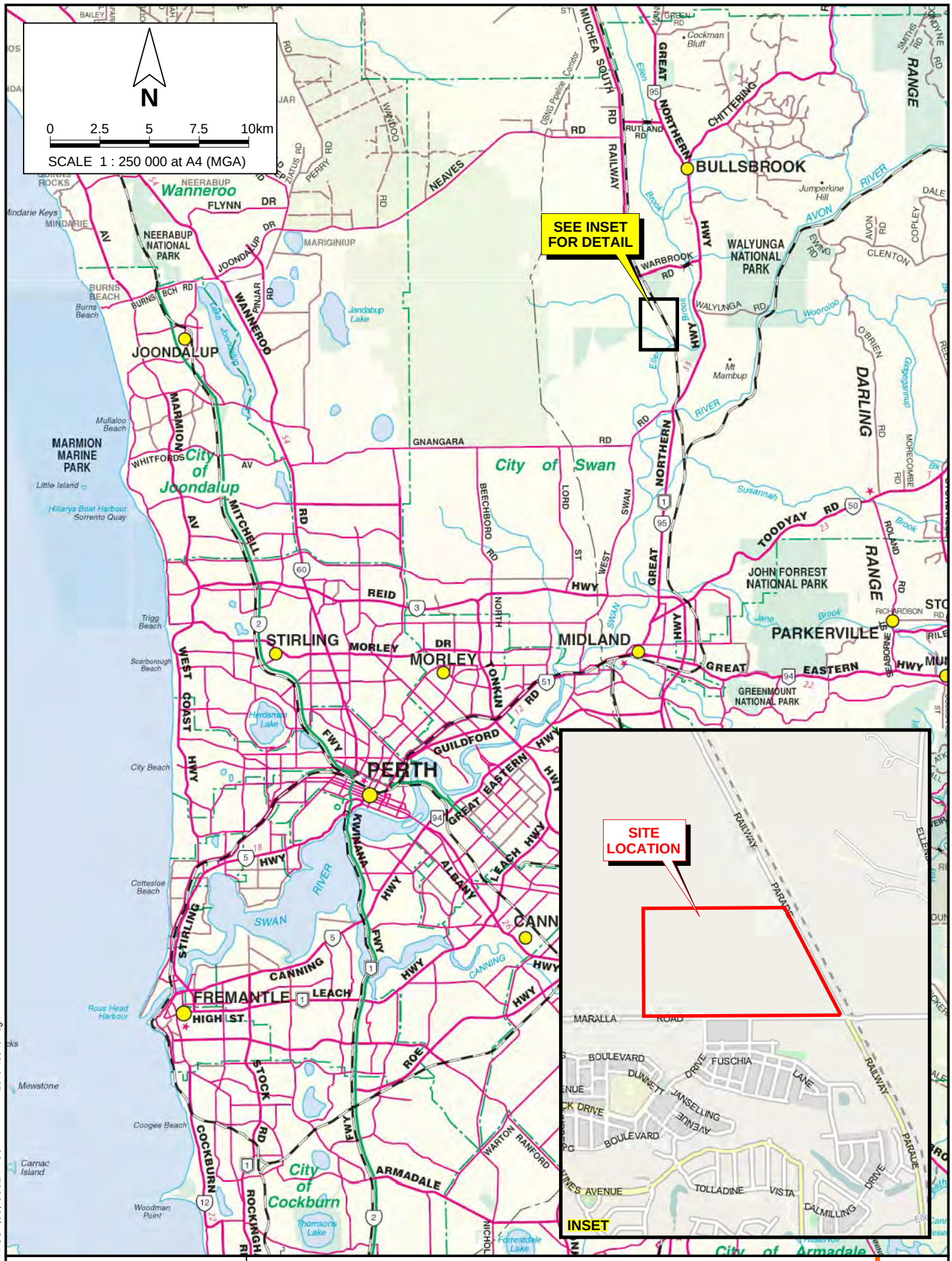
FIGURES



PINPOINT CARTOGRAPHICS (08) 9562 7136 2019-458-f01.dgn

pgv ENVIRONMENTAL

RPS Australia West Pty Ltd
BLACK COCKATOO HABITAT ASSESSMENT
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: J. Cabot	Date: 31 Aug 2019
Job: 10355 Rpt: 2019-458	Revision: A

SITE LOCATION

Figure 1

406 250mE
406 500mE
406 750mE
407 000mE
6 488 250mN
6 488 000mN
6 487 750mN
53
52
39
31
227
542
R 46875
543
R 46875
544
R 46875
9330
Lot 30
Lot 29
RAILWAY
RAILWAY
PARADE
MARALLA
ROAD

N

0 20 40 60 80 100m

SCALE 1 : 3 000 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary

2019-458-f02.dgn

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RPS Australia West Pty Ltd
BLACK COCKATOO HABITAT ASSESSMENT
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: J. Cabot	Date: 31 Aug 2019
Job: 10355 Rpt: 2019-458	Revision: A

SITE BOUNDARY

Figure 2

406 250mE
406 500mE
406 750mE
407 000mE
6 488 250mN
6 488 000mN
6 487 750mN
53
52
31
MR03
MrMt
Mr
MR02
MR01
Cc
Cc
Cc
Cleared
AsMr
MR04
MR05
Mr
MR10
As
AsMr
As
Gc
MR09
MR06
Lot 29
Lot 30
Cleared
Rc
As
Cleared
Jf
Jf
MR08
Gc
MR07
BmBa
Jf
Jf
Exotic
RAILWAY
RAILWAY
PARADE
MARALLA
ROAD
227
542
R 46875
543
R 46875
544
R 46875
9330

Vegetation Types

Cc
Corymbia calophylla Low Woodland over weeds

Mr
Melaleuca rhaphiophylla Shrubland to Tall Open Scrub over weeds

MrMt
Melaleuca rhaphiophylla/M. teretifolia Open Shrubland over weeds

AsMr
Acacia saligna/Melaleuca rhaphiophylla Tall Open Scrub over weeds

As
Acacia saligna Tall Shrubland to Tall Open Scrub over weeds

Jf
Jacksonia furcellata Tall Shrubland over Alexgeorgea nitens Closed Sedgeland

Gc
Grevillea curviloba subsp. *curviloba* Open Heath over *Xanthorrhoea preissii* Low Shrubland

BmBa
Banksia menziesii/B. attenuata Low Open Woodland over *Alexgeorgea nitens/Dasypogon bromeliifolius*

N
0 20 40 60 80 100m
SCALE 1 : 3 000 at A3 (MGA)

Legend
- Site Boundary
- Cadastral Boundary
- Easement Boundary
- Quadrat
- Vegetation Type Boundary
- Foraging Habitat

CADASTRAL SOURCE: Landgate, August 2019.
AERIAL PHOTOGRAPH SOURCE: NearMap, flown July 2019.

2019-467-f03.dgn

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RPS Australia West Pty Ltd
BLACK COCKATOO HABITAT ASSESSMENT
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: P. van der Moezel | Date: 14 Nov 2019
Job: 10355 Rpt: 2019-458 | Revision: A

FORAGING HABITAT

Figure 3

N

0 20 40 60 80 100m

SCALE 1 : 3 000 at A3 (MGA)

Legend

- Site Boundary
- Cadastral Boundary
- Easement Boundary

Significant Trees

- Flooded Gum (*Eucalyptus rudis*)
- Marri (*Corymbia calophylla*)
- Standing Dead Tree
- **14** Tree Number

406 250mE
406 500mE
406 750mE
407 000mE
6 488 250mN
6 488 000mN
6 487 750mN
53
52
31
39
Lot 30
Lot 29
RAILWAY
PARADE
MARALLA ROAD
227
542 R 46875
543 R 46875
544 R 46875
9330

2019-458-f03.dgn

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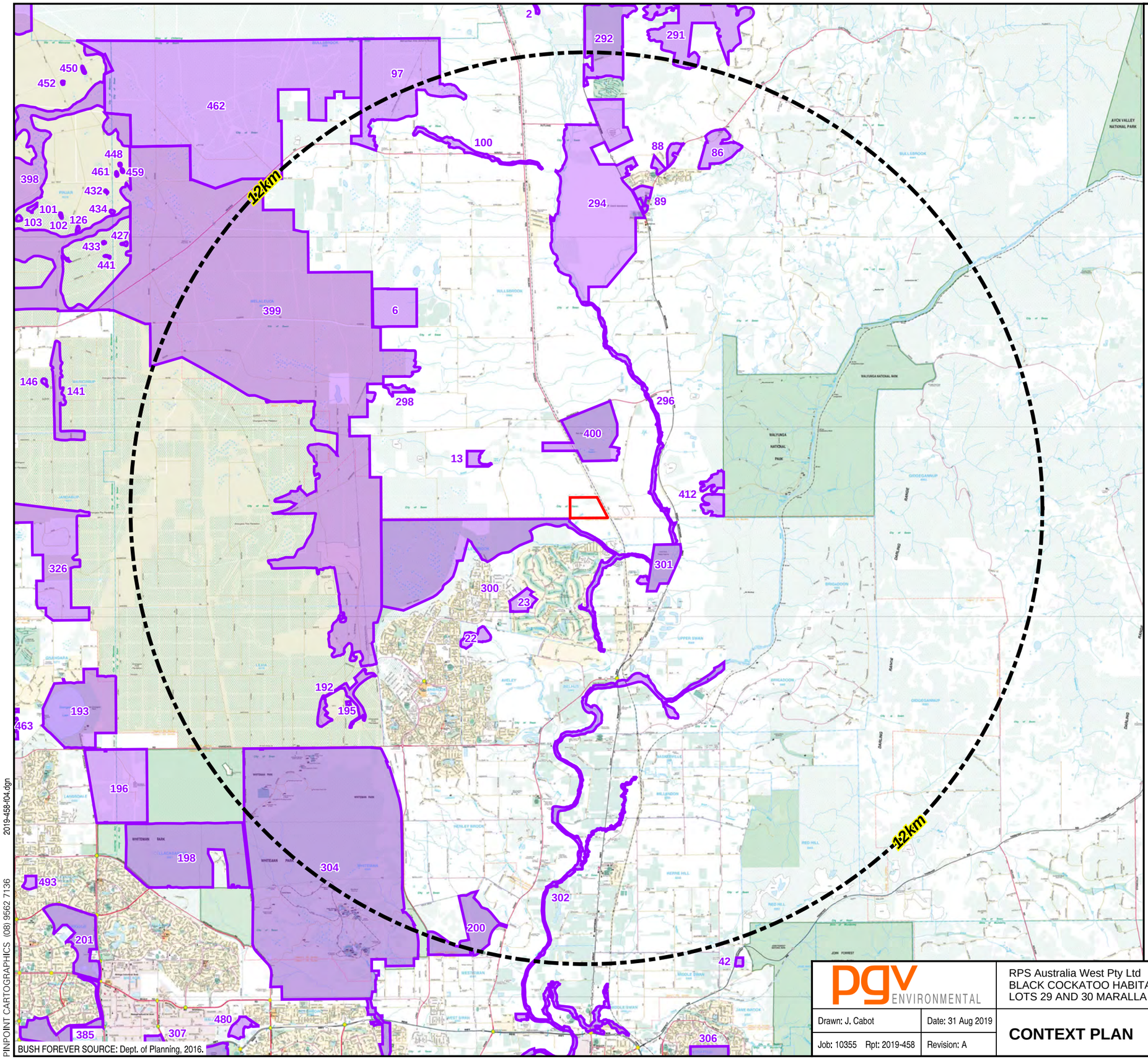
BLACK COCKATOO HABITAT ASSESSMENT
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: J. Cabot	Date: 31 Aug 2019
Job: 10355 Rpt: 2019-458	Revision: A

SIGNIFICANT TREES

Figure 4



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RPS Australia West Pty Ltd
BLACK COCKATOO HABITAT ASSESSMENT
LOTS 29 AND 30 MARALLA ROAD, NORTH ELLENBROOK

Drawn: J. Cabot | Date: 31 Aug 2019
Job: 10355 Rpt: 2019-458 | Revision: A

CONTEXT PLAN

Figure 5

APPENDIX 1

Significant Tree Survey Results

Lots 29 and 30 Maralla Road, North Ellenbrook Potential Black Cockatoo Breeding Tree Data

Tree Number	Species	Easting MGA zn50	Northing MGA zn50	Height (m)	Diameter (mm)			Notes (hollows, bees etc.)
					DBH1	DBH2	DBH3	
1	Marri (*Corymbia calophylla*)	406898	6488277	12	980			Good condition, no hollows
2	Marri (*Corymbia calophylla*)	406875	6488290	10	1020			Good condition, no hollows
3	Marri (*Corymbia calophylla*)	406876	6488284	10	650			Good condition, no hollows
4	Marri (*Corymbia calophylla*)	406870	6488269	12	770			Fair condition, scorched, no hollows
5	Marri (*Corymbia calophylla*)	406879	6488275	8	520			Good condition, no hollows
6	Marri (*Corymbia calophylla*)	406863	6488273	12	740			Fair condition, scorched, no hollows
7	Marri (*Corymbia calophylla*)	406855	6488274	10	670	540	330	Fair condition, scorched, no hollows
8	Marri (*Corymbia calophylla*)	406857	6488266	10	550	300		Good condition, no hollows
9	Marri (*Corymbia calophylla*)	406870	6488265	10	570	380		Fair condition, scorched, no hollows
10	Marri (*Corymbia calophylla*)	406781	6488249	8	610			Poor condition, no hollows
11	Marri (*Corymbia calophylla*)	406787	6488256	8	720	460	390	Fair condition, scorched, no hollows
12	Marri (*Corymbia calophylla*)	406760	6488251	9	530			Fair condition, scorched, no hollows
13	Marri (*Corymbia calophylla*)	406752	6488263	9	700			Poor condition, scorched, no hollows
14	Marri (*Corymbia calophylla*)	406742	6488260	11	550			Good condition, no hollows
15	Marri (*Corymbia calophylla*)	406739	6488250	12	710			Good condition, no hollows
16	Marri (*Corymbia calophylla*)	406716	6488260	10	830			Good condition, no hollows
17	Marri (*Corymbia calophylla*)	406679	6488280	11	1240			Very poor condition, scorched, no hollows, foraging evidence
18	Marri (*Corymbia calophylla*)	406657	6488268	10	880			Poor condition, potential spout and hollow
19	Marri (*Corymbia calophylla*)	406646	6488256	12	620			Good condition, no hollows
20	Marri (*Corymbia calophylla*)	406635	6488271	10	630			Poor condition, scorched, no hollows
21	Standing Dead Tree	406622	6488274	7	930			Potential hollows
22	Marri (*Corymbia calophylla*)	406599	6488283	8	650	540		Good condition, no hollows
23	Marri (*Corymbia calophylla*)	406590	6488227	12	670			Good condition, no hollows
24	Marri (*Corymbia calophylla*)	406598	6488222	11	650			Good condition, no hollows
25	Marri (*Corymbia calophylla*)	406593	6488210	11	810			Poor condition, scorched, no hollows
26	Marri (*Corymbia calophylla*)	406530	6488210	8	600			Good condition, no hollows
27	Marri (*Corymbia calophylla*)	406527	6488208	8	550	440	430	Fair condition, wire around base, no hollows
28	Flooded Gum (*Eucalyptus rudis*)	406488	6488257	6	500	480	480	Very poor condition, no hollows
29	Flooded Gum (*Eucalyptus rudis*)	406474	6488247	6	520	460	460	Good condition, no hollows
30	Marri (*Corymbia calophylla*)	406742	6488222	10	680			Good condition, no hollows
31	Marri (*Corymbia calophylla*)	406737	6488216	9	530			Fair condition, no hollows
32	Standing Dead Tree	406733	6488204	8	500			Leaning, no hollows
33	Flooded Gum (*Eucalyptus rudis*)	406738	6488201	10	650			Good condition, no hollows
34	Standing Dead Tree	406751	6488202	7	500			Burnt base, no hollows
35	Marri (*Corymbia calophylla*)	406781	6488200	11	950			Good condition, no hollows
36	Marri (*Corymbia calophylla*)	406774	6488217	10	580	320		Good condition, no hollows
37	Marri (*Corymbia calophylla*)	406791	6488204	10	560			Good condition, no hollows
38	Marri (*Corymbia calophylla*)	406800	6488193	11	510			Fair condition, scorched, no hollows
39	Marri (*Corymbia calophylla*)	406881	6488243	10	790			Good condition, no hollows
40	Marri (*Corymbia calophylla*)	406906	6488232	12	690			Good condition, no hollows
41	Marri (*Corymbia calophylla*)	406909	6488226	11	680			Good condition, no hollows, evidence of foraging
42	Marri (*Corymbia calophylla*)	406939	6488182	9	690	290	180	Good condition, no hollows
43	Marri (*Corymbia calophylla*)	406934	6488200	11	740	240		Good condition, no hollows

APPENDIX 2

Significant Tree Photos

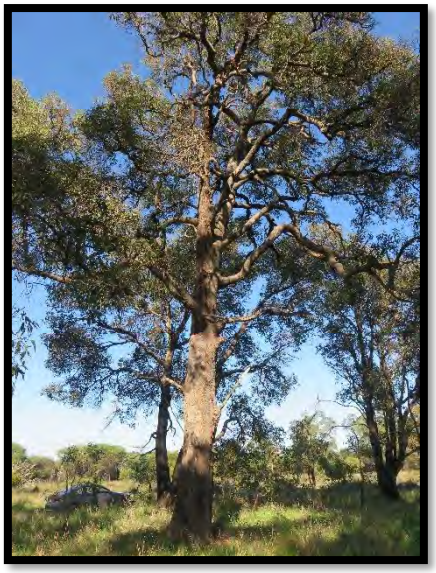
Lot 29 and 30 Maralla Road North Ellenbrook

Tree 1

Tree 2

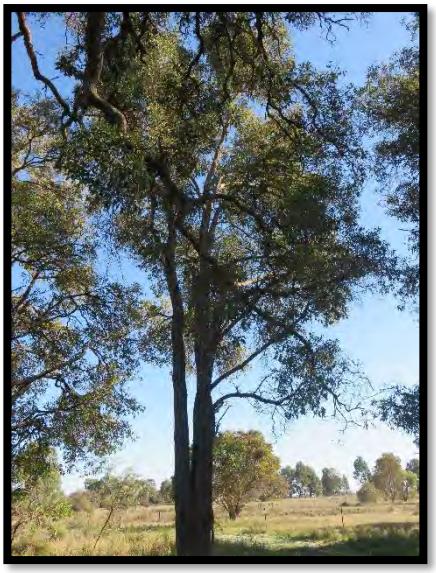
Tree 3

Tree 4



Tree 5

Tree 6



Tree 7

Tree 8

Tree 9

Lot 29 and 30 Maralla Road North Ellenbrook

Tree 10

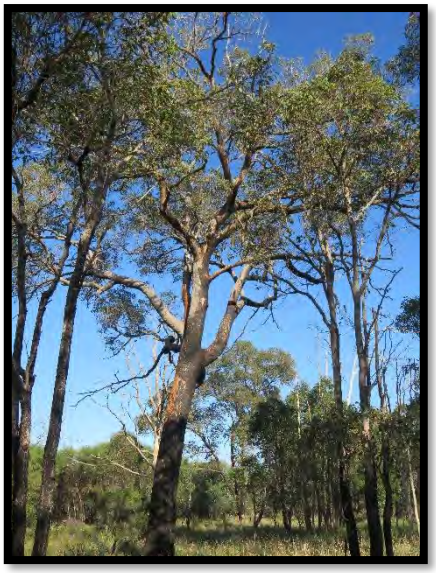
Tree 11

Tree 12

Tree 13

Tree 14

Tree 15



Tree 16

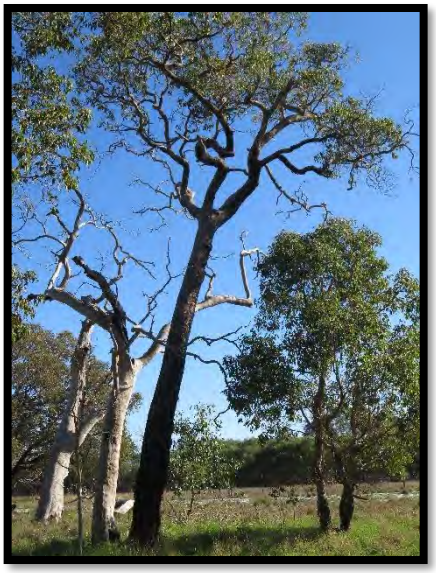
Tree 17

Tree 18

Lot 29 and 30 Maralla Road North Ellenbrook

Tree 19

Tree 20



Tree 21

Tree 22

Tree 23 (L), 24 (R)and 25 (M)

Tree 26 (L) and 27 (R)

Tree 28

Tree 29

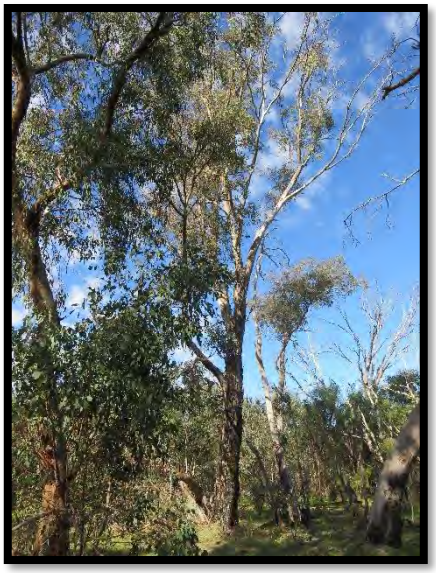
Tree 30

Lot 29 and 30 Maralla Road North Ellenbrook

Tree 31

Tree 32

Tree 33



Tree 34

Tree 35

Tree 36

Tree 37

Tree 38

Tree 39

Lot 29 and 30 Maralla Road North Ellenbrook

Tree 40

Tree 41

Tree 42

Tree 43

Tree 44