Shire of Boyup Brook
Local Planning Scheme No. 2
Scheme Amendment No. 24



Lots 51, 1007 & 1118
Boyup Brook – Arthur Road, Boyup Brook

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November 2024

PLANNING AND DEVELOPMENT ACT 2005
RESOLUTION DECIDING TO AMEND A TOWN PLANNING SCHEME

SHIRE OF BOYUP BROOK LOCAL PLANNING SCHEME No. 2

AMENDMENT No. 24

RESOLVED that the local government in pursuance of Section 75 of the *Planning and Development Act 2005*, amend the above Local Planning Scheme by:

1. Rezoning Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook from the 'Rural' zone to the 'Special Use (SU2)' zone.

2. Inserting the following provisions in Table 5 - Special Use Zones in Scheme Area:

No.	Description of land	Special use	Conditions
SU2	Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook	A future residential estate, contemplating both residential R5 and rural residential zones, where the mix of lots is to be addressed via a structure plan. Permissibility: Uses permitted within the areas designated as 'Residential' are as per the Zoning Table. Uses permitted within the areas designated as 'Rural Residential' are: Ancillary Dwelling 'P' Art Gallery 'D' Community Purpose 'D' Family Day Care 'A' Home Business 'D' Home Occupation 'P' Home Office 'P' Home Store 'D' Hosted short-term rental accommodation 'P' Industry – Cottage 'D' Recreation – Private 'A' Repurposed Dwelling 'D' Residential Building 'A' Rural Home Business 'A' Rural pursuit/hobby farm 'P' Second Hand Dwelling 'D' Single House 'P' Telecommunications Infrastructure 'D' Unhosted short-term rental accommodation 'D' All other uses are 'X' (prohibited).	**General application** 1. The conditions in this schedule apply to SU2 in addition to all other relevant provisions in the Scheme. 2. If there is a conflict between any other provision in the Scheme, this Schedule prevails. **Structure Plan** 3. Prior to subdivision and development, a structure plan is to be prepared and endorsed by the WAPC. 4. Proposed future zones and reserves in the structure plan are to accord with the zones and reserves of the Scheme. 5. In addition to the matters required in clause 16 of the deemed provisions, the structure plan is to address the below: i. Arrangements for licensed electricity supply; ii. Provision of a licensed water supply for lots designated for residential purposes with a minimum lot size of 2000m^2; or iii. If a licensed water supply is not to be provided, lots are to be designated as rural residential with a minimum lot size of 1 hectare; iv. Site and soil evaluation to determine: (a) Areas where depth to groundwater is less than 0.5m which are to contain lots with a 1 hectare minimum lot size; and (b) Land application area locations not subject to inundation; v. Water management and protection as per a Local Water Management Strategy report including nutrient balance modelling and mitigation; vi. Foreshore management, including: (a) Identification of flood prone areas; (b) Allocation, management and design of river and seasonal creek

No.	Description of land	Special use	Conditions
			foreshore reserves and areas of public open space; (c) Proposed arrangements for weed control, revegetation, fencing, pedestrian access and restrictions on vehicular access; vii. Protection of endangered black cockatoo habitat trees and suitable significant trees to the satisfaction of the local government and responsible agencies; viii. Bushfire risk criteria including access and egress for various subdivision stages; ix. Traffic Impact Assessment, including potential upgrades to existing roads and intersections servicing the proposed estate; x. A movement network that provides suitable transport options for vehicle, bicycles and pedestrians. xi. Aboriginal Cultural Heritage survey and management plan to identify and protect Noongar Cultural Heritage Values. **Subdivision** 6. Future subdivision shall generally be in accordance with a structure plan endorsed by the WAPC. 7. Protection of Aboriginal Cultural Heritage values based on a survey and management plan. 8. Based on a Foreshore Management Plan, the WAPC may impose conditions relating to revegetation and management of seasonal creeks. 9. The WAPC may impose conditions relating to: i. Revegetation and landscape planning addressing buffer strip planting adjoining Boyup Brook – Arthur Road/Bode Street and surrounding rural use land; ii. Ongoing separation of lots to remaining rural use land within the structure plan area to be staged as applicable; iii. Restrictive covenants for prevention of direct vehicular access between lots and Boyup Brook – Arthur Road/Bode Street; iv. Notifications on Title relating to: (a) Nuisance impact to residential amenity from adjacent rural operations; or (b) The Shire's resource recovery centre. *Note: Structure plan areas are to be zoned progressively, as land is subdivided, and when opportunities arise for scheme amendments.*

3. Amending the Scheme Map accordingly.

Determines Amendment No. 24 is a standard amendment under the provisions of the *Planning and Development (Local Planning Schemes) Regulations 2015* for the following reasons:

- An amendment relating to a zone that is consistent with the objectives in the scheme for that zone;
- The amendment is consistent with the Local Planning Strategy;
- The amendment would have minimal impact on land in the scheme area that is not the subject of the amendment; and
- The amendment does not result in any significant environmental, social, economic or governance impacts on land in the scheme area.

Dated this _____ day of _____ 2024

_____ _____

Chief Executive Officer Date

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PROPOSAL TO AMEND A LOCAL PLANNING SCHEME

1. **LOCAL GOVERNMENT:** Shire of Boyup Brook
2. **DESCRIPTION OF LOCAL PLANNING SCHEME:** Local Planning Scheme No.2
3. **TYPE OF SCHEME:** Local Planning Scheme
4. **SERIAL NUMBER OF AMENDMENT:** 24
5. **PROPOSAL:**
   i) Rezoning Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook from the Rural zone to the Special Use (SU2) zone.
   ii) Adding provisions to Table 5.
   iii) Amending the Scheme Map accordingly.

REPORT BY THE SHIRE OF BOYUP BROOK

1. INTRODUCTION

The Shire of Boyup Brook seeks the support of the Western Australian Planning Commission (WAPC) and the approval of the Hon. Minister for Planning to rezone Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook (the 'site') from 'Rural' to 'Special Use (SU2)'.

In order to progress subdivision and development of the site, in a manner that reflects the strategic direction of the *Shire of Boyup Brook Local Planning Strategy*, it is proposed to rezone the site to 'Special Use'.

The purpose of this report, supporting technical reports and associated plans are to explain the proposal and set out the planning merits of the Amendment which is consistent with the planning framework including the *Shire of Boyup Brook Local Planning Strategy*.

The Amendment is supported by various technical investigations and a Concept Plan.

The site's suitability for residential and rural residential development includes that it essentially adjoins the Boyup Brook townsite and the technical investigations reveal the site is capable of accommodating residential and rural residential development. More detailed planning and investigations will occur at the structure plan, subdivision application, development application and building permit stages.

The site offers the potential to provide a significant supply of residential and rural residential lots in the short to medium term which are consistent with the Shire's Strategic Community Plan.



Photo 1: central location

2. BACKGROUND

2.1 Cadastral details

A copy of the Certificates of Title are provided in **Attachment 1**.

Cadastral details for the site are summarised below in Table 1.

Table 1 – Cadastral Details

Lot	Diagram	Volume	Folio	Area	Owner
51	62150	2727	332	110.2788 hectares	Leafield Pty Ltd
1007	103924	2618	816	107.4556 hectares	Leafield Pty Ltd
1118	103925	1194	20	4.0481 hectares	Leafield Pty Ltd

The site has a total area of 221.78 hectares.

2.2 Regional context

The site is located in the Shire of Boyup Brook and adjoins the Boyup Brook townsite. Boyup Brook is located approximately 260 kilometres south of Perth and 100 kilometres south-east of Bunbury. Boyup Brook is a district centre in the Warren-Blackwood Region. The town provides a range of services and facilities to residents and visitors.

2.3 Local context

The site's location is set out in **Attachment 2** while **Attachment 3** shows the Amendment site.

As outlined above, the site comprises three separate land parcels being Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook.

The western boundary of the site is around 1.5km north-east of the Boyup Brook townsite. Nearby uses include rural living development, the Country Music Festival site (including tourist accommodation), public uses and rural uses. **Attachment 4** outlines the Context, Opportunities and Constraints Plan. This also shows that most of the site is unconstrained for development.

The site borders the Blackwood River which adds to the site's attractiveness.

2.4 Physical characteristics

The site is outlined in **Attachments 3** and **4** and has the following characteristics and features:

- It is an attractive site bounded by Bode Street to the west, Boyup Brook – Arthur Road to the north, the Blackwood River to the east and south, rural land to the north-east and rural zoned land used for rural living purposes to the south-west. As outlined on the Existing Scheme Map, a Structure Plan Area is identified opposite the site on the southern side of the Blackwood River;
- It is used for rural (grazing) purposes;
- It contains several dams;
- It is predominantly cleared with small pockets of native vegetation, which have been parkland cleared;
- The site contains a range of slopes. It is overall moderately sloping. Elevation varies across the site from approximately 185 metres AHD at the lowest point near the Blackwood River, to approximately 262 metres AHD in a central part of the site. There are some smaller steeper sections as outlined in **Attachment 4**;
- There are seasonal watercourses and some drainage lines. Details relating to surface and groundwater are outlined in **Attachment 5**;
- It has extensive frontage to the Blackwood River;
- Lot 51 contains a dwelling and several outbuildings;
- The soils are overall conducive for on-site sewage disposal as evidenced by **Attachment 6**. Some parts of the site, including the western section, are however, constrained and need appropriate mitigation strategies;
- There are various soil types which generally relate to the associated

vegetation. Details are in **Attachments 5** and **6**; and

- It is not on the Department of Water and Environmental Regulation's Contaminated Site Database.

The site attributes are considered overall favourable to generous sized residential and rural residential development. More detailed investigations will occur at future planning and design stages.

Overall, the site has considerable opportunities and manageable constraints to accommodate residential and rural residential development in the range of 2000m^2 to around 7.5 hectares.

2.5 Existing services

2.5.1 Overview

The site is currently provided with relevant services appropriate for rural land. Infrastructure is required to be extended, provided or as required upgraded to facilitate residential and rural residential development.

2.5.2 Roads

The site adjoins the sealed Bode Street and Boyup Brook – Arthur Road, which are Shire managed roads, and also has access to an unconstructed road reserve near the southern boundary.

2.5.3 Drainage

The site contains three seasonal watercourses. The site drains to the Blackwood River which is located to the east and south of the site. There is no nearby Shire piped drainage systems.

2.5.4 Water supply

The site is not connected to Boyup Brook's reticulated water system operated by Water Corporation. The site is currently located outside of Water Corporation's planned water supply area given the current 'Rural' zoning.

2.5.5 Wastewater disposal

The site is not connected to the reticulated sewerage system noting that there is no reticulated sewerage system in the Shire of Boyup Brook. The site contains a dwelling, which is serviced by on-site sewage disposal.

2.5.6 Power and telecommunications

Power and telephone services are currently available to the site.

2.6 Heritage

The Department of Planning, Lands and Heritage's database reveals there is a Registered Aboriginal Heritage Site (ID 20434) applying to the property. The Registered Aboriginal Heritage Site has mythological significance associated with the Blackwood River and tributaries. Preliminary contact has been made with the South-West Aboriginal Land and Sea Council and the Department of Planning, Lands and Heritage's Aboriginal Heritage team to ensure Aboriginal heritage values are respected, are appropriately addressed and to understand how to respectfully develop the property. Additionally, land developers have an obligation under the *Aboriginal Heritage Act 1972*, to protect places and objects in Western Australia that are important to Aboriginal people because of the connections to their culture.

The proposed Scheme provisions for SU2 set out the need to prepare an Aboriginal Cultural Heritage survey and management plan to identify and protect Noongar cultural heritage values at the structure plan stage.

The site does not contain any structure or place of non-indigenous heritage significance on the Shire of Boyup Brook Municipal Inventory (heritage survey) or on the Shire's Heritage List.

2.7 Council resolution, and EPA Services advice and additional technical investigations

The Council at its Ordinary Meeting on 16 February 2023 adopted Amendment No. 24 in rezoning the site from 'Rural' to 'Special Use (SU2)', inserting provisions in

Table 5 – Special Use Zones in Scheme Area and determining it is a standard amendment.

EPA Services then considered the Amendment and wrote to the Shire on 16 March 2023. In summary, EPA Services required further information and technical investigations relating to:

- Local Water Management Strategy (incorporating nutrient modelling);
- Site and Soil Evaluation; and
- Targeted Black Cockatoo Habit Survey Report.

Following receipt of the EPA Services advice:

- South Environmental prepared the Local Water Management Strategy (incorporating nutrient modelling) and Site and Soil Evaluation (also includes nutrient modelling) and have worked through matters with the Department of Health and the Department of Water and Environmental Regulation;
- Bio Diverse Solutions prepared the Targeted Black Cockatoo Habit Survey Report;
- Based on Department of Planning, Lands and Heritage and Shire advice, the Structure Plan is now 'uncoupled' from the Amendment. The Structure Plan is a proposed statutory requirement. The Structure Plan will be separately progressed should the Minister for Planning's approval be obtained for the Amendment;
- Water Corporation have confirmed there is sufficient scheme water to service subdivision and development of the site; and
- A Concept Plan has been prepared based on initial and additional technical investigations. This has resulted in the expected lot yield reducing from 360 lots to 284 lots. Lot sizes in the western portion of the site and near seasonal watercourses have increased from the initial concept considered by Council on 16 February 2023.



Photo 2: extensive views

3. PLANNING FRAMEWORK

3.1 Overview

The site and proposed residential and rural residential subdivision/development are subject to a range of State Planning Policies, WAPC publications and bulletins, WAPC regional strategies, along with Environmental Protection Authority (EPA) bulletins, various Shire strategies and policies, along with the *Shire of Boyup Brook Local Planning Scheme No. 2 (*LPS2).

The following section will outline how the proposed Amendment suitably addresses relevant planning policies, strategies, plans and LPS2. These documents consider key planning, environmental, servicing and economic development matters. In summary, the Amendment is consistent with the State, regional and local planning framework which support residential and rural residential subdivision in areas which are in close proximity to towns and where land suitability and capability are appropriately addressed.

3.2 State planning framework

3.2.1 Overview

The following strategies and policies are of relevance to the Amendment:

- *State Planning Strategy 2050* - sets a broad strategic plan for Western Australia built on sustained growth and prosperity. The Strategy highlights the importance of job creation and supports developing strong and

resilient regions. The Strategy also supports a diverse, liveable, connected and collaborative State;

- *State Planning Policy 1 State Planning Framework Policy;*
- *State Planning Policy 2 Environment and Natural Resources;*
- *State Planning Policy 2.5 Rural Planning;*
- *State Planning Policy No. 2.9 Water Resources* - a Local Water Management Strategy is set out in **Attachment 5**;
- *State Planning Policy No. 3 Urban Growth and Settlement;*
- *State Planning Policy 3.7 Planning in Bushfire Prone Areas* – the site is partly classified as a Bushfire Prone Area as shown at https://maps.slip.wa.gov.au/landgate/bushfireprone/. A Bushfire Management Plan is set out in **Attachment 7**. This assessment addresses SPP 3.7 and the *Guidelines for Planning in Bushfire Prone Areas;*
- *State Planning Policy 5.4 Road and Rail Noise* – the site is not within the 'trigger distance';
- *Residential Design Codes – Volume 1;*
- *Operational Policy 1.1 Subdivision of Land – General Principles;*
- *Development Control Policy 2.2 Residential Subdivision* – residential lots are required to be capable of development, be located within an area which is suitable for subdivision in terms of its physical characteristics and be provided with an appropriate vehicle movement network;
- *Development Control Policy 2.6 Road Planning;*
- Liveable Neighbourhoods;
- *Government Sewerage Policy*; and
- EPA Guidance Statements including *Guidance Statement 33 – Environmental Guidance for Planning and Development* and *Guidance Statement 3 – Separation Distances between Industrial and Sensitive Land Uses.*

3.2.2 State Planning Strategy 2050

The *State Planning Strategy 2050* sets a broad strategic plan for Western Australia built on sustained growth and prosperity. The vision (page 20) is:

Sustained growth and prosperity

'The vision of sustained growth and prosperity envisages a future where Western Australians enjoy high standards of living, improved public health and an excellent quality of life for present and future generations.'

Sustained growth (page 20) consists of:

- 'A diverse state; offering a diversity of ecosystems, landscapes, enterprises, people and cultures.'
- 'A liveable state; the place of choice for the brightest and best.'
- 'A connected state; as connected to the rest of the world as any other place.'
- 'A collaborative state; enabling alignments that progress the State's sustained growth and prosperity.'

The Strategy (page 20) seeks the following:

> 'By 2050, Western Australia will have a diverse range of interconnected and vibrant local communities and regional centres. The people in these communities will be healthy, resilient, active, prosperous, respectful of cultural difference and participate in the public domain.
>
> Standards of living will continue to be amongst the highest in the world. Improved connections and smarter technologies will enhance the State's ability to attract global and domestic investment capital where and when it is most needed.
>
> A 'can do' attitude will prevail, inspiring new ways of thinking and working, which will deliver optimal outcomes for the economy and communities of Western Australia.'

The Strategy establishes objective and the strategic approach in relation to economic development, physical infrastructure, social infrastructure, environment and security. The Strategy is the lead strategic planning document within Government which informs all other State, regional and local planning strategies, policies and approvals.

The Amendment is consistent with the Strategy. This includes that it supports sustained growth and economic development in Boyup Brook, it promotes development adjoining the townsite and it promotes liveability.

3.2.3 State Planning Policy 1 – State Planning Framework Policy

The State Planning Framework Policy (Variation No. 2) applies to all land within Western Australia. It is an amalgamation of all planning policies, strategies and guidelines that provide direction on the form and methods of growth and development throughout the State. It identifies that the primary aim of planning is to provide for the sustainable use and development of land. The Amendment and the associated Concept Plan have taken consideration of SPP1.

3.2.4 State Planning Policy 2 – Environment and Natural Resources Policy

The Policy defines the principles and considerations that represent good and responsible planning, in terms of environment and natural resource issues, within the framework of the State Planning Strategy. The Policy is supplemented by more detailed planning policies on particular natural resources matters that require additional information and guidance. Noting the site is largely cleared and remaining native vegetation is sought to be conserved, **Attachment 5** considers and addresses matters arising from SPP2.

3.2.5 State Planning Policy No. 2.9 Water Resources

The Policy provides guidance in the planning, protection and management of surface and groundwater catchments, including implementation of total water cycle management principles in the land use planning system.

Attachment 5 sets out the approach to managing stormwater for the site. The Local Water Management Strategy adopts water sensitive urban design which is consistent with the Policy. Further details will be addressed at the subdivision stage through preparation and implementation of an Urban Water Management Plan.

The Local Water Management Strategy was informed by pre-development surface water and groundwater monitoring and also contains a nutrient modelling report (**Attachment 5**).

3.2.6 State Planning Policy No. 3 – Urban Growth and Settlement

This Policy sets out the principles and considerations which apply for urban growth and settlement in Western Australia. In summary, the policy objectives are to:

- Promote a sustainable settlement pattern including providing sufficient and suitable land for a wide variety of housing;
- Build on existing communities with established services and infrastructure and to promote local economies;
- Address environmental, heritage and community considerations;
- Promote accessibility, housing choice and an identifiable sense of place; and
- Ensure appropriate servicing which is provided in an efficient manner.

The Policy sets out requirements for sustainable communities. This includes using land efficiently, convenient access to employment, retail and community facilities, quality design, addressing environmental considerations and supporting a positive planning framework which seeks to facilitate and promote quality development.

The consolidation and expansion of existing settlements is preferred to the development of new settlements. The Amendment is consistent with the Policy given the site is close to the Boyup Brook townsite, a wide variety of housing lot sizes are proposed and it will be appropriately serviced.

3.2.7 Residential Design Codes (Volume 1)

A range of lot sizes will be created to address site conditions with the smallest lot size being 2000m^2 (Residential R5 which has a 30 metre frontage) to approximately 7.5 hectares. Future subdivision will be guided by the Local Structure Plan. Future residential development will be guided by the R-Codes including setbacks, site planning and design, and car parking. Rural residential development will be guided by LPS2. To support the Amendment, a Concept Plan has been prepared (**Attachment 8**).

3.2.8 State Planning Policy 3.7 Planning in Bushfire Prone Areas

Portions of the site are classified as bushfire prone. Accordingly, *State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7)* relates to a portion of the site. SPP3.7 is complemented by *Guidelines for Planning in Bushfire Prone Areas.*

A Bushfire Management Plan is set out in **Attachment 7** to address SPP 3.7 and the Guidelines.

3.2.9 Development Control Policy 1.1 Subdivision of Land – General Principles

This Policy sets out the general principles used by the WAPC in determining subdivision applications. It indicates the WAPC's key requirements for the creation of new lots. Policy objectives include to:

- Ensure that the subdivision of land is consistent with *State Planning Policy No. 1 State Planning Framework* and relevant WAPC policies and plans;
- Ensure the subdivision pattern is responsive to the characteristics of the site and the local planning context;
- Ensure that the subdivision is consistent with orderly and proper planning and the character of the area; and
- Facilitate development which achieves appropriate community standards of health, safety and amenity.

The Amendment is consistent with Policy objectives.

3.2.10 Liveable Neighbourhoods

Liveable Neighbourhoods is an operational policy of the WAPC, which implements *State Planning Strategy* objectives, to guide sustainable urban development. The principal aim of *Liveable Neighbourhoods* is to provide for walkable neighbourhoods which are located around activity centres of compatible mixed uses in order to reduce car dependence and foster a strong local identity.

Liveable Neighbourhoods provides guidance on a number of design elements including the movement network, lot layout, public parkland, urban water management and utility planning. The objectives of community design are a balance between urban and environmental outcomes.

The Amendment and associated Concept Plan (**Attachment 8**) have regard to relevant elements of *Liveable Neighbourhoods* noting that *Liveable Neighbourhoods* has generally been applied to the Perth Metropolitan region and large regional centres. The Concept Plan has considered the movement network, range of housing types and lot sizes, lot layout, provision of environmental conservation/public parkland, and effectively managing stormwater. These details will be refined at the subdivision stage.

Proposed residential development on the site is located 1.5 kilometres from the Boyup Brook townsite. No activity centres are proposed for the Amendment site. Instead, proposed development is intended to support the existing town

centre and other services/facilities in Boyup Brook.

The site adjoins the Blackwood River and it contains seasonal watercourses. Accordingly, there are environmental and recreational assets in close proximity (walking distance) of proposed lots. The Amendment will promote walkable communities and cycling.

3.2.11 Planning for Bush Fire Protection Guidelines

The document forms the foundation for fire risk management planning on private land in Western Australia. As set out in **Attachment 7**, proposed residential and rural residential development can address management issues including development location, vehicular access, water, siting of development, and design of development.

The site is located in an area of predominantly moderate bushfire hazard level on cleared land. There are two small areas within the site which have an extreme bushfire hazard level. Bushfire levels can be suitably addressed to enable suitable development in these areas.

At this stage, a subdivision design is not finalised. BAL contour mapping will be prepared at the subdivision stage to demonstrate compliance with the Guidelines including each lot having sufficient areas of BAL-29 or below.

Further details relating to fire management are set out in section 5.6 and **Attachment 8**.

3.2.12 Visual Landscape Planning in Western Australia Manual

This document was released by the WAPC and the former Department for Planning and Infrastructure in November 2007. Amongst matters, it provides principles and guidelines for the location, siting and design of buildings, structures and new planting. Page 3 states 'The aim should be to accommodate change while maintaining and, where possible, enhancing the quality of our landscapes.'

It is appreciated that portions of the site can in part be viewed from Bode Street/Boyup Brook-Arthur Road. The Concept Plan and this Amendment consider landscape impacts including in section 5.7.

3.2.13 EPA Guidance Statements

The EPA has prepared a series of Guidance Statements. These statements address specific issues, and sometimes set preferred limits for various activities. The statements provide assistance to proponents of development and other decision-making authorities on the expectations of the EPA. Of particular note to the Amendment are *Guidance Statement 33 – Environmental Guidance for Planning and Development* and *Guidance Statement 3 – Separation Distances between Industrial and Sensitive Land Uses* (2005). Guidance Statement 3 is further considered in section 5.5.2.

3.2.14 Government Sewerage Policy

The *Government Sewerage Policy* establishes the Western Australian Government's position on the provision of sewerage services in the State through the planning and development of land.

Noting the proposed large lot sizes and the site conditions, the Site and Soil Evaluation prepared by South Environmental (**Attachment 6**) addresses the *Government Sewerage Policy* for this stage of the planning process. This sets out the property is suitable for on-site disposal based on the report recommendations including on siting. Further details are outlined in section 5.12.3.

3.3 Regional planning framework

3.3.1 South-West Regional Planning and Infrastructure Framework

The Framework supports a diverse and adaptive economy and supporting population growth. The Framework identifies Boyup Brook as a 'town'.

The Framework's vision is expressed through objectives and an agreed strategic direction for economic growth, population and sustainable settlements, transport, community infrastructure, essential services, natural assets, and culture, heritage and visual landscape. There is also a list of regional planning initiatives, a list of committed projects, a list of anticipated directions for regional infrastructure, and a framework map.
The Framework highlights there are opportunities for in-migration from retirees and tree-changers. The Framework promotes development in or near existing communities. Accordingly, the Amendment is consistent with the Framework.

3.3.2 Warren-Blackwood Regional Planning Strategy

Boyup Brook is identified as a 'district centre'. The site is located in Planning Unit BR3 – Tweed and parts of BR3 are suitable for townsite and rural residential development.

3.3.3 Warren-Blackwood Rural Strategy

The Strategy provides in-principle support for rural residential development (page 53) and rural smallholdings development (page 55) within 5km of an urban area. The site is located within Planning Unit BR3 Tweed. The site is broadly outlined for non-rural use on Map 9.

3.3.4 South West Regional Blueprint

The Blueprint establishes priorities for economic development and growth of the South West region and provides an analysis of local, regional, national and global factors influencing the region. A strategic economic growth plan and proposed transformational projects are set out. The Blueprint supports growing the region's population, promoting a vibrant economy and growing the economy. The Amendment is consistent with the Blueprint.

3.4 Local planning framework

3.4.1 Shire of Boyup Brook Local Planning Strategy

The *Shire of Boyup Local Planning Strategy* includes the site in a Planning Area as 'Residential & Rural Residential' (see **Attachment 9**). The Strategy also summarises planning considerations and issues/opportunities for the site.

The Strategy recognises that the Boyup Brook townsite will not be provided with infill sewerage. The lack of infill sewerage is expected to result in only modest growth prospects for the existing townsite. Most of the proposed growth will occur on greenfield land close to the townsite (including on the Amendment site).

The Strategy notes that people are moving to the region and taking up residence on the fringes of the Boyup Brook townsite, on rural lifestyle properties.

The Strategy notes that Boyup Brook needs more lots in the vicinity of around 2000m^2 – 5000m^2. The Strategy supports a diversity of lot sizes including 4000m^2 – 5000m^2.

The inclusion of the site as a Planning Area recognises that subject to suitable technical investigations, the site is broadly suitable and capable for development. The site:

- Is cleared and has low environmental impacts and will deliver high economic and community outcomes;
- Will comply with *State Planning Policy 3.7 Planning in Bushfire Prone Areas* and the *Guidelines for Planning in Bushfire Prone Areas*. This includes access routes in different directions;
- Adjoins a sealed road which enhances viability compared to an unsealed road;
- Is an attractive and marketable property, including that it adjoins the Blackwood River and has a range of views/aspects; and
- Is owned by a landowner who has the will, experience and financial capacity to develop the site.

The Amendment site provides a realistic opportunity to grow and complement the Boyup Brook townsite with lot sizes and pricing that are appropriate for a country town and for market expectations.

Without landowners/developers willing to 'play the long game', committing to investing in Boyup Brook over the long-term and having experience in delivering larger scale subdivisions, it is expected that lot creation and associated population growth (if any) will be low. Practically, there are considerable risks, high upfront costs and a delay in generating a profit in undertaking land development in Boyup Brook.

3.4.2 Shire of Boyup Brook Local Planning Scheme No. 2

The site is zoned 'Rural' in the *Shire of Boyup Brook Local Planning Scheme No. 2* (LPS2). The 'Rural' zone is intended for primarily agricultural pursuits with permitted uses within the Zoning Table including extensive and intensive agriculture. The existing Rural zoning is not applicable to the use and development of the site as envisaged by the Local Planning Strategy.

The current LPS2 zonings and reservations relating to the site and adjoining land are shown on the Existing Scheme Map. Surrounding land is zoned 'Rural' and 'Rural Residential' while land to the south and east is reserved as 'Public Open Space'. A Structure Plan Area is located on the opposite side of the Blackwood River.

Boyup Brook – Arthur Road and Bode Street are reserved as a 'Regional Distributor Road'.

The aims of the Scheme are outlined in clause 9. This includes to 'provide for reasonable expansion of residential, industrial and commercial uses based on the District's established structure'.

Other sections of LPS2 relevant to the Amendment include:

- Clause 16 - zone objectives;
- Table 3 – Zoning Table; and
- Clause 21 and Table 5 – Special Use zones.

Given the above, the Amendment is consistent with LPS2 aims, objectives and future development can achieve required standards. The Amendment will assist to create an appropriate interface zoning between the townsite and existing Rural Residential zoned land and agricultural uses. The site is appropriately located for residential and rural residential development and it will address the aims and objectives of LPS2.
The proposed Special Use zoning can accommodate envisaged uses including low-key employment and tourism accommodation uses.

3.4.3 Local Planning Policies

The Council has endorsed a number of planning policies and various policies are of relevance to the future subdivision and development of the site including drain and fill, naming new roads and fire. The Concept Plan and Amendment have taken into account relevant Local Planning Policies.

3.4.4 Shire of Boyup Brook Strategic Community Plan 2021-2031

The Plan recognises the importance of population growth, maintaining and upgrading facilities and infrastructure, increasing new housing, supporting economic development and creating new jobs.

The Strategic Community Plan sets the community's vision for the future and is the principal strategic guide for the Council's future planning and activities. The vision for Boyup Brook is:

> 'Growing our community together. Our Shire will be:
>
> A place for people, with a sense of community, one that is active, vibrant, engaged and connected.

A place with community and visitor facilities that are well maintained and further developed as required.

A place that is safe and secure. An inclusive place that nurtures local youth and aging population and retains local health and medical services.

A place that grows housing and employment opportunities through economic development based on our local comparative advantage.'

The Amendment is consistent with the vision and objectives of the Strategic Community Plan. Key implications for the Amendment include promoting new investment and new housing, protecting natural resources, supporting economic development and the appropriate provision of infrastructure.

3.5 Planning framework implications for Amendment

Common themes of the policies, strategies, plans and LPS2 and their implications for the Amendment include:

- Expansion of the Boyup Brook townsite has been anticipated and supported in the Local Planning Strategy;
- Boyup Brook will remain the Shire's key centre and a focus for employment and population growth;
- Promoting residential and rural residential development in appropriate locations;
- Ensuring that key environmental assets are conserved or enhanced;
- Addressing key environmental assets and bush fire risk;
- Addressing land use compatibility;
- Consolidation of existing settlements, including Boyup Brook, is preferable to isolated 'stand-alone' developments;
- Support for a variety of housing and promoting liveability;
- Appropriate servicing including addressing stormwater management;
- Addressing landscape impact;
- Supporting local communities and local economies;
- The need for structure planning and adopting relevant principles of *Liveable Neighbourhoods;* and
- A requirement for sustainable and quality design.

Based on the above, the Amendment and associated Concept Plan are consistent with the planning framework. In particular, the Amendment promotes a sustainable settlement pattern as it builds onto a district centre, environmental assets will be conserved and the subdivision will be appropriately serviced.

4. AMENDMENT PROPOSAL

4.1 Overview

The intent of the Amendment is to provide for a range of residential and rural residential lot sizes which complement the Boyup Brook townsite. The purpose of the Amendment is to:

- Facilitate new lots and dwellings in Boyup Brook;
- Provide for the orderly and proper planning of the site in terms of land use, servicing and design;
- Address the planning requirements set out in LPS2 and in the planning framework; and
- Require a structure plan prior to subdivision.

The Amendment is supported by a Concept Plan. The Concept Plan (**Attachment 8**) provides a framework for the site to be subdivided and developed. Future subdivision and development is required to be in accordance with a Local Structure Plan.

4.2 Proposed scheme amendment

The Amendment proposes to rezone the site from the 'Rural' zone to the 'Special Use (SU2)' zone. The Amendment will facilitate subdivision/development between 2000m^2 and approximately 7.5 hectares. To control and guide subdivision

and development, various planning provisions are proposed to apply to Special Use (SU2). To address site opportunities and constraints, development will be setback from the Blackwood River and seasonal watercourses.

The Amendment requires a structure plan to be prepared and endorsed by the WAPC prior to subdivision.

4.3 Concept Plan

In support of the Amendment, a Concept Plan is provided in **Attachment 8** which provides a broad framework for future subdivision and development. The Concept Plan has been informed by various technical investigations, has considered the site's context, including adjoining and nearby land uses, bushfire management, servicing, environmental assets, landscape considerations and market requirements.

It is highlighted the Concept Plan has no planning 'status'. It is also highlighted that all road alignments and lots are conceptual and are subject to further investigation. The Concept Plan will be refined at the Structure Plan and subdivision stages.

The development of the site requires some degree of flexibility relating to design details. Factors that may alter the design include servicing requirements and market demand.

The Concept Plan has been informed by technical investigations which includes servicing (water management, sewage assessment), environmental, bushfire, and land management considerations.

The Concept Plan assesses the future subdivision/development of the land having considered its physical form and relationship with its context and physical attributes. The Concept Plan provides a broad framework to develop the site for residential and rural residential land use which is consistent with the Shire's strategic planning vision.

The Concept Plan provides land for housing (residential and rural residential), public open space/foreshore reserve and infrastructure. The predominant land use is residential followed by rural residential. The Concept Plan guides land uses, densities and the estimated lot yield of 284 lots. The Concept Plan supports a variety of lot sizes, budgets and lifestyles.

The proposed land uses are complementary with adjoining and nearby uses. More detailed planning and investigations will occur at the structure plan, subdivision, development application and building permit stages.

The Concept Plan addresses key development considerations for the site and outlines:

- Residential and rural residential lots ranging between 2000m^2 – 7.5 hectares;
- A highly connective design with linkages to the surrounding properties and roads;
- Roads which are aligned to avoid native vegetation wherever possible and significant Black Cockatoo habitat trees in particular. The road reserves are indicatively 20 metres wide and will incorporate stormwater pipes or swales for managing stormwater;
- Buildings can be located on cleared land which are setback from Boyup Brook-Arthur Road, the Blackwood River and the seasonal watercourses/drainage lines;
- Building envelopes are provided on some lots to address matters such as land use compatibility, flood risk, and setbacks for on-site sewage disposal from the Blackwood River and seasonal watercourses. Development on other lots will be guided by the R-Codes and LPS2 standards;
- Future dwellings and buildings are to be located within building envelopes to address setback standards in LPS2;

- Provide for approximately 284lots with any new lot to be least 2000m^2 in area. It is expected that a range of lot sizes will be provided based on market requirements and feasibility considerations; and
- Future dwellings can achieve BAL-29 or below.

4.4 Rational for Concept Plan Design

The Concept Plan (**Attachment 8**) responds to the site's context, opportunities and constraints, appropriate linkages to surrounding properties (**Attachment 4**) and the planning framework. In particular, key planning and design considerations include:

- Taking account of site characteristics soil types and overall gentle to moderate gradients;
- Technical investigations;
- Considering key environmental assets and conserving the majority of the site's native vegetation;
- Taking account of *State Planning Policy 3.7: Planning in Bushfire Prone Areas,* the *Guidelines for Planning in Bushfire Prone Areas* and the Bushfire Management Plan including the provision of multiple access routes;
- Considering seasonal drainage lines and stormwater management. The road pattern is integrated with stormwater management;
- Generous lots sizes on the boundaries of the site to address land use compatibility between off-site uses including the resource recovery facility to the north-west and with agricultural uses to the north and east along with the provision of smaller lots internally;
- Providing a range of lot sizes to enhance attractiveness to the market and to promote feasibility;
- Proposing no direct vehicle access between lots and Bode Street/Boyup Brook – Arthur Road;
- Appropriate access to Bode Street/Boyup Brook-Arthur Road to satisfy Shire requirements and provide suitable sight distances;
- Proposing an interconnected network of streets which facilitate safe, efficient and pleasant walking, cycling and driving;
- Road linkages to adjoining land;
- Ensuring there are suitable areas, on each proposed lot, to locate a dwelling and outbuilding and also to appropriately dispose of sewage;
- Responding to the site's landform with no need for retaining walls on property boundaries; and
- Seeking to create regularly shaped lots with generous frontages, that generally orientate north-south or east-west to promote opportunities for passive solar building design.

The Concept Plan seeks to adopt principles including connectivity, walkability, affordability and quality of life. The Concept Plan seeks to integrate with surrounding uses and development. Future design should seek to promote the site's 'sense of place' and create a built form that is site responsive. To promote a sense of place, the following is proposed:

- Street trees – likely to be suitable exotics that address Boyup Brook's climate, enhance amenity, and minimise increased bushfire risks;
- Entry statements onto new roads intersecting Bode Street/Boyup Brook – Arthur Road;
- Signage to meet Shire requirements; and
- Restrictive covenants.

4.5 Local Structure Plan

The preparation and approval of a Local Structure Plan is a separate statutory process to the rezoning of the site. The Regulations outline the requirements and procedure for the preparation and approval of Structure Plans. The Local Structure Plan will be subject to community and stakeholder consultation.

The Local Structure Plan will provide for a range of lot sizes including those not currently available in Boyup Brook. The lot sizes will reflect Boyup Brook's non-

metropolitan lifestyle. The aim is to provide choice, to create an estate with its own identity and to enhance liveability in Boyup Brook.

The Local Structure Plan is a proposed statutory requirement. The Local Structure Plan will be separately progressed should Minister for Planning approval be obtained for the Amendment.

4.6 Future servicing and more detailed planning

Future lots and development will be appropriately serviced for low density residential and rural residential development in accordance with Shire, WAPC and other government agency requirements. This includes for on-site sewage disposal, stormwater management, underground power and telecommunication services. Further details are outlined in **Attachment 10** and later sections of this report, with more detailed planning to occur at the subdivision, development application and building permit stages.

The future subdivision and development will consist of:

- Sealed roads;
- Reticulated scheme water;
- On-site sewage disposal;
- Enhanced stormwater management;
- Underground power;
- Telecommunication services;
- Upgraded fire management measures including fire hydrants;
- New and upgraded fencing; and
- Appropriate replanting.

Most lots will require no fill. There may be a need for modest fill, on some lots, to address the findings in the Site and Soil Evaluation.

Based on Water Corporation's recent advice, the Boyup Brook townsite and proposed subdivision development on the Amendment site have a sufficient and secure scheme water supply. This includes to service planned development in the townsite along with servicing the Amendment site.

The provision of sufficient scheme water and storage capacity for the Boyup Brook townsite is strategically important to the Shire, the local community and to the landowner. This will assist to support planned growth and development in Boyup Brook. Some of the benefits include:

- Supporting new development and housing. This includes making a significant contribution to providing lots and housing for Talison Lithium;
- Supporting the local and regional economy to complement the State Government's Just Transition Fund;
- Facilitating population growth, job creation and economic development along with assisting to create a more sustainable local economy and sustaining local facilities and services; and
- Assisting to 'rebrand' Boyup Brook through providing a different product including a range of lot sizes, lifestyle opportunities, affordability and housing choices to suit a wide range of people. This includes lot sizes not currently available in Boyup Brook.

Further details are outlined in later sections of this report.

4.7 Scheme provisions

The proposed residential and rural residential subdivision/development and land use will be controlled by existing and proposed LPS2 provisions plus provisions in the Local Structure Plan. The proposed scheme provisions will address subdivision, development and land use, servicing requirements, bushfire management and purchaser notification.



Photo 3: view of Blackwood River and future public open space

5. PLANNING CONSIDERATIONS AND PLANNING JUSTIFICATION

5.1 Overview

This section brings together an assessment of the site's attributes and the planning framework in considering key planning considerations and justifying the requested zoning for Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook from 'Rural' to 'Special Use (SU2)' zone.

5.2 Planning suitability for residential and rural residential development

The Concept Plan proposes predominantly Residential R5 (minimum lot size of 2000m^2) plus rural residential lots, along with public open space land uses consistent with those proposed by the Local Planning Strategy.

The Concept Plan shows additional details and illustrates that approximately 284residential and rural residential lots could be established on the site, with a minimum lot size of 2000m^2. There is additional land set aside for foreshore reserve and public open space/community purposes.

Lots adjoining Boyup Brook – Arthur Road and Bode Street will have a landscape buffer that will maintain the 'low key' rural feel for the area.

The site is suitable to be rezoned to Special Use (SU2) to facilitate residential and rural residential subdivision/development. The reasons include:

- It is consistent with the planning framework. Various planning policies and strategies support residential and rural residential subdivision adjoining or close proximity to existing towns. The site adjoins the Boyup Brook townsite and accordingly is near the town's associated educational, medical, community, recreational and retail services;
- It promotes and delivers on new investment and population growth which is consistent with the vision of the Local Planning Strategy and the Council's Strategic Community Plan;
- It will integrate with and complement the Boyup Brook townsite;
- The site provides a realistic opportunity to grow and complement the Boyup Brook townsite with lot sizes and pricing that are appropriate for a country town and market expectations;
- The site provides a suitable interface between the Boyup Brook townsite and rural residential development and agricultural areas;
- Development will be compatible with adjoining and surrounding land uses;
- Appropriate buffers can be provided to adjoining and nearby uses;
- Most the site has been previously cleared. Remaining environmental assets, focused on riparian vegetation and water resources, can be appropriately conserved;
- There are opportunities for revegetation/environmental repair;
- The technical investigations confirm subdivision/development will address on-site sewage disposal requirements and bushfire risks;
- It is overall moderately sloping land, with suitable soil types for development;

- It will be appropriately serviced in accordance with local government and State Government guidelines;
- Traffic impacts will be manageable, and traffic can readily be accommodated on Bode Street/Boyup Brook – Arthur Road as outlined in the Traffic Management Assessment;
- There is no direct access between lots and Bode Street/Boyup Brook – Arthur Road;
- The site is not located in a public drinking water source area;
- Bushfire management measures will comply with the objectives of *State Planning Policy 3.7 Planning in Bushfire Prone Areas* and the *Guidelines for Planning in Bushfire Prone Areas*. This includes access routes in different directions;
- There will be manageable landscape impacts, when associated with the preparation and implementation of a landscape plan. The site's attributes, along with landscaping and design guidelines will create a unique 'sense of place';
- It assists to provide a variety of housing and lifestyle choices near Boyup Brook;
- It is near the town centre and there are opportunities for enhanced walking and cycling connections including along the Blackwood River and Ritson Street;
- There will be enhanced public access to the Blackwood River;
- The proposal will complement Boyup Brook increasing its overall viability, vitality and prosperity, increasing the economic viability of existing services and adding to the range of services that can be provided;
- Approval and implementation will assist to support the viability and sustainability of local services, facilities and businesses;
- It assists to 'rebrand' Boyup Brook through providing a different product including a range of lot sizes, lifestyle opportunities, affordability and housing choices to suit a wide range of people. This includes lot sizes not currently available in Boyup Brook;
- It provides families, empty nesters, first homebuyers and others wishing to relocate to Boyup Brook with greater spaciousness and lifestyle options;
- The site is attractively located on the Blackwood River and there are a range of views which will be attractive to the market;
- It provides community benefits including, if required by the Shire, ceding land adjoining the Blackwood River free-of-cost to the Crown. Securing public land adjacent to the Blackwood River offers conservation, recreation and accessibility opportunities to the community; and
- It will provide a new standard of subdivision in Boyup Brook.

Further details relating to the site's suitability for the residential and rural residential uses are outlined in this section and summarised in Table 2.

5.3 Range of lot sizes

It is acknowledged that the Local Planning Strategy identifies the site as a Planning Area 'Residential & Rural Residential'. Accordingly, the Concept Plan propose lot sizes between 2000m^2 – 7.5 hectares. The reasons for the range of lots include:

- The requirement to provide reticulated water and address associated feasibility;
- To provide a range of lifestyle opportunities to meet anticipated market demand;
- Boyup Brook does not have many lots in the range of 2000m^2 to 1 hectare. These lots are generally favoured by the market for reasons including space for growing families, they are more manageable than lot sizes between 1 – 2 hectares and they are expected to be provided in a country town;
- It more efficiently uses land adjoining the Boyup Brook town site; and
- It follows technical investigations which reveal the need for different lot

sizes over the site to address opportunities and constraints.

5.4 Consistency with planning framework

As outlined in Section 3 of this report, the Amendment is consistent with the State, regional and local planning framework. For instance:

- The Amendment will support implementing a sustainable use of the land consistent with the objectives of the *State Planning Policy 3: Urban Growth* and the Local Planning Strategy in terms of accommodating additional residential and rural residential development near an established district centre;
- The Amendment will facilitate development that meets the vision outlined in the Local Planning Strategy. The subdivision/development will conserve local environmental assets and character whilst providing increased opportunities for new residents to experience a tree-change lifestyle;
- The site is identified as a Planning Area 'Residential & Rural Residential' in the Local Planning Strategy. The intent of the Amendment is to implement the recommendations of the Local Planning Strategy by rezoning the site to 'Special Use (SU2)' under LPS2;
- The creation of residential and rural residential lots will facilitate increased population in close proximity to existing services and facilities provided in the Boyup Brook townsite. These include retail/commercial, services and health, education and recreational facilities. The additional population will assist in supporting and increasing the provision of such services and facilities in the district; and
- Key matters such as bushfire risks, stormwater management, traffic impact and on-site sewerage disposal are addressed in the technical investigations.

From a spatial perspective, the rezoning of the site will provide a logical extension to providing additional residential and rural residential lots near the Boyup Brook townsite without causing adverse amenity impacts to the locality. **Attachment 4** shows the Context, Opportunities and Constraints Plan. The proposed Special Use (SU2) zone provides an appropriate transition use between the Boyup Brook townsite and rural residential areas and agricultural operations.

Development of the site will significantly assist to address the need for additional residential and rural residential land in Boyup Brook.

5.5 Compatibility with adjoining and nearby land uses

5.5.1 Overview

A key planning requirement is separating potentially conflicting land uses. The Amendment and supporting Concept Plan have considered the site's context, including adjoining and nearby land uses, and considered the compatibility of future subdivision/development.

The proposed residential and rural residential uses are compatible with adjoining and nearby land uses/development as outlined in **Attachment 4**. The reasons include:

- There is rural residential land to the south-west;
- It is consistent with community/public uses to the west including the cemetery and the resource recovery facility. If required, a notification on the title can be included on lots within the resource recovery facility buffer;
- Generous sized lots and an appropriate buffer are provided to the farming land to the north and north-east;
- The Local Planning Strategy recognises the existing and proposed co-existence of multiple land uses nearby including residential, rural residential, industry and agriculture;

- Proposed revegetation will be undertaken adjoining the Bode Street/Boyup Brook - Arthur Road boundary including to the resource recovery facility. This will assist in conserving local amenity.

Environmental Protection Authority Guidance Statement No. 3 provides recommendations on separation distances for industrial and sensitive land uses.

5.5.2 Resource recovery facility

The Concept Plan provides appropriate buffers between proposed future dwellings and the resource recovery facility.

The Shire's resource recovery facility is located on Reserve 15706 (No. 184 Bode Street). An appropriate separation distance will be provided between the resource recovery facility and new dwellings (sensitive uses) on the site. The EPA's Separation Distances between Industrial and Sensitive Land Uses (2005) outlines the buffer distance is determined 'case by case'. The Concept Plan shows a buffer of 200 metres with future dwellings to be appropriately setback which is achieved via rural residential lots and appropriately locating a building envelope. Planting on the site, near the resource recovery facility, will complement the native vegetation in the Unallocated Crown Land and assist to screen and lower impacts from the facility.

It is expected there will be a notification placed on the titles for lots within the resource recovery facility buffer.

5.5.3 Buffers to agricultural operations

It is recognised that there can be issues at the interface between agricultural and residential/rural residential development, including spraying, the use of machinery, or that farmers can be required to adopt different practices. While noting this, the Amendment and associated Concept Plan can minimise possible or perceived impacts of agricultural operations through appropriate buffers. This in part includes the provision of generous sized lots adjoining Bode Street/Boyup Brook – Arthur Road and to the north-east. The vegetated Bode Street/Boyup Brook – Arthur Road reserve will be complemented with proposed replanting to assist in screening and assisting to minimise potential impacts.

In order to ensure that appropriate setbacks to nearby agricultural land is undertaken, there will be generous sized lots fronting Boyup Brook - Arthur Road. Dwellings are expected to be set back to agricultural land by approximately 50 metres from the north side of Boyup Brook - Arthur Road to future dwellings.

Accordingly, future dwellings will not impact existing agricultural operations including for properties to the north of Boyup Brook – Arthur Road. This is complemented with proposed revegetation (indicatively 5m width) along with a vegetated road reserve to the north. There will also be a suitable buffer to off-site agricultural areas (grazing/cropping) through larger lots to the north-east and south-west.

It is proposed that notifications are placed on the titles which alert prospective purchasers that there are nearby farming operations.

While noting the above, farming operations also have a requirement to contain impacts on their own land and follow established best practice.

5.6 Bushfire management

A portion of the site is designated by the Fire and Emergency Services Commissioner as a 'Bushfire Prone Area' at https://maps.slip.wa.gov.au/landgate/bushfireprone/. To address *State Planning Policy 3.7 Planning in Bushfire Prone Areas* and the *Guidelines for Planning in Bushfire Prone Areas,* Smith Consulting have assessed bushfire risks and have prepared a Bushfire Management Plan (**Attachment 7**).

As outlined in **Attachment 7**, the site is overall classified as having a moderate bushfire hazard level given the site is generally cleared, has low fuel levels, is well separated from vegetated areas and has moderate slopes.

Based on the Smith Consulting assessment, the Amendment and future subdivision can meet the 'Acceptable Solutions' of each element of the bushfire mitigation measures as per the *Guidelines for Planning in Bushfire Prone Areas.* Accordingly, based on the Smith Consulting assessment, acceptable protection can be offered to future residents from bushfire hazards within acceptable limits.
To address the Guidelines, there will be:

- The provision of multiple access routes via the public road network;
- A fire service access route is proposed adjacent to the Blackwood River. The proposed fire service access route will be 6m wide;
- Provision of a reticulated water supply and fire hydrants (for lots below 1 hectare); and
- The establishment of 20m Asset Protection Zones around future dwellings. This can be readily achieved, as part of detailed subdivision design, given the site is largely cleared and fuel levels are generally low;
- Boyup Brook is serviced by fire response units located in the Boyup Brook townsite which are close to the site. It is understood they have heavy duty and fast response vehicles that could readily service the site;
- A permeable road network is proposed;
- Advising prospective purchasers of bushfire risk, their obligations and relevant publications addressing bush fire safety; and
- For lots within the bushfire prone area, building construction and protection standards pursuant to the Building Code of Australia and if required to Australian Standard 3959-2009 *Construction of Buildings in Bushfire Prone Areas*.

There will be a need to prepare a Bushfire Management Plan to support a subdivision application(s) with associated BAL-Contour mapping. Future development can achieve a BAL rating between BAL – Low to BAL 29.

Additional more detailed bushfire investigations will occur at the subdivision, development and building permit stages.

5.7 Landscape enhancement

The site and area are characterised by a mix of land uses including agricultural, rural residential, tourism and community uses. Agricultural operations are primarily cropping and grazing. There is some native vegetation on the site which includes on rocky outcrops, along the seasonal watercourses and adjoining the Blackwood River.

The site's landscape, when viewed from Bode Street/Boyup Brook-Arthur Road, forms part of the 'gateway' into Boyup Brook. The site presents as an open cropping landscape which is complemented with areas of native vegetation.

The site is partially screened from Bode Street/Boyup Brook-Arthur Road by existing vegetation.

There is a need to retain the 'rural' character of the site adjoining Bode Street/Boyup Brook - Arthur Road.

The site will assist to accommodate a sizeable component of the future growth of Boyup Brook. As such, it is not intended that development be invisible, but development will be sensitively integrated with the landscape. The landscape impact of new development will be mitigated by measures including:

- Retaining existing native vegetation where possible;

- Revegetation will enhance the amenity of the site. Revegetation will be undertaken at the subdivision stage particularly adjoining Bode Street/Boyup Brook-Arthur Road, to provide a vegetated entrance into Boyup Brook;
- It is proposed to undertake planting with a depth of 5m adjoining Bode Street/Boyup Brook-Arthur Road. While details are proposed to be addressed as a subdivision condition, it is expected there will be a mix of trees and shrubs of different heights. The proposed planting, when combined with the existing vegetation in the road reserves, will effectively filter future development when viewed from Bode Street/Boyup Brook-Arthur Road;
- The Amendment and resulting subdivision/development will have manageable landscape impacts given future lots will be spacious. There will be generous sized lots adjoining Bode Street/Boyup Brook – Arthur Road will be at least 1 hectare in area. Accordingly, there will be a sensitive interface between future development and Bode Street/Boyup Brook - Arthur Road;
- Future dwellings will have generous setbacks from Bode Street/Boyup Brook - Arthur Road of approximately 50 metres;
- LPS2 provisions will control new development including building materials and outbuildings;
- LPS2 provisions and the Residential Design Codes only permit only one house on each lot. This is considered appropriate in the context of spaciousness and minimising visual impact; and
- There are opportunities to establish restrictive covenants to control building design. This matter is further considered in section 5.13.

There is landowner support for a landscaping theme for the estate along with consideration of long term management of the vegetation.

The landowner supports planting suitable street trees along with planting near Bode Street/Boyup Brook-Arthur Road. At this early stage of the planning/design process, the preference is London Plane trees given they have lower bushfire risks than native trees. It is proposed to enhance the site through street trees in road reserves to enhance the area's amenity which is done in a way that does not impact BAL ratings. There will also be replanting on future lots.

It is considered that the above measures adequately serve to maintain the desired landscape character for the site and for Boyup Brook.

5.8 Environmental impact

5.8.1 Overview

Various technical assessments relating to environmental land management considerations were proposed to support the Amendment including:

- Local Water Management Strategy (**Attachment 5**);
- Site Soil Assessment (**Attachment 6**); and
- Targeted Black Cockatoo Habit Survey Report (**Attachment 11**).

Both **Attachments 5** and **6** include a nutrient modelling report.

Based on these assessments and the resulting design of the Concept Plan (**Attachment 8**), it is expected that the Amendment and associated subdivision/development will have negligible environmental impacts for reasons including:

- The site has been generally cleared. The remaining native vegetation can be conserved through larger lots containing important areas of native vegetation, building envelopes and carefully designing roads and locating development on cleared land and avoiding significant/Black Cockatoo habitat trees in particular;

- Most native vegetation is degraded due to past stocking. While noting this, there are opportunities for appropriate revegetation/landscaping on portions of the site including the seasonal watercourses, additional planting adjoining Bode Street and Boyup Brook-Arthur Road, in road reserves and planting undertaken by landowners;
- Key environmental assets, including water resources, can be suitably addressed through appropriate servicing, design and management;
- The site is not within a public drinking water source area;
- Groundwater is well below the natural ground level for most of the site (**Attachments 5** and **6**);
- Detailed design, at the subdivision and development stages, will address road design, lot layout and orientation, on-site stormwater management and ensure there is minimal disturbance of the topography;
- The site is not within the trigger distance area of SPP 5.4 Road and Rail Noise;
- There will be appropriate setbacks between future development areas and Bode Street/Boyup Brook – Arthur Road to further reduce noise impacts;
- Site conditions are overall appropriate for on-site sewerage disposal (refer to **Attachment 6**);
- Nutrient modelling reveals the subdivision/development will have similar or lower nutrients than existing rural activities (**Attachments 5** and **6**);
- It will be appropriately serviced including that stormwater will be effectively managed in accordance with the Local Water Management Strategy (**Attachment 7**);
- The site is not classified as a contaminated site by the Department of Water and Environmental Regulation (DWER);
- There is low acid sulphate soil risk;
- The site adjoins the Boyup Brook townsite reducing the need for motorised transport and providing opportunities for cycling; and
- It will be subject to subdivision and development conditions.

There are no significant impediments to the future subdivision and development of this site as evidenced by the supporting technical investigations. This is subject to an appropriate design response and adopting appropriate mitigation measures. Accordingly, it is suggested that subject to addressing subdivision and development conditions, future subdivision/development should result in minimal on-site or off-site environmental impacts.

5.8.2 Flora and fauna

The majority of the site has been cleared and used for cropping. Remaining native vegetation is focused in a few smaller sections of the site. It is proposed to incorporate these areas into public open space or larger lots.

A Targeted Black Cockatoo Habit Survey (**Attachment 11**) has informed the Amendment and Concept Plan.

It is proposed to limit clearing of native vegetation where possible and practical.

It is proposed to conserve all significant/Black Cockatoo habitat trees.

5.8.3 Flood risks

A small portion of the site, near the Blackwood River, is subject to flood risk (**Attachment 5**). While there is no available flood mapping, a precautionary approach has been adopted based on DWER advice.

At the subdivision stage, the detailed design will provide building envelopes. This will ensure that all lots have a suitably sized building envelope located outside of the 1 in 100 ARI floodplain. This is reflected in the provision of public open space and generous residential lots near the Blackwood River. Future buildings are required to be appropriately setback from the Blackwood River and seasonal

watercourses. There is also a need for a minimum floor level of 190.5m AHD based on DWER advice (be outside of the 190m AHD plus development to have a freeboard of 0.5m).

5.8.4 Hydrology

The site adjoins the Blackwood River. There are three seasonal watercourses on the site which drain into the Blackwood River.

The site is not located within a Public Drinking Water Source Area.

5.8.5 Road noise

State Planning Policy 5.4 Road and Rail Noise (SPP 5.4) does not apply to the site with no part within the 'trigger distance'.

5.9 On-site sewage disposal

The Concept Plan responds to the characteristics of the site (including in **Attachment 6**) and sets out a range of lot sizes and other design elements. In particular, larger lots are provided in the western section, adjoining the Blackwood River and adjoining seasonal watercourses.

South Environmental have undertaken a Site Soil Evaluation which is provided in **Attachment 6**. In summary, the assessment reveals:

- There are three soil types which are all capable to accommodate residential development;
- 13 test holes were undertaken throughout the site to a depth of 2 metres. Only 2 test holes encountered groundwater. Typically, the test holes revealed soils consisting of silty sand over deep sands or over sandy loam/sandy clay loam;
- There was no evidence of acid sulphate soils;
- The site is physically capable of residential subdivision/development. In particular, the site contains soils that are conducive for on-site sewage disposal, stormwater management and building construction; and
- South Environmental conclude that the site is physically capable of unsewered residential and rural residential subdivision/development.

5.10 Movement Networks

5.10.1 Overview

Proposed roads are required to be designed and constructed to meet Shire requirements. Detailed design will occur at the subdivision stage and will be required to address topography, drainage, erosion and other requirements. In particular, all roads and intersections will be designed and constructed in accordance with the Austroads Design Guidelines to the Shire's satisfaction.

5.10.2 Roads

The Amendment site adjoins the sealed Bode Street and Boyup Brook - Arthur Road.

There is a high level of connectivity between the Amendment site and the Boyup Brook townsite which will ensure convenient vehicular and cycling access.

The Traffic Impact Assessment prepared by Donald Veal Consultants (Attachment 12) sets out that future subdivision to create 360 lots will not introduce any significant traffic or road safety issues. Since preparation of the Traffic Impact Assessment, the Concept Plan now proposes 284 lots.

The existing road network has sufficient capacity to address the additional traffic generation from the proposed subdivision/development. The subdivision/development will have manageable impacts on local roads, including on traffic flow. Additionally, there are appropriate vehicle sight distances at the intersections.

Anticipated traffic volumes from the development will not have a detrimental impact on the role or functioning of the existing road network.

The Concept Plan proposes:

- Three subdivision roads connecting with Bode Street/Boyup Brook-Arthur Road plus connections to properties to the south and east;
- Appropriate vehicular sight distances at the intersection of proposed access roads and Bode Street/Boyup Brook – Arthur Road which will facilitate safety for road users;
- No direct vehicular access between future lots and Bode Street/Boyup Brook-Arthur Road;
- Convenient vehicular access which will meet safety and amenity objectives; and
- Road reserves will be a width of 20 metres.

The Concept Plan outlines a connected and legible system which is responsive to landform. It will spread the traffic load across a number of routes. As part of detailed design, the road alignment will seek to reflect site conditions and topography and aims to minimise road construction costs by considering drainage and earthworks. It is expected that the design will incorporate measures to create an appropriate speed environment throughout the development. This may in part include some round-a-bouts, median islands, change of road construction materials and the use of street trees.

The internal road network will be designed to meet the *Liveable Neighbourhoods* standards.

The alignment and orientation of roads will cater for stormwater management requirements as well as seeking to create where possible, lots orientated north-south or east-west to maximise solar access.

As outlined in the Traffic Impact Assessment, the intersection of Bode Street/Access Road 1 is unlikely to require auxiliary right turn lane treatment (when turning right from Bode Street into Access Road 1) as subdivision/development proceeds.

At the subdivision stage, crossovers to be suitably located and designed.

5.10.3 Walking and cycling

The site's location and attributes provide opportunities for cycling and walking.

Walking and cycling will be promoted through the provision of low-speed roads to encourage convenient and safe pedestrian and cycling movement.

It is intended to provide opportunities for informal walking/cycling within generous sized road reserves (20 metres wide) with overall low traffic volumes. There will be opportunities for looped walking/cycling circuits.

At the subdivision stage, a dual use path may be constructed by the developer along Road 1 (west of Road 2) as set out in the Traffic Impact Assessment.

A pedestrian/cyclist link is proposed, in-time, to be established between the site and the Boyup Brook townsite, via the trail to Skeleton Bridge with a connection to the site. There will also be a path near the Blackwood River adjoining the Amendment site. The link will be appropriately aligned to minimise clearing. It will be a valuable recreation resource for residents and visitors.

5.10.4 Connectivity to adjoining land

As outlined in earlier sections, the Concept Plan provides a high degree of connectivity to adjoining land. The Concept Plan proposes various road connections to the east and south. These measures provide appropriate connectivity between future development on the site and surrounding areas.

5.11 Development setbacks and building exclusion areas

Most lots will rely on Scheme setbacks.

At the subdivision stage, it is expected there will be a need to set building envelopes for rural residential lots and for

some residential lots that have site specific constraints including flood impacted land, rock outcrops or seasonal waterlogging. Additionally, wastewater exclusion areas may be required for lots to address setbacks from the Blackwood River and seasonal watercourses.

Building envelopes are generally not sought to be established unless practically justified to account for sewage disposal, visual buffering or other requirements.

In most instances building setbacks will specifically relate to the *Residential Design Codes* for the R5 code, however where the physical site characteristics dictate building envelopes will be established.

The key development considerations are shown on Attachment 4, in particular setbacks for lots near the resource recovery facility, near the Blackwood River and adjoining seasonal watercourses. These development considerations have guided the Concept Plan (**Attachment 11**).

5.12 Services

5.12.1 Overview

The Servicing Report by Peter Eastlake Consulting Engineer is outlined in **Attachment 12**.

The site is capable of being serviced by all necessary utilities required for subdivision/development. Since preparation of the Servicing Report, Water Corporation have advised there is sufficient scheme water available for growth of the Boyup Brook townsite plus subdivision/development of the Amendment site. It is understood that capacity allowances have been made to provide services to the locality. There is a need for more detailed investigations and design to ensure there is capacity of these services for the subdivision/development. The capacity of infrastructure to service future subdivision will need to be determined prior to the issue of titles.

Future subdivision will be appropriately serviced in accordance with Shire, WAPC and other government agency requirements. Future subdivision will require the extension and upgrading of essential civil infrastructure such as reticulated water and power.

Given the moderate slopes and generous lot sizes, it is expected that retaining walls on property boundaries can be avoided. There may be minor filling and retaining associated with the house and shed pads or in some instances, the land application area for on-site wastewater disposal. Houses should be suitably raised above the natural ground level.

5.12.2 Stormwater management

The site is located at the top of the catchment and it contains parts of separate smaller sub-catchments.

A Local Water Management Strategy (LWMS), see **Attachment 7**, has been prepared by South Environmental to support the Amendment and associated Concept Plan. The LWMS sets out:

- Groundwater and surface water considerations can be suitably addressed;
- Stormwater from future subdivision/development is required to be effectively managed and appropriately implemented. The details will be progressed through addressing subdivision conditions;
- The proposed lots are generous in size can accommodate stormwater drainage detention on-site;
- Future dwellings and sheds will require drainage to be contained on-site for relevant rainfall events. This is expected to occur through a combination of soakwells and rainwater tanks;
- Each lot is provided with a stormwater connection;
- It is proposed that there will be piped drainage in the road reserves which will be detained in basins; and
- To accommodate major events, the roads will be designed to safely

convey runoff from large storm events (up to 1% AEP).

The LWMS outlines that stormwater can be appropriately managed to achieve the water quality objectives outlined in *State Planning Policy 2.9 Water Resources* and associated guidelines *Better Urban Water Management*. In particular, there is a need to adopt a water sensitive design that seeks to retain, treat and use water, to minimise runoff and to promote at source infiltration.

Stormwater is required to be effectively designed, constructed and managed to the satisfaction of the Shire and DWER to meet publications such as *State Planning Policy 2.9 Water Resources*, *Better Urban Water Management* and *Stormwater Management Manual for Western Australia*. This will require a water sensitive design that seeks to detain, slow down and treat peak flows that especially addresses 'first flush' run off treatment. This includes that post development hydrology is required to be designed to be as close as possible to the pre-development hydrology.

The LWMS has informed the Concept Subdivision Plan, including proposed lot sizes.

Noting the proposed generous lot sizes, future subdivision/development will create manageable stormwater implications. There is also the opportunity to revegetate where appropriate.

Based on **Attachment 7**, it is suggested that stormwater can be effectively managed on the site. For instance, there are opportunities for infiltration on the site. Additional runoff generated by the development will be detained within the site and managed through the use of rainwater tanks, soak wells, vegetated swales and detention basins.

In addition to reticulated water supplies, onsite rainwater capture and storage is encouraged as a sustainability measure and will assist in stormwater attenuation.

A key matter for the detailed civil design stage is treating and controlling runoff from roads.

The LWMS identifies that an Urban Water Management Plan (UWMP) is required as a condition of subdivision approval. The UWMP will need to address relevant matters to support detailed design. The UWMP:

- Is required to ensure that peak discharge from the subdivision/development does not exceed the pre-development levels;
- Will outline management arrangements to improve water quality leaving the site, as a result of the proposed development and the associated drainage strategy, compared to the current situation;
- Address the extent of localised flooding on the site and ensure that no development is located in flood impacted areas;
- Give appropriate consideration for 'wet' sections of the site and their future use and management and should development be proposed in these areas, this will need to appropriately address land capability and suitability, provide engineering designs/certification;
- Give careful consideration to the retention and future management of existing dams and unless required as part of an approved drainage system for on-site detention;
- Ensure that any dams not required for drainage purposes should be privately owned and managed with responsibilities known to all stakeholders 'up-front'; and
- Ensure that any new dams, relocating existing dams and generally altering watercourses will be determined in close association with DWER.

5.12.3 On-site sewage disposal

The *Government Sewerage Policy* outlines the general requirement to connect new subdivision and/or development to, or provide for, reticulated sewerage in accordance with the provisions of 5.1.1.

Where provisions 5.1.1 do not apply, such as future subdivision and development proposed on this site, on-site sewage disposal may be considered where the responsible authority is satisfied that:

- Each lot is capable of accommodate on-site sewage disposal without endangering public health or the environment; and
- The minimum site requirements for on-site sewage disposal are met.

The site is remote from the reticulated sewerage network.

Reticulated sewerage is not available in the Shire of Boyup Brook, feasible or necessary. Instead, future subdivision/development will be serviced by on-site sewerage disposal. As reflected in the *Local Planning Strategy,* connection to reticulated sewerage will not be required.

Given the proposed generous lot sizes, future subdivision/development will be serviced by on-site sewage disposal to comply with the *Government Sewerage Policy*.

Attachment 6 sets out the Site Soil Evaluation, from South Environmental, which addresses the *Government Sewerage Policy* for this stage of the planning process. Other than the more constrained western section, the assessment demonstrates that the proposed residential and rural-residential uses and anticipated lot sizes are capable of accommodating on-site sewage disposal.

South Environmental note that:

- The site is considered to be suitable for receiving wastewater for onsite disposal using conventional wastewater systems for most of the property;
- Future lots will be generous in area which will provide space to accommodate and treat on-site sewage disposal (land application area). In more constrained areas, lot sizes will be above 1 hectare and will require secondary treatment systems;
- The site is not within a Public Drinking Water Source Area and is not classified as sewage sensitive;
- The minimum lot size for residential development is one dwelling per 2,000m^2;
- There are three seasonal watercourses which traverse the site. On-site sewage disposal systems within 100m of the seasonal watercourses are required to be secondary treatment systems;
- Site conditions have appropriate capability for residential and rural residential subdivision/development; and
- There will be a further need to address on-site sewage and gain relevant approvals at the subdivision, development and building permit stages.

There may be a need to provide modest fill to accommodate a land application area for a small portion of the site. This is in order to ensure suitable clearances between the natural ground level and late winter ground water levels to accommodate on-site sewage disposal.

The Concept Plan has been informed by the Site and Soil Evaluation through generous lots sizes and appropriate setbacks from the Blackwood River and seasonal watercourses.

5.12.4 Water supply

Rural residential lots will be serviced with rainwater tanks that are a minimum of 92,000 litres.

Proposed lots below 1 hectare are required to be connected to the reticulated (scheme) water system based on WAPC requirements.

Water Corporation has confirmed there is sufficient reticulated water supply network to serve the Boyup Brook townsite. There is a need to extend the network and also construct a high-level water tank to

maintain minimum water pressure requirements.

Water Corporation's advice confirms there is sufficient capacity to service the proposed subdivision/development on the Amendment site. It is expected there will be a need to create an elevated tank on the site.

At the subdivision stage, the developer's consulting engineer will again approach Water Corporation for information about system capacity and constraints and will conduct engineering investigations to determine the viability of water servicing, from both an engineering and cost perspective. The developer's consulting engineer is required to determine if the system pressure and tank elevation is sufficient to supply the proposed subdivision/development. Proposed lots are required to have sufficient pressure to meet Water Corporation's licence conditions and it's Customer Charter.

The subdivision will also be serviced by fire hydrants.

In addition to reticulated water, there are opportunities for additional water supply provision such as landowner's installing rainwater tanks which have sustainability and stormwater management benefits.

5.12.5 Power supply and telecommunications

All proposed lots will be serviced with underground power and required telecommunication infrastructure.
Subject to State Government policy and project feasibility, there may be scope for 'green' energy provision and/or battery storage. Alternatively, it is expected that the electrical network will be extended and designed to service future lots. The subdivision will be serviced with underground power. Transformer(s) will be suitably located and will distribute power to the lots by means of low voltage cabling and pillar units (green domes).

It should be noted that due to the dynamic nature of Western Power's network, infrastructure requirements and connection points referred to in the Engineering Servicing Report may differ when applications are placed in the future.

It would be preferable that there is no street lighting but instead to promote 'dark sky' principles.

Based on **Attachment 10**, it is expected NBN will be provided by fixed wireless.

5.12.6 Gas

Reticulated gas is not available in this locality. If required, it will be provided by bottled gas.

5.13 Restrictive covenants

Restrictive covenants will be required to limit direct vehicular access between lots and Bode Street/Boyup Brook – Arthur Road.

It is expected that the developer will establish restrictive covenants prior to the issue of titles. The restrictive covenants will assist to promote suitable building design to maintain the area's amenity.

5.14 Land supply

There is a shortage of available and serviced residential and rural residential lots in Boyup Brook.

The planning framework supports the on-going growth of Boyup Brook as a district centre. The site forms part of Boyup Brook's 'development footprint' as established by the planning framework including the Local Planning Strategy which identifies the site in a Planning Area of 'Residential & Rural Residential'.

The Local Planning Strategy sets out a need to provide additional residential and rural residential land in Boyup Brook. The Amendment site will provide an important supply of lots in Boyup Brook. The site provides an opportunity for a wide range of lot sizes and housing choices.

5.15 Foreshore reserve and public open space

A foreshore reserve of approximately 5.2 hectares is outlined on the Concept Plan. Additionally, a centrally located area of public open space/community purpose site of approximately 2 hectares is provided.

The foreshore will have recreation 'nodes' along with a continuous reserve adjoining the Blackwood River for the site's entire frontage.

The proposed Scheme provisions set out the need for appropriate management of the foreshore. A Foreshore Management Plan will be required (preparation and implementation) as a subdivision condition. The foreshore reserve will be ceded free of cost by the subdivider.

The subdivider will be responsible for defining, likely through suitable fencing (that does not impede flood waters) the boundary between freehold lots and the foreshore reserve. The Concept Plan shows indicative walk/cycle on the foreshore.

There is a need to work through matters including weed control, revegetation and restricting vehicular access to the foreshore (other than a Fire Service Access Route and to designated public carparks).

Most proposed lots are within 400 metres of future POS (centrally located or on the foreshore). A range of recreational facilities are nearby in Boyup Brook.

It is noted the generous lot sizes (minimum lot size of 2000m^2 to 2 hectares) also provide opportunities for on-site recreation.

There will be cycling paths linking the site to the Boyup Brook townsite via Ritson Street and along the former railway line.

The Concept Plan provides for convenient cyclist and pedestrian links throughout the site. It is intended to provide opportunities for informal walking/cycling within generous sized road reserves (20 metres wide) with overall low traffic volumes. There will be opportunities for looped walking/cycling circuits.

5.16 Staging

A staged development will occur. The first stage is expected to be the northern section given this reduces upfront servicing costs due to proximity to services. The staging will be dependant on a number of factors including pre-sales/demand, feasibility, detailed servicing considerations and ensuring there is two-way vehicular access to address *State Planning Policy 3.7 Planning in Bushfire Prone Areas.*

5.17 Supporting the local economy and community

Approval and implementation of the Amendment will have various economic and community benefits including:

- Supporting local employment through the construction of subdivision works and new dwellings;
- Supporting existing or additional local services and community infrastructure;
- Assisting in a more sustainable local economy;
- Increasing population in Boyup Brook which assists in its overall viability, vitality and prosperity;
- Building onto an existing community with established facilities, services and infrastructure and assist to strengthen and sustain Boyup Brook;
- Providing a greater choice for those wishing to buy lots in Boyup Brook in an attractive locality close to the townsite; and
- Broadening the Shire's economic base to assist with increasing local resilience.

The Amendment is consistent with the planning framework which promotes employment and economic growth in Boyup Brook.

5.18 Planning justification

The planning justification for the Amendment is summarised in Table 2. Given the below, the Amendment and associated Concept Plan are considered consistent with the planning framework and the principles of orderly and proper planning.

Table 2 – Summarised Planning Justification

Strategic	Land Use Planning	Environment and Landscape	Transport and Servicing	Economic and Community
The Amendment is consistent with the planning framework. The site adjoins the Boyup Brook townsite which will reinforce Boyup Brook as a district centre. The site is well located for residential and rural residential uses including it is compatible with adjoining and nearby uses. The proposed Special Use zone, between the townsite and rural uses, represents orderly and proper planning. It assists to meet the demand for residential and rural residential development in Boyup Brook in a planned, orderly and sustainable manner. It will provide opportunities for a significant supply of land offering a range of lifestyle choices close to the Boyup Brook townsite. The proposal will provide a new form of lot sizes and lifestyle opportunities in Boyup Brook.	The site is suitable and capable of residential and rural residential uses. Development will be effectively controlled through LPS2 provisions. The Concept Plan provides a co-ordinated approach to future subdivision/ development. The site is well located for the proposed land uses. There are appropriate buffers and mitigation measures to the resource recovery facility and to farming operations. Aboriginal heritage constraints are acknowledged and will be reviewed in greater detail at the structure plan stage.	The majority of the site has been previously cleared. Remaining environmental assets, in particular native vegetation, can be appropriately conserved and there are opportunities for environmental repair/replanting. Subject to suitably addressing stormwater management, future development is unlikely to create any adverse environmental impacts. Bushfire management measures will comply with the objectives of SPP 3.7 and the *Guidelines for Planning in Bushfire Prone Areas*. The site is not located in a public drinking water source area. There are manageable landscape impacts when viewed from Bode Street/ Boyup Brook-Arthur Road and opportunities to enhance the site's appearance including through replanting.	The site has excellent road connectivity and easy access to Boyup Brook and other areas. Traffic impacts can be readily accommodated on Bode Street/Boyup Brook - Arthur Road. Safe vehicular access can be achieved between the site and Bode Street/Boyup Brook - Arthur Road. There is no direct access between lots and Bode Street/Boyup Brook - Arthur Road. The Concept Plan facilitates opportunities for cycling and walking. The subdivision/ development will be appropriately serviced. On-site sewage disposal and stormwater management can be appropriately located and designed to the satisfaction of the WAPC, Shire and relevant agencies. The site is suitable and capable for the intended use including achieving realistic building, effluent disposal and stormwater outcomes.	It will promote job creation by supporting the development of Boyup Brook and assist to diversify and grow the local economy. This includes adding to its overall viability, vitality and prosperity and adding to the range of services that can be provided. Approval and implementation of the application will assist to increase population in Boyup Brook and in-turn support economic activity and support local services. The site is close to the Boyup Brook townsite and will complement Boyup Brook and supporting businesses, facilities and services.

6. CONCLUSION

This report confirms that the Amendment is consistent with the planning framework and that the site is both suitable and capable of accommodating residential and rural residential subdivision/development.

The Amendment will facilitate the development of the site into generous sized lots that will complement the Boyup Brook townsite. The preceding sections have examined various planning principles, statutory and policy considerations, environmental and servicing matters regarding the proposed rezoning.

The Amendment will establish the appropriate zoning for the site and future subdivision/development will be guided by the Concept Plan and a required Local Structure Plan. Existing and proposed LPS2 provisions will ensure that subdivision and development will be effectively controlled.

The support of the WAPC and the Hon. Minister for Planning is requested to approve the Amendment to rezone the site from 'Rural' to 'Special Use (SU2)'.



Photo 4: central location

PLANNING AND DEVELOPMENT ACT 2005

SHIRE OF BOYUP BROOK

LOCAL PLANNING SCHEME No. 2

AMENDMENT No. 24

The Shire of Boyup Brook under and by virtue of the powers conferred upon it in that behalf by the *Planning and Development Act 2005* hereby amends the above Local Planning Scheme by:

1. Rezoning Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook from the 'Rural' zone to the 'Special Use (SU2)' zone.

2. Inserting provisions in Table 5 - Special Use Zones in Scheme Area:

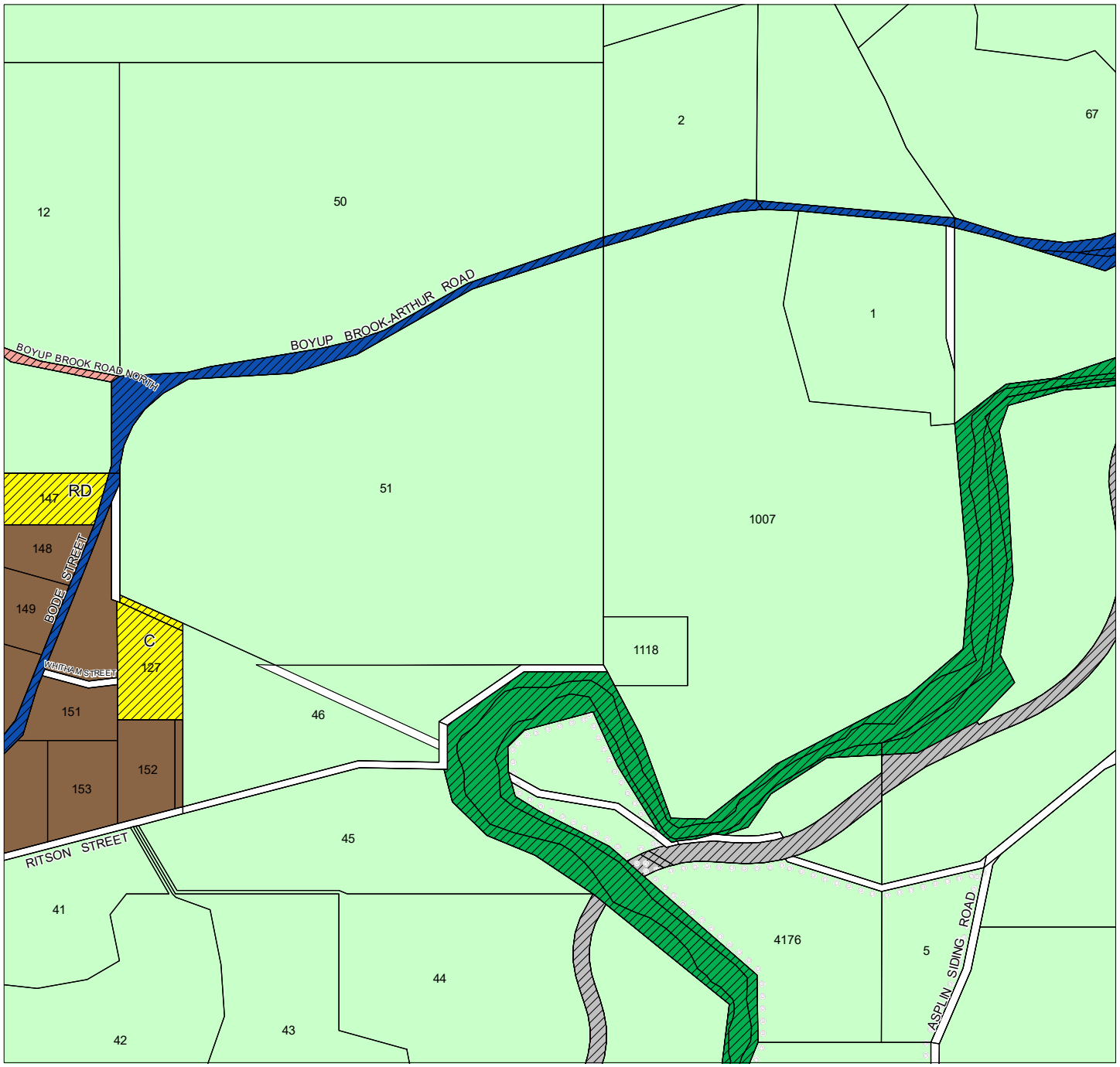
No.	Description of land	Special use	Conditions
SU2	Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook	A future residential estate, contemplating both residential R5 and rural residential zones, where the mix of lots is to be addressed via a structure plan. Permissibility: Uses permitted within the areas designated as 'Residential' are as per the Zoning Table. Uses permitted within the areas designated as 'Rural Residential' are: Ancillary Dwelling 'P' Art Gallery 'D' Community Purpose 'D' Family Day Care 'A' Home Business 'D' Home Occupation 'P' Home Office 'P' Home Store 'D' Hosted short-term rental accommodation 'P' Industry – Cottage 'D' Recreation – Private 'A' Repurposed Dwelling 'D' Residential Building 'A' Rural Home Business 'A' Rural pursuit/hobby farm 'P' Second Hand Dwelling 'D' Single House 'P' Telecommunications Infrastructure 'D' Unhosted short-term rental accommodation 'D' All other uses are 'X' (prohibited).	**General application** 1. The conditions in this schedule apply to SU2 in addition to all other relevant provisions in the Scheme. 2. If there is a conflict between any other provision in the Scheme, this Schedule prevails. **Structure Plan** 3. Prior to subdivision and development, a structure plan is to be prepared and endorsed by the WAPC. 4. Proposed future zones and reserves in the structure plan are to accord with the zones and reserves of the Scheme. 5. In addition to the matters required in clause 16 of the deemed provisions, the structure plan is to address the below: i. Arrangements for licensed electricity supply; ii. Provision of a licensed water supply for lots designated for residential purposes with a minimum lot size of 2000m²; or iii. If a licensed water supply is not to be provided, lots are to be designated as rural residential with a minimum lot size of 1 hectare; iv. Site and soil evaluation to determine: (a) Areas where depth to groundwater is less than 0.5m which are to contain lots with a 1 hectare minimum lot size; and (b) Land application area locations not subject to inundation; v. Water management and protection as per a Local Water Management Strategy report including nutrient balance modelling and mitigation; vi. Foreshore management, including: (a) Identification of flood prone areas; (b) Allocation, management and design of river and seasonal creek foreshore reserves and areas of public open space; (c) Proposed arrangements for weed control, revegetation, fencing, pedestrian access and restrictions on vehicular access; vii. Protection of endangered black cockatoo habitat trees and suitable significant trees to the satisfaction of the local government and responsible agencies; viii. Bushfire risk criteria including access and egress for various subdivision stages; ix. Traffic Impact Assessment, including potential upgrades to existing roads and intersections servicing the proposed estate;

No.	Description of land	Special use	Conditions
			x. A movement network that provides suitable transport options for vehicle, bicycles and pedestrians. xi. Aboriginal Cultural Heritage survey and management plan to identify and protect Noongar Cultural Heritage Values. **Subdivision** 6. Future subdivision shall generally be in accordance with a structure plan endorsed by the WAPC. 7. Protection of Aboriginal Cultural Heritage values based on a survey and management plan. 8. Based on a Foreshore Management Plan, the WAPC may impose conditions relating to revegetation and management of seasonal creeks. 9. The WAPC may impose conditions relating to: i. Revegetation and landscape planning addressing buffer strip planting adjoining Boyup Brook – Arthur Road/Bode Street and surrounding rural use land; ii. Ongoing separation of lots to remaining rural use land within the structure plan area to be staged as applicable; iii. Restrictive covenants for prevention of direct vehicular access between lots and Boyup Brook – Arthur Road/Bode Street; iv. Notifications on Title relating to: (a) Nuisance impact to residential amenity from adjacent rural operations; or (b) The Shire's resource recovery centre. *Note: Structure plan areas are to be zoned progressively, as land is subdivided, and when opportunities arise for scheme amendments.*

3. Amending the Scheme Map accordingly.

Determines Amendment No. 24 is a standard amendment under the provisions of the Planning and Development (Local Planning Schemes) Regulations 2015 for the following reasons:

- An amendment relating to a zone that is consistent with the objectives in the scheme for that zone;
- The amendment is consistent with the Local Planning Strategy;
- The amendment would have minimal impact on land in the scheme area that is not the subject of the amendment; and
- The amendment does not result in any significant environmental, social, economic or governance impacts on land in the scheme area.



EXISTING SCHEME MAP

Legend

- Cadastre with Lot number

LPS Zones

- Rural
- Rural residential

LPS Reserves

- Local distributor road
- Local road
- Public open space
- Public purposes
- *C* Public purposes : Cemetery
- *RD* Public purposes : Rubbish disposal
- Railways
- Regional distributor road

LPS Other Categories

- Structure plan area

GOVERNMENT OF WESTERN AUSTRALIA

Department of **Planning, Lands and Heritage**

Produced by Geospatial Research and Modelling, Department of Planning, Lands and Heritage, Perth WA
Base Information supplied by Western Australian Land Information Authority SLIP 1096-2018-1

Shire of Boyup Brook

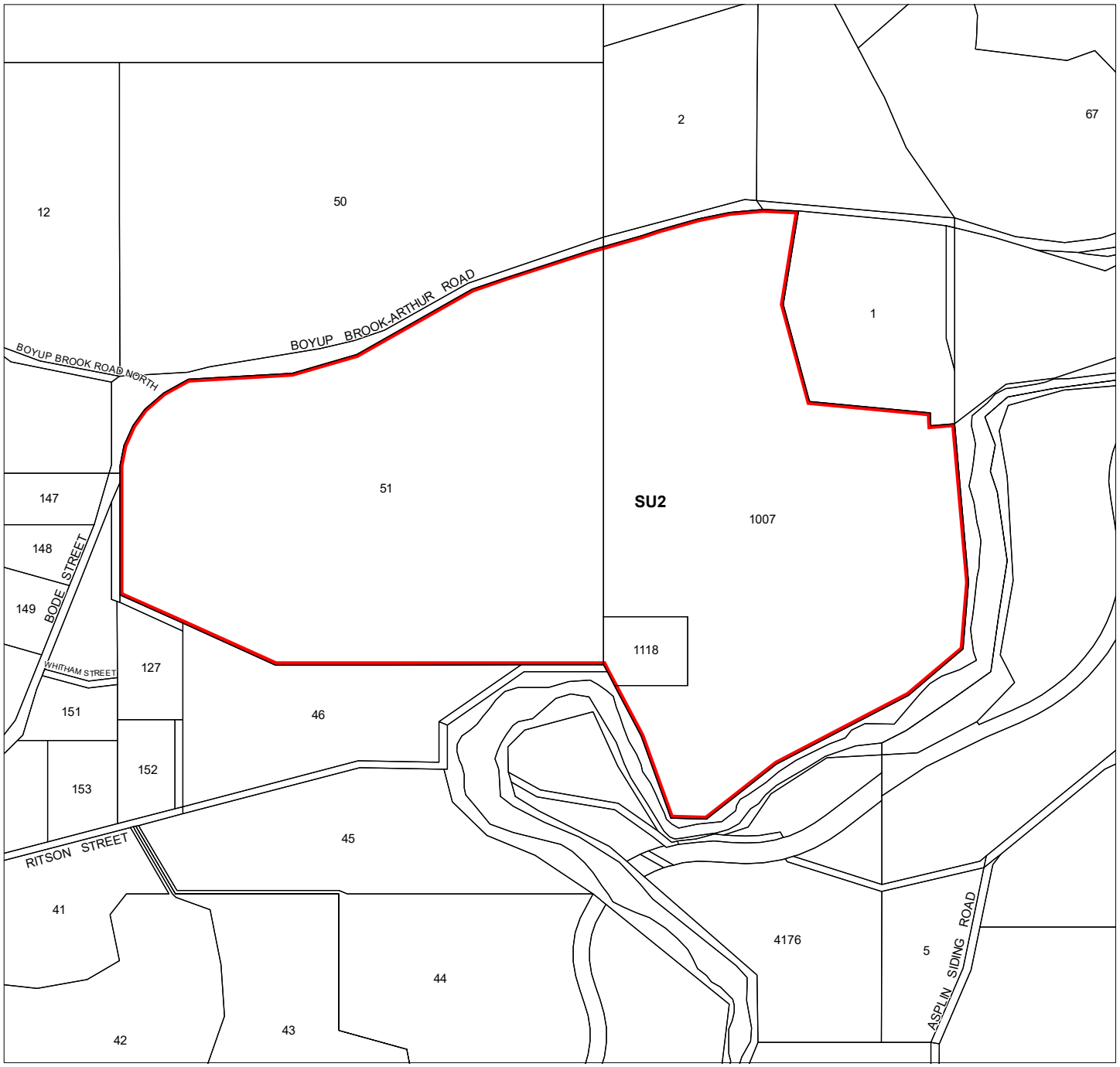
Town Planning Scheme No. 2

Amendment No. 24

N

0 150 300 450 600

metres



PROPOSED SCHEME AMENDMENT MAP

Legend

Cadastre with Lot number

LPS Zones and Reserves Amendments

Special use

Department of **Planning, Lands and Heritage**

GOVERNMENT OF WESTERN AUSTRALIA

Produced by Geospatial Research and Modelling, Department of Planning, Lands and Heritage, Perth WA
Base Information supplied by Western Australian Land Information Authority SLIP 1096-2018-1

Shire of Boyup Brook

Town Planning Scheme No. 2

Amendment No. 24

N

0 150 300 450 600

metres

COUNCIL ADOPTION FOR ADVERTISING

This Standard Amendment was adopted by resolution of the Council of the Shire of Boyup Brook at the …… Meeting of the Council held on the ..... day of ..... 20…..

.....
SHIRE PRESIDENT

.....
CHIEF EXECUTIVE OFFICER

COUNCIL RECOMMENDED/SUBMITTED FOR APPROVAL

This Amendment is recommended for approval by resolution of the Shire of Boyup Brook at the Ordinary Meeting of the Council held on the ……... day of ……..…… 20..… and the Common Seal of the Shire of Boyup Brook was hereunto affixed by the authority of a resolution of the Council in the presence of:

.....
SHIRE PRESIDENT

.....
CHIEF EXECUTIVE OFFICER

WAPC RECOMMENDED/SUBMITTED FOR APPROVAL

.....
DELEGATED UNDER S.16 OF THE
PLANNING AND DEVELOPMENT ACT 2005

DATE…….....

APPROVAL GRANTED

.....
MINISTER FOR PLANNING
S.87 OF THE PLANNING AND DEVELOPMENT ACT 2005

DATE…….....

ATTACHMENT 1

WESTERN AUSTRALIA

REGISTER NUMBER	
51/DP62150	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
1	18/9/2009

VOLUME 2727 FOLIO 332

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 51 ON DEPOSITED PLAN 62150

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LEAFIELD PTY LTD OF POST OFFICE BOX 799, FREMANTLE

(AF L067594) REGISTERED 8/9/2009

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

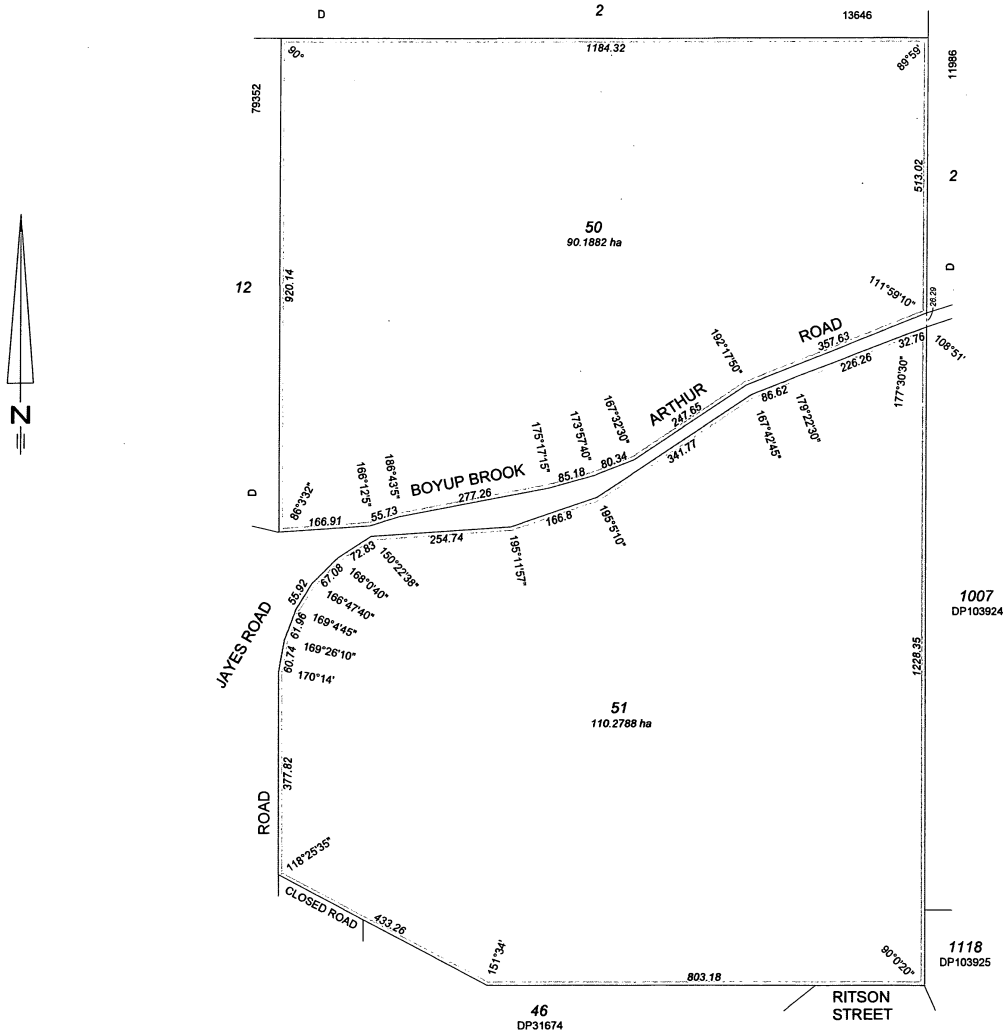
The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	DP62150
PREVIOUS TITLE:	68-144A
PROPERTY STREET ADDRESS:	54 BOYUP BROOK-ARTHUR RD, BOYUP BROOK.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF BOYUP BROOK

LANDGATE COPY OF ORIGINAL NOT TO SCALE 17/11/2022 07:35 AM Request number: 64384170

Landgate
www.landgate.wa.gov.au

VERSION	AMENDMENT	AUTHORISED BY	DATE



N

COMPILED FROM DP's 103924 , 103925 , 124044 , 130070 ,144392 , 207577, 215402 , 252763 , & D's 11986 , 13646 & 79352

KEVIN MOIR
LICENSED SURVEYOR
BOX 8 , WILGA , W.A. 6243 .
PH - 97661046
FAX - 97661076

TYPE FREEHOLD
PURPOSE SUBDIVISION

PLAN OF

LOTS 50 AND 51

SSA YES / NO

DISTRICT NELSON
TOWNSITE
FILE
LOCAL AUTHORITY SHIRE OF BOYUP BROOK
LOCALITY BOYUP BROOK

FORMER TENURE: LOT 441 ON DP252763 C/T 68 - 144A
ON INDEX: BH29 (10) 1.4

SCALE: 1 : 6000 at A2
ALL DISTANCE ARE IN METRES
0 100 200

FIELD BOOK: COMPILED

SURVEYOR'S CERTIFICATE - Reg 54
I ..... hereby certify that this plan is accurate and is a correct representation of the -
(a) * survey; and / or
(b) * calculations from measurements .
(* delete if inapplicable)
undertaken for the purposes of this plan and that it complies with the relevant written law(s) in relation to which it is lodged.

Licensed Surveyor ..... Date .....

SURVEYOR'S CERTIFICATE - Compiled
I K. J. MOIR
hereby certify that this compiled plan
(a) is a correct and accurate representation of the survey(s) of subject land ; and
(b) is in accordance with the relevant law in relation to which it is lodged

✓ K J Moir
Licensed Surveyor ..... Date .....

APPROVED BY
WESTERN AUSTRALIAN PLANNING COMMISSION
FILE 131324
DELEGATED UNDER S.16 OF THE P & D ACT 2005
DATE 9/7/2009

LODGED
DATE 29-Jun-09
FEE PAID $305.00
ASSESS No. 5442266

TYPE OF VALIDATION
FULL AUDIT
LEGAL COMPONENT G.G.M.
DOCKET 1170-2005/19
CERTIFIED CORRECT George Method 7 July 2009
LS.C.
P.S.C.

IN ORDER FOR DEALINGS
SUBJECT TO

FOR INSPECTOR OF PLANS & SURVEYS AUTHORIZED LAND OFFICER
DATE 14.7.2009

APPROVED
Approved 8.9.2009
INSPECTOR OF PLANS & SURVEYS AUTHORIZED LAND OFFICER
DATE

Landgate
Western Australian Land Information Authority

DEPOSITED PLAN
62150
ORIGINAL
SHEET 1 OF 1
VERSION 1

DP 62150

LANDGATE COPY OF ORIGINAL NOT TO SCALE 17/11/2022 07:35 AM Request number: 64384170
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WESTERN AUSTRALIA

REGISTER NUMBER	
1007/DP103924	
DUPLICATE EDITION **5**	DATE DUPLICATE ISSUED **18/9/2009**

VOLUME **2618** FOLIO **816**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 1007 ON DEPOSITED PLAN 103924

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LEAFIELD PTY LTD OF POST OFFICE BOX 799, FREMANTLE

(AN L067593) REGISTERED 8/9/2009

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

1. THE LAND THE SUBJECT OF THIS CERTIFICATE OF TITLE EXCLUDES ALL PORTIONS O F THE LOT DESCRIBED ABOVE EXCEPT THAT PORTIN SHOWN IN THE SKETCH OF THE SUPERCEDED PAPER VERSION OF TITLE 1075-905

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1075-905 (1007/DP103924)
PREVIOUS TITLE:	1075-905
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF BOYUP BROOK

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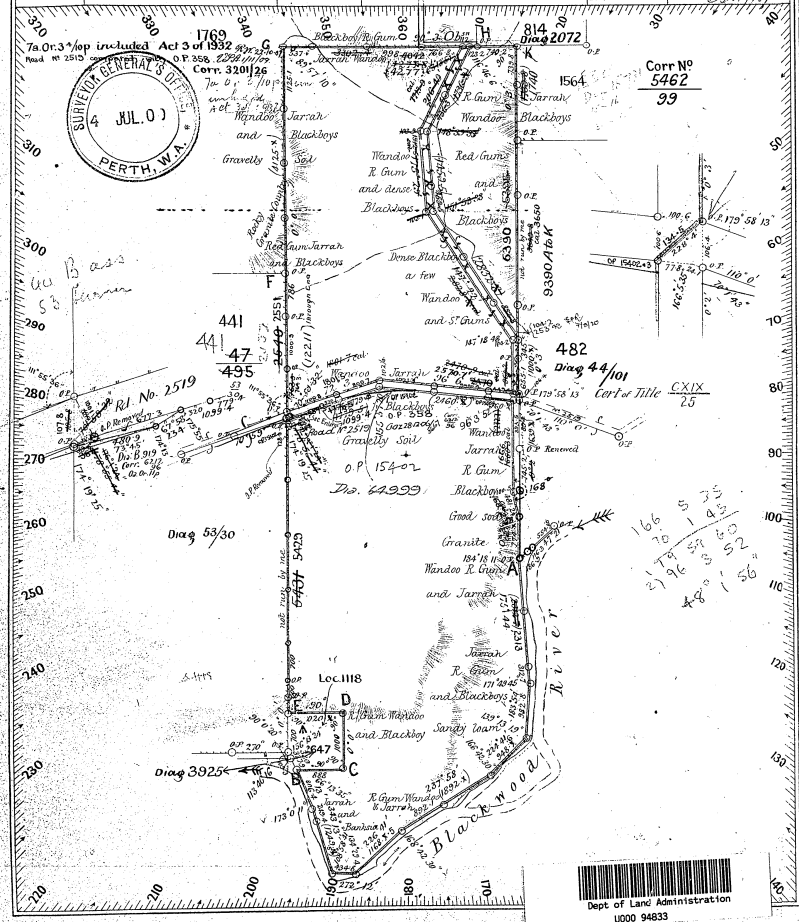
c/t 1075/904

Locn No	District or Town	C.P. No	Name of Lessee or Grantee	Acreage	Original Plan No
1007	Nelson	~~170~~ 69	George F Dickson	~~588·0·3 ac~~ 501 (Ex Roads)	102 a 142



Calculations for Area of Locn 1007

216. 2 05

No & Page of Field Book	True Bearing	Distance	N.	S.	E.	W.	Multipliers	Double Areas
144 9	0 0'	1221·1	1221·1				0·0	1221·1
10	90 3	4277·8		5·7	4277·8		4277·0	5·7
12	180 3	6389·7		6389·7		5·6	8548·4	1389·7 — 54·6 — 21711
12.13	180 2	3000·9		3000·9		1·7	8541·1	3000·9 — 25·6 — 30987
5	175 44	2312·7		2306·3	172·1		2211·5	2306·3 — 20·0 — 91332
5	183 54	982·8		980·5		66·8	8816·8	980·5 — 8·6 — 44872
6	224 41	948·7		674·5		667·1	8052·8	674·5 — 5·4 — 51849
	237 58	1892·1		1003·6		1604·0	5811·3	1003·6 — 5·8 — 32221
	226 41	1168·7		801·8		850·3	3356·5	801·8 — 2·6 — 91242
7	272 12	434·8	16·7			434·4	2071·4	16·7 — 34592
	34·3 13	1249·4	1196·2			360·8	1276·4	1196·2 — 15 — 26351
	336 13	806·4	737·9			325·2	590·0	737·9 — 4 — 3361
11	90 0	888·0			888·0		1152·8	0·0
	0 0	1000·0	1000·0				3040·8	1000·0 — 20 — 100800
13	270 0	1020·2				1020·2	1020·2	0·0
								1220 — 40 — 37104 — 80039
Total area excluding roads 581·32 ac								40 — 37104 — 1189 — 42935
Portion joining river.								594 — 21467
Close H+2·7 E+0·4					Portion NE corner.			Roads — 13 — 2931
Angles -0°8'23"					Close N-1 E-1			581 — 42157
Portion NW corner.					Angles 0°0'23"			
Close K-2·5 E+1·2								
Angles -0°0'53"								

Survey Approved as adjusted
Harry F Johnston Surveyor General
Date 6.8.1901

REFERENCE TO TREES FROM CORNERS

Corner	Bearing	Dist in Links	No & Mark on Tree	Descn of Tree	Corner	Bearing	Dist in Links	No & Mark on Tree	Descn of Tree
A	62° 20'	79·6	T N1919 1007	R. Gum	F	338° 8'	8·1	∧ 47 495	Jarrah
B	217° 21'	14·5	N 2647 1007	"	G	328° 18'	67·8	∧ 1007	"
C	158° 34'	80·2	" "	Jarrah	H	140° 4'	15·5	∧ 814	R. Gum
D	262° 15'	54·8	" "	Wandoo	J				
E	63° 35'	11·6	" "	Jarrah	K				

Azimuth observed at A and H
or assumed from
Date of Survey 13-20 June 1900
Field Book No 44 Pages 5-14
Scale 16 Chains to an Inch

I hereby certify that I personally performed the Survey represented on this diagram which to the best of my belief is accurate, and the work has been executed in accordance with the Regulations for the guidance of Surveyors.

A.G. Lewis Licensed Surveyor
Date 29 June 1900

Account passed
Calculation Bk No 1 Folio 11
Compared with F.B. 3.12.00 J.H.B.
Examined R.A.C. Maitland 7.12.00
Diagram passed S. E. Smith Acting S. of Plans 11/8/01

On Standard 123 of 1901
415 50 Plan No 1 2415 Diagram
If Plan 25 01 25-12-01
Registered 10 E 246 5/1/05
No 3924

ble Areas.

Class of holding	Name of Grantee or Lessee	No	Acreage	District or County	Original Plan No	Diagram No
Loc. ~~C.P.~~	G.F. Dickson	~~47~~ ~~495~~ 441	500 ex Road 2519	Nelson	102	53/30

352/91

Dev^n of Road No 2519 compared with OP 358 [illegible] 11/11/09

1769

1872

1007

C

D

A

B

Undulating downs

Dia. 65000'

Road No 2519 Gaz 28.12.06/967 Con 6212/96

250 59½

Road No 2519 Gaz 6212/96

OP 358

Grazing & agr^l land

Wandoo, Jarrah, gums & blkboy.

Rd Closed 4749

Loc. 4174

Loc 7921

Loc. 1118

Loc. 4175

PROPOSED

233

3992

5887

(7756)

(8786)

180°

90° 0'

90° 59'

0° 0'

Ses Diag 3924

Compared with F.B.

Area 501.0.13.

Del L. Parnell 5.5.95

REFERENCE TO CORNERS										
Corner	Bearing	Dist. in Links	No & Mark on Tree	Descn of Tree	Corner	Bearing	Dist. in Links	No & Mark on Tree	Descn of Tree
A	329°56	70.5	47/495	B.gm	H				
B	349°5	34½	—"—	—"—	I				
C	135°33	35.7	—"—	Jarrah	J				
D	335°0'	8	—"—	—"—	K				
E					L				
F					M				
G					N				

Azimuth Observed from 233

Date of Survey Aug 1892

Field Book No 45 Page 5

Scale 20 Chains to an Inch

G.R. Lummis

Surveyor. 31.10.92

Examined & Passed 4/2/95 William Rowley Inspecting Surveyor.

On Standard Plan S.23 Cdh 22-4-95

Registered W.I.C.

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WESTERN AUSTRALIA

REGISTER NUMBER	
1118/DP103925	
DUPLICATE EDITION **2**	DATE DUPLICATE ISSUED **18/9/2009**

VOLUME **1194** FOLIO **20**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

The person described in the first schedule is the registered proprietor of an estate in fee simple in the land described below subject to the reservations, conditions and depth limit contained in the original grant (if a grant issued) and to the limitations, interests, encumbrances and notifications shown in the second schedule.

BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 1118 ON DEPOSITED PLAN 103925

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

LEAFIELD PTY LTD OF POST OFFICE BOX 799, FREMANTLE

(AN L067593) REGISTERED 8/9/2009

LIMITATIONS, INTERESTS, ENCUMBRANCES AND NOTIFICATIONS:
(SECOND SCHEDULE)

Warning: A current search of the sketch of the land should be obtained where detail of position, dimensions or area of the lot is required.
* Any entries preceded by an asterisk may not appear on the current edition of the duplicate certificate of title.
Lot as described in the land description may be a lot or location.

----------END OF CERTIFICATE OF TITLE----------

STATEMENTS:

The statements set out below are not intended to be nor should they be relied on as substitutes for inspection of the land and the relevant documents or for local government, legal, surveying or other professional advice.

SKETCH OF LAND:	1194-20 (1118/DP103925)
PREVIOUS TITLE:	238-8
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF BOYUP BROOK

NOTE 1: A000001A LAND PARCEL IDENTIFIER OF NELSON LOCATION 1118 (OR THE PART THEREOF) ON SUPERSEDED PAPER CERTIFICATE OF TITLE CHANGED TO LOT 1118 ON DEPOSITED PLAN 103925 ON 02-MAY-02 TO ENABLE ISSUE OF A DIGITAL CERTIFICATE OF TITLE.

NOTE 2: THE ABOVE NOTE MAY NOT BE SHOWN ON THE SUPERSEDED PAPER CERTIFICATE OF TITLE OR ON THE CURRENT EDITION OF DUPLICATE CERTIFICATE OF TITLE.

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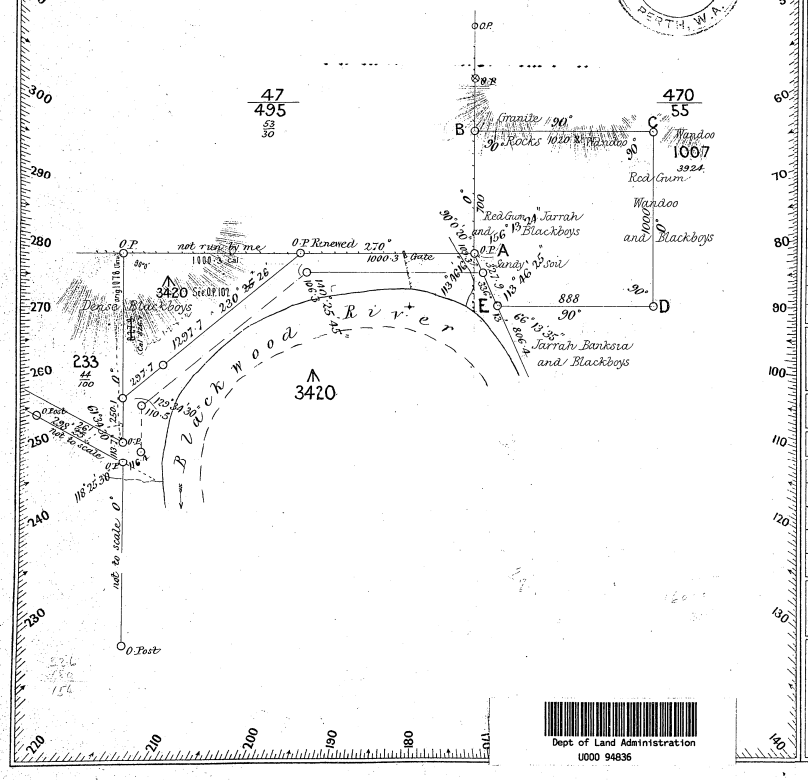
www.landgate.wa.gov.au

~~Res.~~ Locⁿ Nº	District or Town	C.P. Nº	Name of Lessee or Grantee	Acreage	Original Plan Nº
Loc 1118 A ~~2647~~ (School)	Nelson		Church of England School Site	10	102

Gaz. 9. 11. 94

Corr Nº 2545/94

SURVEYOR GENERAL'S OFFICE 4 JUL 00 PERTH, W.A.



Dept of Land Administration U000 94836

Calculations for Area of A 2647

Nº & Page of Field Book	True Bearing	Distance	N.	S.	E.	W.	Multipliers		Double Areas	
44 13	0 0	700	700					700		
"	90 0	1020·2			1020·2		1020·2			
14	180 0	1000·		1000			2040·4	1000	20	4004
"	270 0	888				888	1152·4			
"	336 11	327·9	300·1			132·2	132·2	300·1	39673	
									20	4004
										39673
									20	00727
									10	00363

Area 10.0.0 a r p
Close N 0·0 x E 1·0·2 Links
Angles + 0·9"

Survey approved as adjusted ✓
Harry F Johnston Surveyor General
Date 21. 9. 1900

REFERENCE TO TREES FROM CORNERS

Corner	Bearing	Dist in Links	Nº & Mark on Tree	Descⁿ of Tree	Corner	Bearing	Dist in Links	Nº & Mark on Tree	Descⁿ of Tree
A	329° 59'	70·3	A 2647	Ma Tree (not noted)	F				
B	63° 39'	116	A 2647 1007	Jarrah	G				
C	262° 45'	54·8	" "	Wandoo	H				
D	158° 34'	80·2	" "	Jarrah	J				
E	217° 21'	14·5	" "	R Gum	K				

Azimuth observed at
or assumed from survey of Loc 1007
Date of Survey 20 June 1900
Field Book Nº 44 Pages 13 & 14
Scale 5 Chains to an Inch

I hereby certify that I personally performed the Survey represented on this diagram which to the best of my belief is accurate, and the work has been executed in accordance with the Regulations for the guidance of Surveyors.

Alfred Lewis Licensed Surveyor
Date 29 June 1900

Account passed
Calculation Bk Nº 17 Folio 42
Compared with F.B. C.P. Hardy 1.9.00
Examined C.M.R.U. 20.9.00
Diagram passed William Rowly 20.9.00

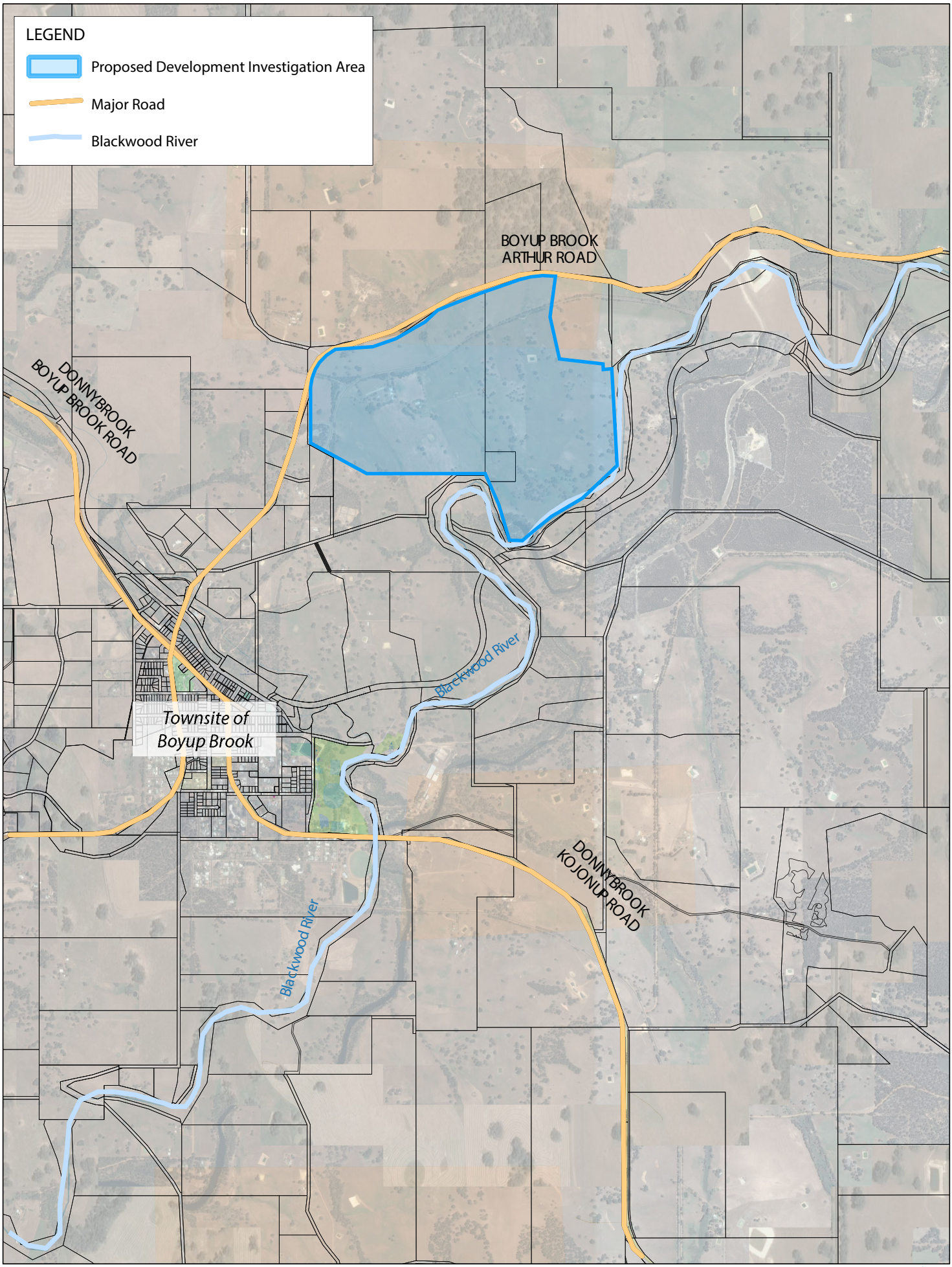
On Standard Plan A 8/1 20.12.01

Registered W & Land 5.7.00.

Diagram Nº 3925

3925

ATTACHMENT 2



LOCATION PLAN - PROPOSED DEVELOPMENT INVESTIGATION AREA
Boyup Brook - Arthur Road
Boyup Brook

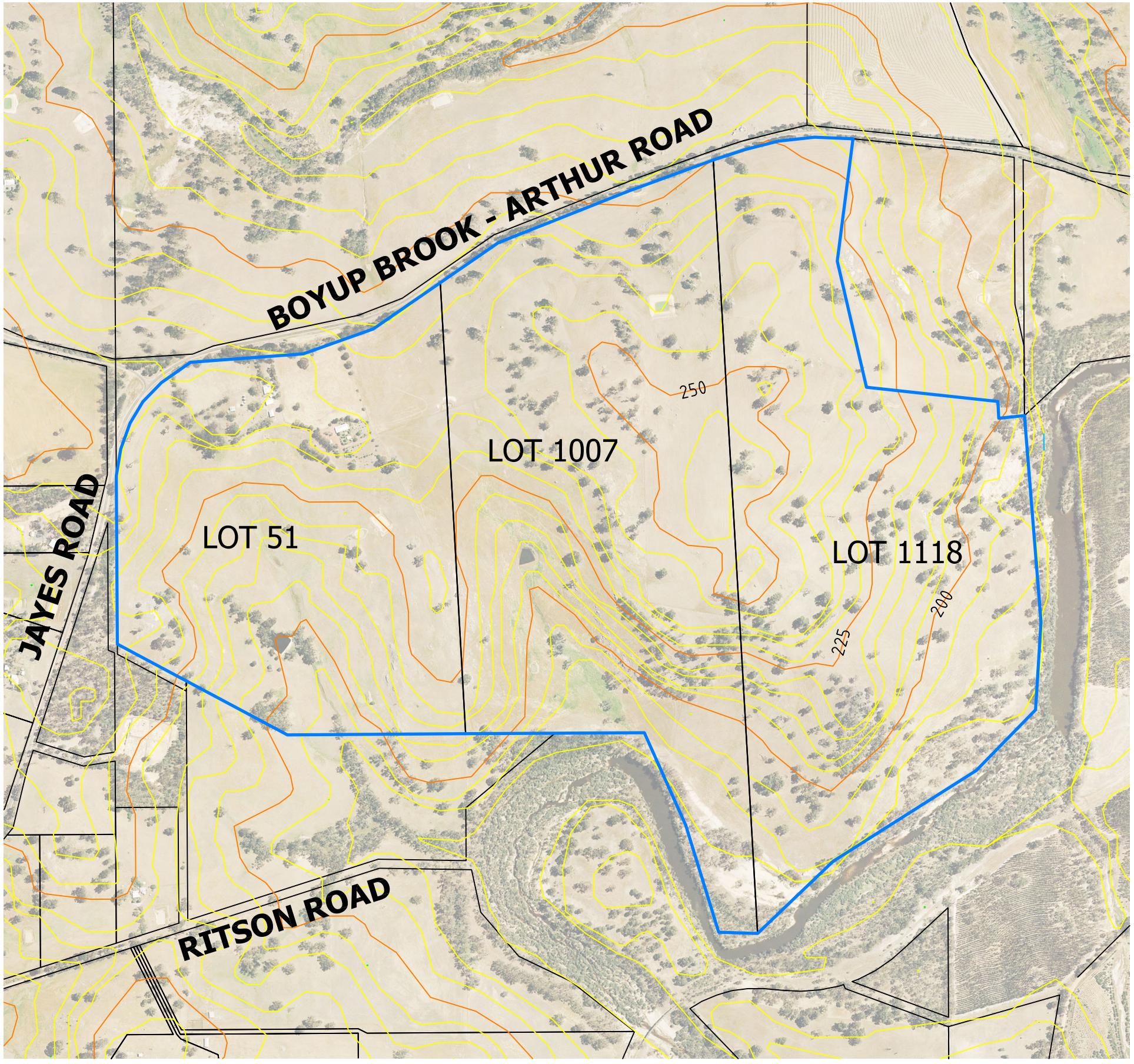
N

0 500 1000 1500 m

1:40,000

edge PLANNING & PROPERTY
Edge Planning & Property
134 Hare Street, Mount Clarence
ALBANY WA 6330
E: steve@edgeplanning.com.au
M: 0409 107 336

ATTACHMENT 3



LEGEND

- Local Structure Plan Boundary
- Existing Lot Boundary
- Contours

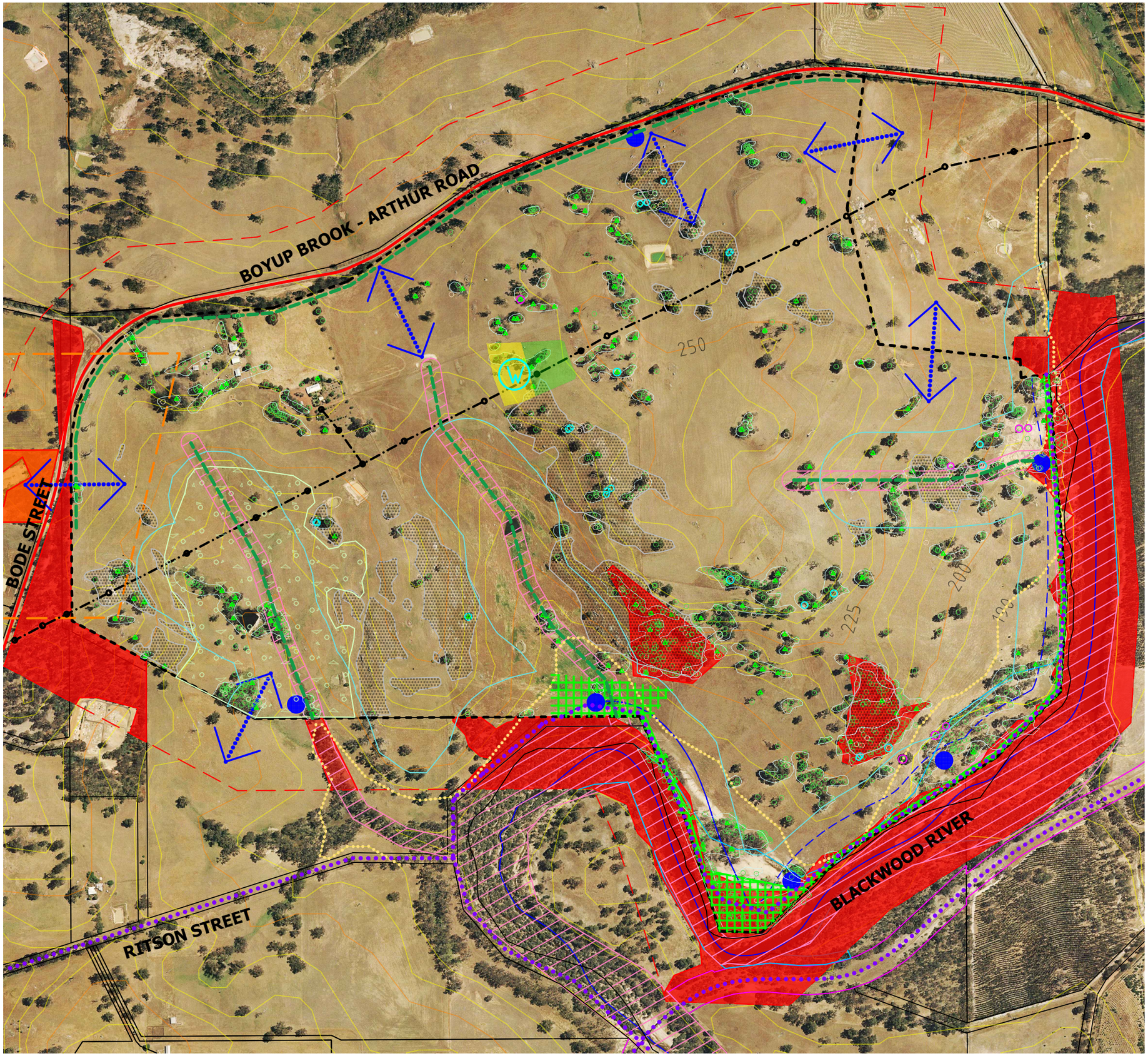
SITE PLAN
LOT 51, 1007 and 1118.
BOYUP BROOK-ARTHUR ROAD, BOYUP BROOK
SHIRE OF BOYUP BROOK

N
SCALE APPROX. 1/10000
DATE 12th OCTOBER 2021

edge PLANNING & PROPERTY

ROD LAKELIN
PO BOX 70 VASSE WA 6280
0428 171 306
rodlakelin@bigpond.com

ATTACHMENT 4



LEGEND

- Subject Land
- Indicative High Level Water Tank Site
- Resource Recovery Centre with 200m buffer
- Stormwater Storage Area
- River and Watercourses
- Proposed Foreshore Reserve
- Proposed Public Open Space
- Proposed Public Purpose
- Replanting (Indicative)
- Walk/Cycle Trail
- Aboriginal Heritage Site
- Contours
- 100m Setback from River/Watercourses
- 190m AHD - Extent of 1% Annual Exceedance Probability (AEP) Flood Level
- Indicative Road/Intersection Connection
- Western Power Asset (Line and Poles)
- Suitable Significant Trees
- Potential Significant Trees
- Black Cockatoo Habitat Trees
- Fauna Habitat Trees
- Seasonal Waterlogging
- Rocky Outcrop

BUSHFIRE

- Extreme Bushfire Risk Area

Most of the Site has a moderate Bushfire Hazard Level.

CONTEXT, OPPORTUNITIES AND CONSTRAINTS PLAN
LOT 51, 1007 and 1118.
BOYUP BROOK-ARTHUR ROAD, BOYUP BROOK
SHIRE OF BOYUP BROOK

0 80 160 240 320 400m

1:8000(A3)

N

SCALE APPROX. 1/8000

DATE 23rd May 2024

edge PLANNING & PROPERTY

ROD LAKELIN
PO BOX 70 YASSE WA 6280
0428 171 306
rodlakelin@bigpond.com

ATTACHMENT 5

Local Water Management Strategy

Lot 51, 1007, 1118 Boyup Brook – Arthur Rd, Boyup Brook, WA



5th July 2024

SOUTH ENVIRONMENTAL

Document Control

Title: Local Water Management Strategy: Lot 51, 1007, 1118 Boyup Brook – Arthur Rd, Boyup Brook WA
Author: Chiquita Cramer
Job No.: A002
Client: Leafield Pty Ltd

Revision Record – South Environmental

Revision	Summary	Prepared by	Revised/Comments Received by	Date
Final LWMS 05/07/24	LWMS updated to include revised Local Structure Plan/Subdivision Concept Plan.	C. Cramer	DPLH & SoBB	05/07/2024

Revision Record – Bio Diverse Solutions

Revision	Summary	Prepared by	Revised/Comments Received by	Date
Draft Id 23/08/21	Internal QA review	C. Cramer	B. Theyer K. Kinnear	23/08/2021
Draft Id 24/08/21	Sent to client for comment	C. Cramer	P. Eastlake	24/08/2021
Final Id 06/09/21	Final report issued to client	C. Cramer	-	06/09/2021
Draft Id 26/06/23	Updated to include LSP updates and additional monitoring data	C. Cramer	S. Thompson	01/07/2023
Draft Id 11/07/23	Technical Review	C. Cramer	K. Kinnear	11/07/2023
Final Id 12/07/23	Final report issued to client	C. Cramer	-	12/07/2023
Final Id 09/02/23	Final report updated to address DoH and DWER comments	C. Cramer	DoH & DWER	09/02/2024

SOUTH ENVIRONMENTAL

Mobile: 0493 980 199
Email: chiquita@southenvironmental.com.au
Website: www.southenvironmental.com.au
ABN: 21 755 740 121

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1 Introduction

Lots 51, 1007 and 1118 Boyup Brook-Arthur Road Local Water Management Strategy (LWMS) has been prepared by Bio Diverse Solutions on behalf of Leafield Pty Ltd ('The Client') in support of an amendment to the Local Planning Scheme and to provide guidance to the Local Structure Plan (LSP) prepared for the site.

The LWMS provides the framework for the application of total water cycle management to the proposed urban structure. This is consistent with the Department of Water and Environmental Regulation (DWER) principles of Water Sensitive Urban Design (WSUD) described in the Stormwater Management Manual (DoW, 2007).

The information presented in this LWMS has been derived from the previously prepared Local Water Management Strategy – Lot 51, 1007, 1118 Boyup Brook-Arthur Road, Boyup Brook (Bio Diverse Solutions, 2024). The LWMS has been updated by South Environmental, upon the direction of the client, to include recent modifications to the Local Structure Plan/Subdivision Concept Plan and to address comments from the Department of Planning, Lands and Heritage (DPLH) and the Shire of Boyup Brook. This SSE prepared by South Environmental supersedes the previous SSE prepared by Bio Diverse Solutions.

1.1 Key Design Principles and Objectives

The LWMS employs the following key documents to define its content, key principles and objectives:

- Stormwater Management Manual for Western Australia (DoW, 2007).
- Better Urban Water Management (WAPC, 2008).

A summary of the key design principles and objectives from these documents is summarised below and provided in Table 1.

1.1.1 Stormwater Management Manual (DoW 2007)

The Department of Water (DoW) (now Department of Water and Environmental Regulation (DWER)) released *A Manual for Managing Urban Stormwater Quality in Western Australia* in 1998. The manual defines and practically describes Best Management Practices (BMP's) to reduce pollutant and nutrient inputs to stormwater drainage systems. The Manual also aims to provide guidelines for the incorporation of water sensitive design principles into urban planning and design, which would enable the achievement of improved water quality from urban development.

The document was released to provide a guideline for best planning and management practices and was intended for use by the DoW (now DWER), but also by other State and Local Government Authorities and sectors of the urban development industry.

DoW completed a major review of the manual in consultation with a working team comprising industry and government representatives. The revised manual was officially launched in August 2007.

DWER's current position on urban stormwater management in Western Australia is outlined in Chapter 2: *Understanding the Context of the Stormwater Management Manual for Western Australia* (DoW, 2007), which details the management objectives, principles and a stormwater delivery approach for WA. Principle objectives for managing urban water in WA are stated as:

- Water Quality: To maintain or improve the surface and groundwater quality within development areas relative to pre-development conditions.
- Water Quantity: To maintain the total water cycle balance within development areas relative to the pre-development conditions.
- Water Conservation: To maximise the reuse of stormwater.
- Ecosystem Health: To retain natural drainage systems and protect ecosystem health.
- Economic Viability: To implement stormwater systems that are economically viable in the long-term.
- Public Health: To minimise public risk, including risk of injury or loss of life to the community.

- Protection of Property: To protect the built environment from flooding and water logging.
- Social Values: To ensure that social aesthetic and cultural values are recognised and maintained when managing stormwater.
- Development: To ensure the delivery of best practice stormwater management through planning and development of high-quality developed areas in accordance with sustainability and precautionary principles.

1.1.2 Better Urban Water Management (WAPC, 2008)

The guideline document Better Urban Water Management (WAPC, 2008), focuses on the process of integration between land use and water planning. The document specifies the level of investigation and documentation required at various decision points in the planning process, rather than the provision of any specific design objectives and criteria for urban water management. This LWMS complies with the BUWM process.

Table 1: Summary of design principles and objectives

Key Guiding Principles		
• Facilitate implementation of sustainable best practice urban water management. • Provide integration with planning processes and clarity for agencies involved with implementation. • To minimise public risk, including risk of injury or loss of life. • Protection of infrastructure and assets from flooding and inundation. • Encourage environmentally responsible development. • Facilitate adaptive management responses to the monitored outcomes of development.		
Category	**Key Design Principles & Objectives**	**LWMS Criteria**
Surface Water Management	• Minimise changes in hydrology to prevent impacts on receiving environments. • Manage water flows from major events to protect infrastructure and assets. • Apply the principles of WSUD. • Adopt nutrient load reduction design objectives for stormwater runoff. • Floodplain management and urban drainage. • Adopt treatment train approach.	• Post-development critical peak flows will be consistent with pre-development peak flow at the discharge point of each catchment within the Subject Site up to the 20% AEP storm event. • First 15mm of rainfall from storm events will be treated at source where possible. • Manage surface water flows from major events to protect infrastructure and assets from flooding and inundation. • An adopted Blackwood River 1% AEP flood level fronting the Subject Site of 190m AHD based on flood levels recorded in 1982.
Groundwater Management	• Manage groundwater levels to protect infrastructure and assets. • Maintain groundwater regimes for the protection of groundwater-dependent ecosystems. • Protect the value of groundwater resources. • Adopt nutrient load reduction design objectives for discharges to groundwater.	• Managing and minimising changes in groundwater levels and groundwater quality following development.
Monitoring and Implementation	• Adopt an adaptive management approach. • Maintain drainage and treatment structures.	• Design based on methodology in Stormwater Management Manual of adopting a treatment train including: • structural treatment measures (infiltration storages, plus bio-retention treatment structures). • Non-structural measures to reduce applied nutrient loads. • Maintain groundwater quality at pre-development levels (median winter concentrations) and, if possible, improve the quality of water leaving the development area to maintain and restore ecological systems.
Water Conservation	• Adopt drinking water consumption target. • Ensure that non-potable water supply systems deliver a net benefit to the community. • Ensure that non-potable water supply systems are designed as part of an integrated water supply.	• Aim to achieve the State Water Plan target for water use and reduce water use where possible. • Consider alternative fit for purpose water sources where appropriate and cost-effective.

1.2 Suitable Qualified Hydrologist

This LWMS has been prepared by Chiquita Cramer, who has 15 years of experience working as a hydrologist and hydrogeologist.

Chiquita Cramer currently has the following tertiary qualifications:

- Bachelor of Science in Natural Resource Management (University of Western Australia); and
- Graduate Certificate in Hydrogeology (University of Western Australia).

Chiquita completed a Bachelor of Science in Natural Resource Management in 2008 at the University of Western Australia. She then went on to work as a hydrologist and senior hydrologist at JDA Consultant Hydrologists in Perth where she worked for 8 years. Chiquita furthered her studies in 2012 by completing a Graduate Certificate in Hydrogeology, in 2017 she joined Bio Diverse Solutions to provide expertise in hydrology and hydrogeology to the company, and in 2024 she founded South Environmental in Albany WA. Chiquita's experience includes the preparation of local and urban water management strategies, hydrological and hydraulic investigations, surface water and groundwater monitoring reports and hydrogeological reports.

1.3 Location

Lots 51, 1007 and 1118 Boyup Brook-Arthur Road (herein referred to as the Subject Site) comprises of 221.8 ha and is located approximately 2.5 km northeast of the Boyup Brook town centre. The Subject Site is bound by Boyup Brook-Arthur River Road to the north, the Blackwood River to the east and southeast and adjoins cleared agricultural land to the east, west and southwest. The location of the Subject Site is shown on Figure 1.

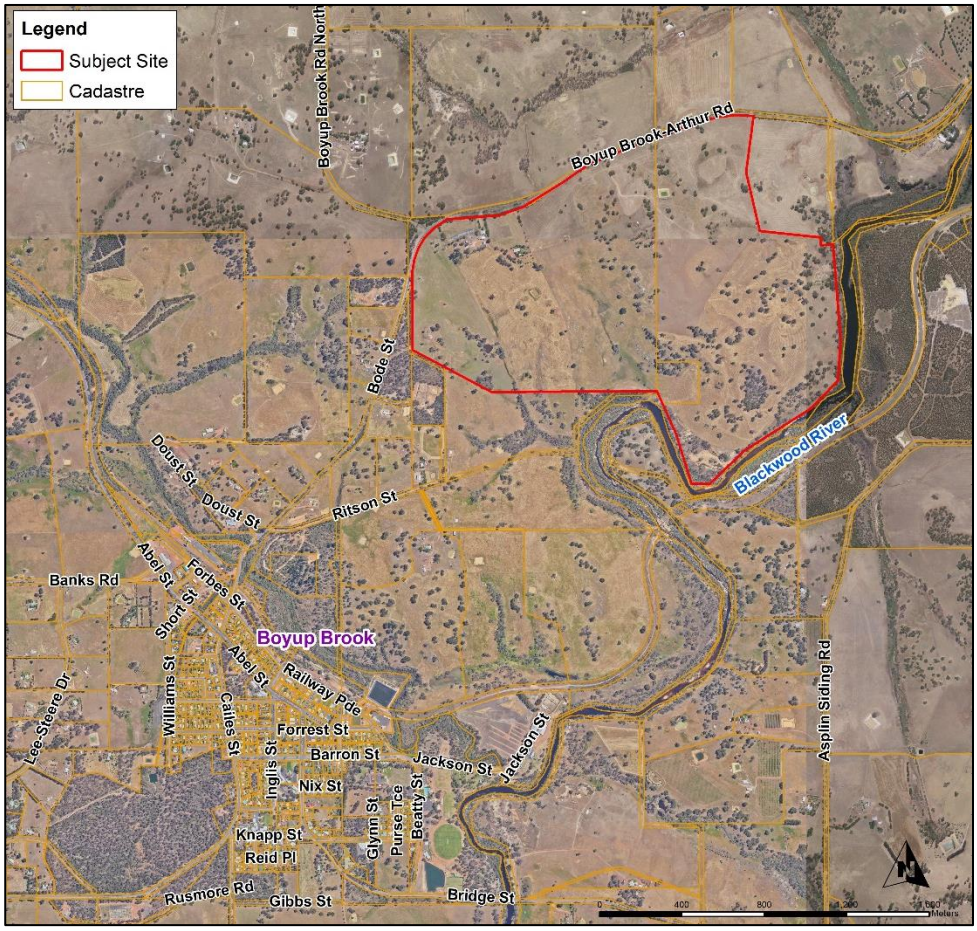

Figure 1: Location Plan

2 Proposed Development

The Subject Site is situated within the Shire of Boyup Brook and zoned *Rural* under the Shire of Boyup Brook Local Planning Scheme No. 2. It is proposed to rezone the Subject Site from *Rural* to *Special Rural* to allow for residential and rural residential lots ranging in size from 2,000m^2 up to ~5 ha. A LSP and subdivision concept plan showing the planning proposal for the Subject Site is shown in Figure 2.

Key elements of the rezoning and future development proposal relating to water management includes:

- Use of bio-retention treatment systems for detention and treatment of stormwater runoff from internal roads;
- Building finished levels shall be a minimum 300 mm above the 1% AEP flood levels in stormwater storages and road reserves, and 500 mm above the 1% AEP flood level (190.0 mAHD) within the Blackwood River, which is based on flood levels recorded in 1982;
- A 50 m setback between building envelopes and the outer edges of the Blackwood River riparian zone or creek lines; and
- Promotion of the use of local native plants for gardens, streetscaping and Public Open Spaces (POS). Any non-local species will be selected for drought tolerance and low fertiliser requirements.

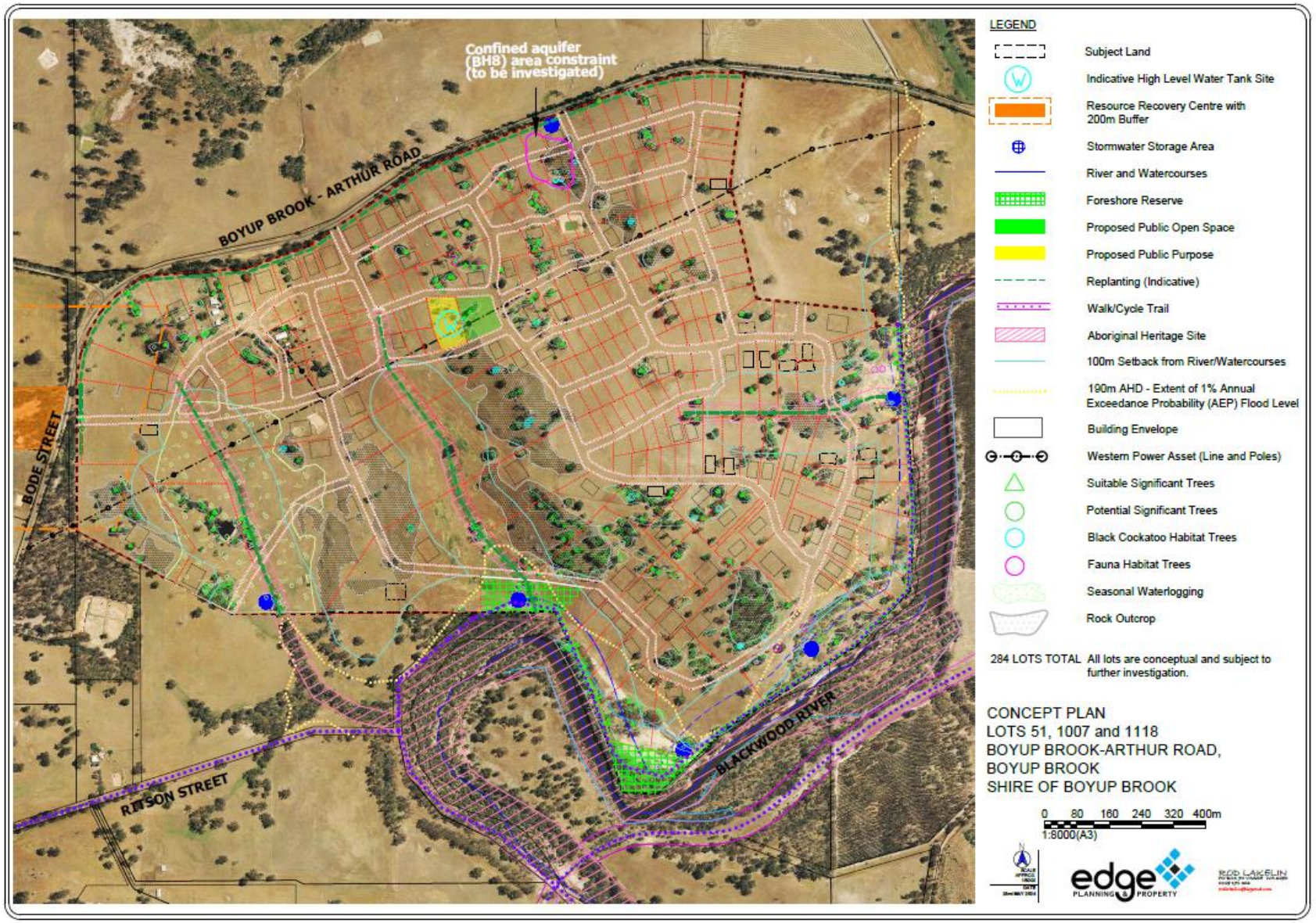

Figure 2: Concept Plan (Edge Planning & Property, 2024)

3 Pre-development Environment

3.1 Existing Land Use

The site currently consists of agricultural land used for mixed cropping and livestock. There is one dwelling located in the northwest of the site, which consists of a house and several machinery sheds. The eastern and south-eastern boundary of the Subject Site fronts the Blackwood River, which is the largest river in the southwest extending from the township of Wagin through the southwest to Augusta.

3.2 Topography

The Subject Site generally slopes from northwest to southeast towards the Blackwood River, from a high point of 255 m AHD in the central portion of the site to 180m AHD along the Blackwood River foreshore in the southeast and east of the site. A smaller northern portion of the site slopes down towards the Boyup Brook-Arthur Road which lies at approximately 225 m AHD. Topographic contours (5 m contours) for the Subject Site are shown on Figure 3.

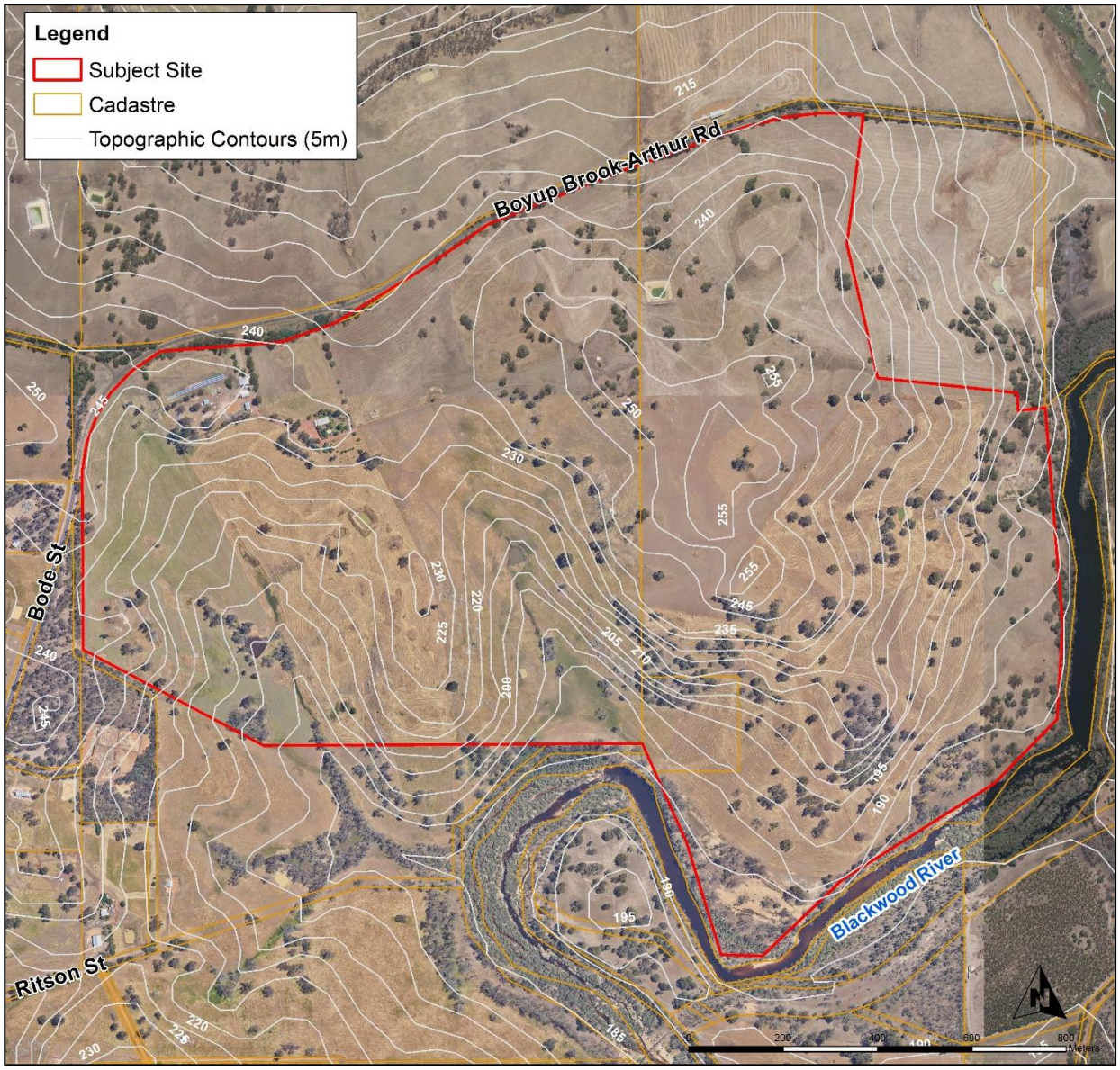

Figure 3: Topography

3.3 Climate

The Boyup Brook area is characterised by a Mediterranean climate with warm dry summers and cool wet winters. Rainfall data is from the nearby Bureau of Meteorology (BoM, 2021) Boyup Brook Station (Site No. 9504). The long-term average annual rainfall is 646 mm (1914 to 2020), there was no BoM data available at this site for 2021 and 2023. This average has decreased between 2000 to 2020, to an average annual rainfall of 542mm, reflecting a 16% reduction compared to the long-term average, consistent with a general drying trend in the Southwest of WA. The total rainfall distribution has also altered, with a reduction of average winter monthly rainfall, but no significant reduction in average summer monthly rainfall (BoM, 2023).

The average annual pan evaporation for the Boyup Brook area is approximately 1399 mm (Luke et al 1988).

3.4 Remnant Vegetation

The Subject Site predominantly consists of cleared agricultural land with scattered paddock trees (eucalyptus), and small patches/strips of remnant vegetation along the river foreshore.

The Subject Site lies within the JF02 – Jarrah Forrest Interim Bio-geographic Regional Area (IBRA).

The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd et al 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics. A GIS search of J.S. Beards vegetation classification places the Subject Site within one System and Vegetation Association (DPIRD, 2017a):

- **System Association Name**: Bridgetown.
- **Vegetation Association Number:** 992 & 3.
- **Vegetation Description:** Mainly jarrah and marri *Eucalyptus marginata*, *Corymbia calophylla*.

There are no Conservation Parks or Class "A" Reserves within the Subject Site or within the vicinity of the Subject Site. A Black Cockatoo Survey of the existing site trees was conducted by BDS in June 2023, results of the Black Cockatoo Survey are provided in a separate report.

3.5 Acid Sulphate Soils

Acid sulphate soils (ASS) are naturally occurring soils and sediments containing sulphide minerals, predominantly pyrite (an iron sulphide). When undisturbed below the water table, these soils are benign and not acidic (potential acid sulphate soils). However, if the soils are drained, excavated or exposed by lowering of the water table, the sulphides will react with oxygen to form sulphuric acid. Acid Sulphate Soil (ASS) Risk Mapping indicates the Subject Site does not lie within any known areas of ASS (DWER, 2017).

3.6 Geology and Soils

Soil mapping – Zones (DPIRD, 2017a) shows the Subject Site lies within one soil zone being; the Eastern Darling Range Zone (253). The Eastern Darling Range Zone is described as; '*Moderately to strongly dissected lateritic plateau on granite with eastward-flowing streams in broad shallow valleys, some surficial Eocene sediments. Soils are formed in laterite colluvium or weathered in-situ granite.'* (DPIRD, 2017a).

Soil mapping – Systems (DPIRD, 2018) shows the Subject Site lies within one soil systems being; the Boyup Brook Valleys System (253Bv). The Boyup Brook Valleys System is described as *'Valleys, in the south of the Eastern Darling Range (Blackwood Catchment). Gravel, sandy duplex loamy duplex. Jarrah-marri-wandoo forest and woodland.'* (DPIRD, 2018).

The Subject Site is also located within four sub-systems of the Boyup Brook Valley Systems as defined by DPIRD (2017b). The sub-systems are described in Table 1 shown and shown in Figure 4.

Table 2: Soil Sub-systems

Map Unit Symbol	Map Unit Name	Map Unit Description
253BvNWg	Newlgalup granitic slopes phase	Relief 30-50 m, slopes 5-20%. Soil parent material is granite and gneiss. Soils are deep loamy duplex soils, deep sandy duplex soils, loamy and sandy gravels, with some loamy earths and shallow loamy duplex soils.
253BvNW4	Newlgalup moderate slopes phase	Deeply incised valleys. Relief 60-100 m, slopes 15-35%. Soil parent material is gneiss and granite. Soils are deep loamy duplex soils, and yellow loamy earths with some shallow loamy duplex soils.
253BvDM	Dalmore subsystem	Undulating ridges and hill crests on laterite and granite. Relief 5-20 m, slopes 5-15%. Soils are gravels, loamy duplex and sandy duplex soils.
253BvCP	Condinup subsystem	River channel, flood plain and raised alluvial terraces, soils are brown deep sands.

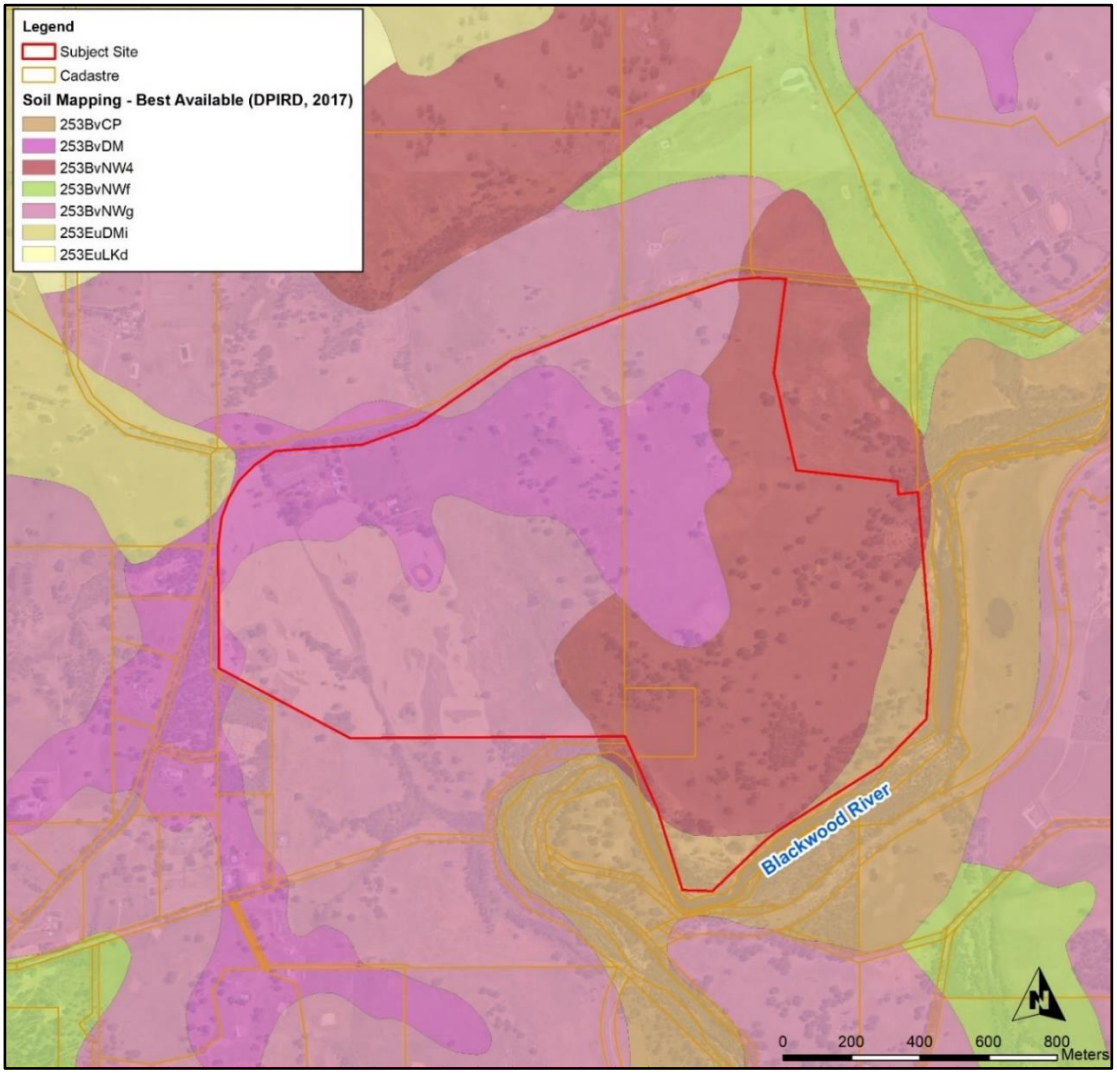

Figure 4: Soil Mapping (DPIRD, 2018)

3.6.1 Site Soil Investigation

A site soil investigation was conducted on the 3rd August 2021 by Bio Diverse Solutions. The site investigation included the construction of 13 test holes to a depth of up to 2 metres, logging of soils to the depth of the hole and inspection and measuring of the water table.

The test holes were constructed using a 75 mm diameter hand auger and were left open for 1hr for inspections of water table depth. The location of the 13 test holes is shown in Figure 5.

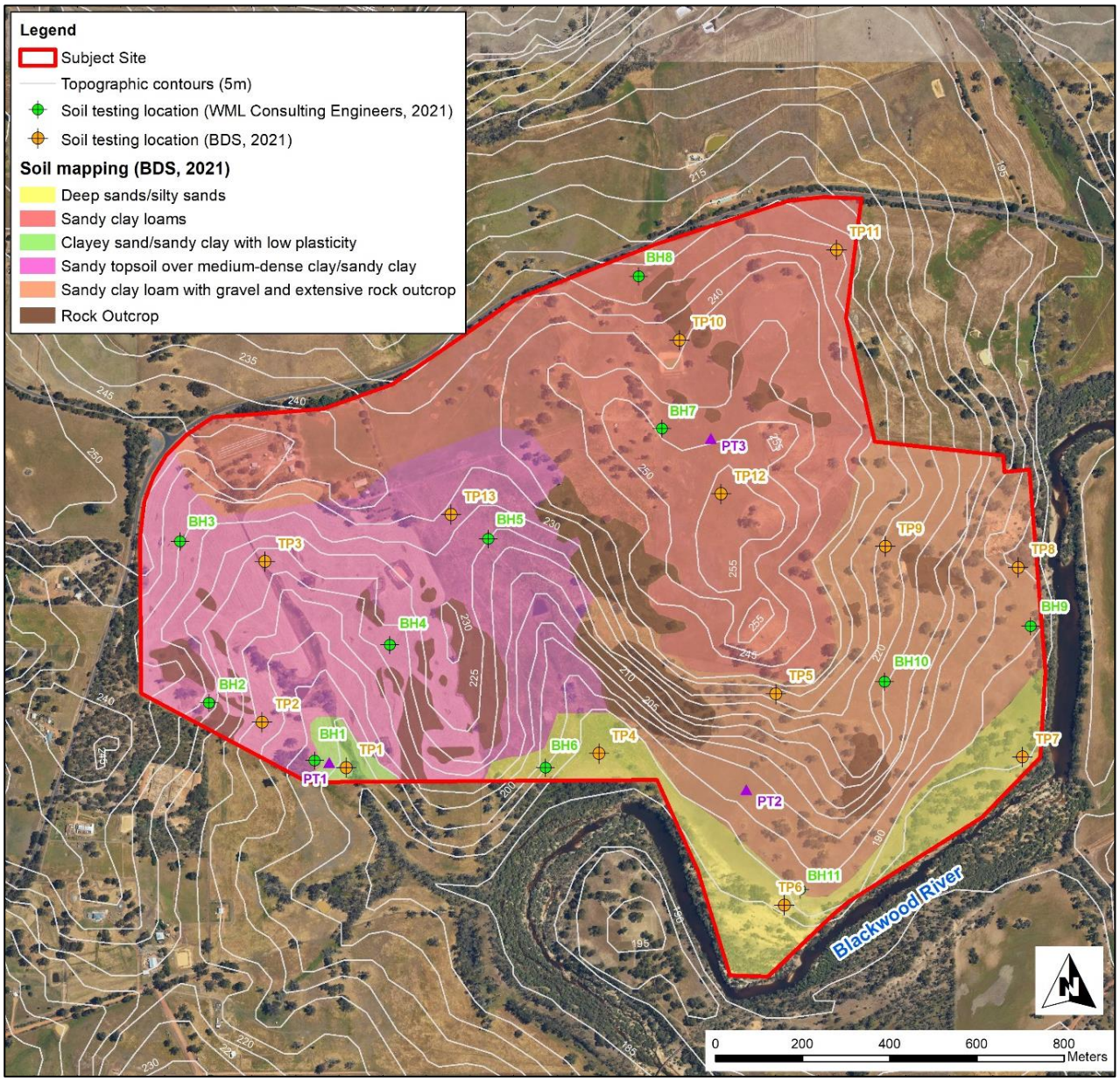

Figure 5: Soil testing and mapping

The site soil investigation by BDS revealed that soils across the site comprised of six main soil types:

1. Silty sand topsoil over deep sands, no groundwater encountered to 2 metres (found along the Blackwood River foreshore);
2. Silty sand over clay with medium to high plasticity, a perched water table encountered in the lower reaches following heavy winter rainfall (found in the western portion of the site);
3. Silty sand over moderately to poorly sorted sandy loam and sandy clay loam with low plasticity and generally no groundwater encountered to 2 metres (found in the higher elevations in the northeast of the site);
4. Gravelly sandy clays/clayey sands. Low plasticity clays, no groundwater encountered to 2m (found in the southeast of the Subject Site).
5. Well sorted clayey sand/sandy clay with low plasticity. Includes a small area in the southwest in the lower reaches of the valley system; and
6. Granite outcrop (scattered throughout the site, predominantly situated on the elevated hill slopes).

The estimated boundaries of the six main soil types are shown in Figure 5 with the BDS soil testing results presented in Table 3.

Table 3: Soil Testing Results

Test Hole	Depth	Soil Type	Soil Description
TP1	0-150mm 150-1000mm 1000-1300mm 1300-1500mm 1500mm +	Sand with silt Sand with silt Sandy clay Sand with silt Bedrock	Grey, fine, roots and root fibres (Topsoil), moist. Dark grey, medium, well sorted, saturated. Low plasticity, dark grey, medium grained sand, saturated. Orange, fine, well sorted, saturated. Refusal, granite rock. **Water table encountered at 0.3m BGL.**
TP2	0-150mm 150-500mm 500-800mm 800mm+	Sand with silt Sandy loam Sandy loam Clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, medium, well sorted, moist. Brown, medium, well sorted, saturated. High plasticity, orange brown mottled, saturated. **Water table encountered at 0.17m BGL.**
TP3	0-150mm 150-500mm 500mm+	Sand with silt Sandy loam Clay	Grey, fine, roots and root fibres (topsoil), moist. Brown, medium, well sorted, moist. High plasticity, red/orange, moist. **Water table encountered at 0.5m BGL.**
TP4	0-300mm 300-1800mm	Sand with silt Sand with silt	Grey, fine, roots and root fibres (topsoil), moist. Brown/orange, fine, well sorted, moist-saturated. **Water table encountered at 0.65m BGL.**
TP5	0-300mm 300-1500mm	Sand with silt Gravelly clay	Grey, fine, roots and root fibres (topsoil), moist. Low plasticity, cemented layer, red/brown, coarse gravel, moist. **No water table encountered.**
TP6	0-300mm 300-2000mm	Sand Sand	Dark brown, fine, well sorted, roots and root fibres (topsoil), dry. Yellow, fine, well sorted, dry. **No water table encountered.**
TP7	0-300mm 300-2000mm	Sand Sand	Brown, fine, well sorted, roots and root fibres (topsoil), dry. Brown-yellow, fine, well sorted, dry. **No water table encountered.**
TP8	0-150mm 150-300mm 300-800mm 800-1500mm	Sand with silt Sandy loam Sandy clay Sandy loam	Grey, fine, roots and root fibres (topsoil), moist. Orange/brown, fine, well sorted, moist. Low plasticity, yellow/brown, medium sand, moist. Yellow/brown, medium, well sorted, moist. **No water table encountered.**
TP9	0-150mm 150-300mm 300-800mm 800-1500mm	Sand with silt Sandy loam Sandy clay loam Sandy clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, well sorted, moist. Orange/brown, medium, poorly sorted, moist. Low plasticity, orange, medium-coarse sand, moist. **No water table encountered.**
TP10	0-150mm 150-300mm 300-700mm 700-1300mm	Sand with silt Sandy loam Sandy clay loam Sandy clay loam with gravel Gravelly clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, moderately sorted, moist. Dark brown, fine-coarse, moderately sorted, moist. Red-brown, fine-coarse, poorly sorted, moist. Low plasticity, orange/red, moist. **No water table encountered.**
TP11	0-150mm 150-300mm 300-700mm 700-1500mm	Sand with silt Sandy loam Sandy loam Sandy clay loam	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, moderately sorted, moist. Orange/brown, fine-coarse, poorly sorted, moist. Orange, fine-coarse, poorly sorted, moist. **No water table encountered.**

Table 3 continued.

Test Hole	Depth	Soil Type	Soil Description
TP12	0-150mm 150-300mm 300-600mm 600-1500mm	Sand with silt Sandy loam Sandy clay loam Sandy clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, well sorted, moist. Dark brown, fine, moderately sorted, moist. Low plasticity, orange/brow, moist. **No water table encountered.**
TP13	0-150mm 150-600mm 600mm+	Sand with silt Sandy clay Clay	Grey, fine, roots and root fibres (topsoil), moist. Moderate plasticity, black, moist. High plasticity, orange, moist. **No water table encountered.**

A further soil investigation was conducted from 30th of September to 1st October 2021 by WML Consulting Engineers as part of the installation of 11 groundwater monitoring bores across the Subject Site, the soil investigation report including bore logs is presented in Appendix A. Generally, the WML Consulting Engineers soil investigation showed similar soil types to BDS with deep sands found in a band fronting the Blackwood River and medium - dense clays in the west of the site. Unlike BDS, WML encountered medium - dense clays across the northeast of the Subject Site whereas BDS encountered sandy loams/clay loams with low plasticity, which also corresponded to the in-situ permeability testing conducted in this area. The WML Consulting Engineers (2021) soil testing results are shown in Table 4.

Table 4: Soil Testing Results (WML Consulting Engineers, 2021)

Bore Hole	Depth	Soil Type	Soil Description
BH1	0 – 200mm	Sand	Moist, dark brown, loose, fine to medium grained, **SAND** with a trace of clay and a trace of fine roots and a trace of organics.
	200 – 4200mm	Clay	Moist, orange brown mottled grey, very stiff, **CLAY** with a trace of fine-grained sand.
	4200 – 5200mm	Clay	Moist, grey, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.* **Water-table encountered at 4.9 m BGL**
BH2	0 – 200mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 600mm	Sandy clay	Moist, brown mottled orange white, firm, **sandy CLAY**.
	600 – 1600mm	Clayey sand	Dry, orange, very dense, fine to medium grained, **clayey SAND**.
	1600 – 2200mm	Clayey sandy gravel	Dry, grey orange, very dense, fine to medium, **clayey sandy GRAVEL**. *Highly cemented, potentially granite rock.* **Water-table encountered at 2.0 m BGL**
BH3	0 – 300mm	Sand	Dry, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	300 – 1000mm	Clay	Dry, orange, firm, **CLAY** with a trace of fine gravel and some fine to coarse grained sand.
	1000 – 3100mm	Clay	Dry, red brown, very stiff, **CLAY** with a trace of fine to medium grained sand.
	3100 – 3700mm	Clay	Moist, yellow brown, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	3700 – 4200mm	Clay	Moist, red brown, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	4200 – 6600mm	Clay	Moist, pale brown mottled red white, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	6600– 10000mm	Clay	Moist, pale brown grey, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	10000 - 10800mm	Clay	Wet, pale brown grey, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.* **Water-table encountered at 10.5 m BGL**

Table 4 continued.

Bore Hole	Depth	Soil Type	Soil Description
BH4	0 – 300mm	Sand	Moist, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	300 – 2300mm	Clay	Moist, grey, firm, **CLAY** with some fine-grained sand.
	2300 – 2600mm	Clay	Moist, grey, firm, **CLAY** with some fine-grained sand.
			Water-table encountered at 0.25 m BGL
BH5	0 – 300mm	Sand	Moist, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	300 – 800mm	Clayey Gravel	Moist, brown, medium dense, fine, **clayey GRAVEL** with a trace of organics and some fine to coarse grained sand.
	800 – 1300mm	Gravelly clay	Moist, pale brown, firm, **gravelly CLAY** with some fine to coarse grained sand.
	1300 – 1800mm	Clay	Moist, brown slightly mottled dark brown orange, firm, **CLAY** with some fine to coarse grained sand and some fine to medium gravel.
	1800 – 2500mm	Clay	Moist, pale brown, stiff, **CLAY** with some fine to coarse grained sand.
			Water-table encountered at 1.4 m BGL
BH6	0 – 100mm	Sand	Moist, dark brown, loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	100 – 3000mm	Sand	Moist, pale brown, medium dense, fine to medium grained, **SAND**.
			Water-table encountered at 1.5 m BGL
BH7	0 – 300mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics and a trace of fine to coarse gravel.
	300 – 1300mm	Clay	Dry, orange, stiff, **CLAY** with some fine to medium gravel and a trace of fine to coarse grained sand.
	1300 – 2600mm	Clay	Dry, orange slightly mottled white red, stiff, **CLAY** with a trace of fine to coarse gravel and a trace of fine to coarse grained sand.
	2600 – 3500mm	Clay	Dry, red cream, stiff, **CLAY** with a trace of fine to medium grained sand.
			Water-table encountered at 10.5 m BGL
BH8	0 – 200mm	Sand	Moist, grey, very loose, fine to medium grained, **SAND** with a trace of clay and a trace of fine gravel.
	200 – 400mm	Sandy Clay	Moist, orange mottled grey, soft, **sandy CLAY** with a trace of fine to medium gravel.
	400 – 600mm	Clay	Moist, orange, firm, **CLAY** with some fine to coarse grained sand and a trace of fine to medium gravel.
	600 – 7000mm	Clay	Moist, orange, stiff, **CLAY** with some fine to medium grained sand.
	7000 – 10000mm	Clay	Moist, grey, stiff, **CLAY** with some fine-grained sand.
			Water-table encountered at 0.1 m BGL
BH9	0 – 200mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 4000mm	Gravelly clay	Dry, brown, very stiff, **gravelly CLAY** with a trace of fine to coarse grained sand.
			No water-table encountered

Table 4 continued.

Bore Hole	Depth	Soil Type	Soil Description
BH10	0 – 200mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 1500mm	Gravelly clay	Dry, brown red, stiff, **gravelly CLAY** with a trace of fine to coarse grained sand.
	1500 – 4500mm	Clay	Dry, brown orange, very stiff, **CLAY** with some fine to coarse grained sand.
	4500 – 6000mm	Clay	Dry, orange, very stiff, **CLAY** with a trace of fine to coarse grained sand.
	6000 – 10000mm	Clay	Dry, orange, very stiff, **CLAY**.
			Water-table encountered at 3.3 m BGL
BH11	0 – 200mm	Sand	Moist, dark brown, loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 1700mm	Sand	Dry, yellow grey, medium dense, fine to medium grained, **SAND** with some silt.
	1700 – 3000mm	Sandy clay	Dry, brown orange, stiff, **sandy CLAY**.
			No water-table encountered

Phosphorous Retention Index

Phosphorous Retention Index (PRI) is the ability of soils to absorb nutrients and heavy metals within the soil (i.e. Soil microbe disinfecting ability). Soils with a PRI less than 1 have a very poor ability to retain nutrients and heavy metals, whilst soils with a PRI of >5 having a high ability to retain nutrients and heavy metals. PRI testing was conducted on samples from soil testing holes TP1, TP4, TP6, TP8 and TP11 with analysis conducted by CSBP Soil Laboratories. PRI results are presented in Table 5.

Table 5: Phosphorus Retention Index

Soil Testing Hole	Depth (mm)	Soil Type	PRI
TP1	150-1000	Sand with silt	27.2
TP4	300-1800	Sand with silt	5.9
TP6	300-2000	Sand	3.6
TP8	800-1500	Sandy loam	79.0
TP11	700-1500	Sandy clay loam	129.7

The PRI test results indicate that the site soils have a moderate to very high ability of fixing nutrients and contaminants consistent with soil types found across the site. As expected, the lowest PRI was found at TP4 and TP6 in the south of the site within the deep sands. Whilst the PRI was found to be lowest fronting the Blackwood River the PRI found at TP4 (5.9) and TP6 (3.6) was found to be greater than 1 and considered to provide some ability to fix nutrients and contaminants. A higher PRI was found in the clays and loams across the more elevated portions of the site, with the highest level found in the sandy clay loam at TP11 in the northeast of the site.

Soil Permeability

Silts and clay soils generally record poor permeability results whereas coarse sands and loose gravels generally record high permeability, as shown in Figure 6.

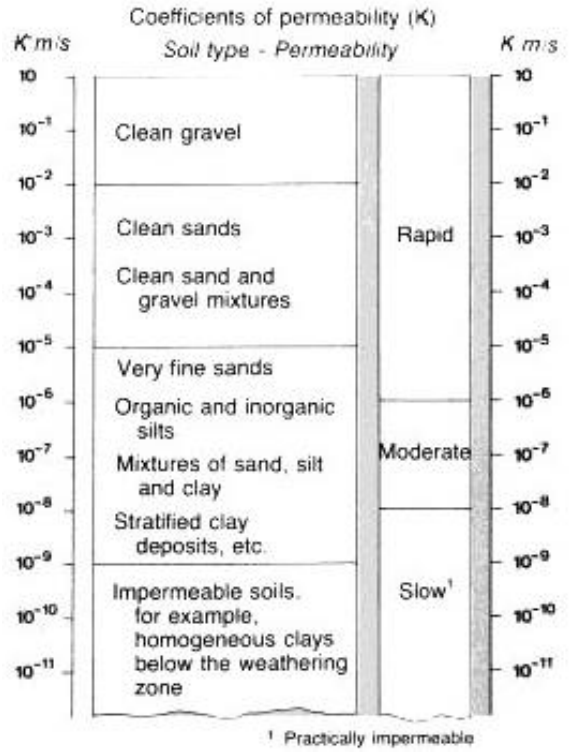

Figure 6: Hydraulic Conductivity of Soil Types (Artiola et al*, 2004)*

In-field permeability testing was conducted at three locations during the site soil investigation by BDS, the location of the permeability tests is shown in Figure 5. Permeability testing was conducted using the Talsma-Hallam method. The Talsma-Hallam permeameter is suitable for use in soils with permeability in the range 0.009 to 2.9 metres/day ($1x10^{-7}$ to $3x10^{-5}$ m/s). The permeability (hydraulic conductivity) recorded at the three testing locations is shown in Table 6.

Table 6: Permeability Results

Permeability Testing Site	Soil Type	Hydraulic conductivity (m/d)	Hydraulic conductivity (m/s)
PT1	Clayey sand	0.15	1.7×10^{-6}
PT2	Sandy clay loam with gravel	0.12	1.4×10^{-6}
PT3	Sandy loam	0.25	2.8×10^{-6}

Despite the permeability testing conducted in differing soil types including clayey sand, sandy clay loam with gravel and sandy loam, the permeability at all three testing sites was found to be moderate, as shown in Figure 6.

3.7 Surface Water Hydrology

There are no major drainage networks or water bodies within the Subject Site. Surface water generally runs off the site in a south easterly direction towards the Blackwood River, which runs along the southern boundary of the Subject Site. The Blackwood River is the largest river in the southwest of Western Australia with a catchment area of 28,100 km^2. The river begins near the township of Wagin and flows through many small towns in the southwest prior to discharging to the coast line near Augusta.

There are three seasonal creek lines located across the Subject Site that flow in a southeasterly and easterly direction towards the Blackwood River. A relatively smaller portion of the site in the north drains in a northerly direction towards Boyup Brook-Arthur Road and in an easterly direction towards an adjacent agricultural property, which ultimately drains to the Blackwood River.

The Subject Site is located within the Hardy Estuary – Blackwood River Hydrographic Catchment and the Middle Blackwood Sub-catchment (DWER, 2018a).

The pre-development surface water hydrology of the site and surrounding areas is shown in Figure 7. The general surface water hydrology of the site shall be maintained post-development.

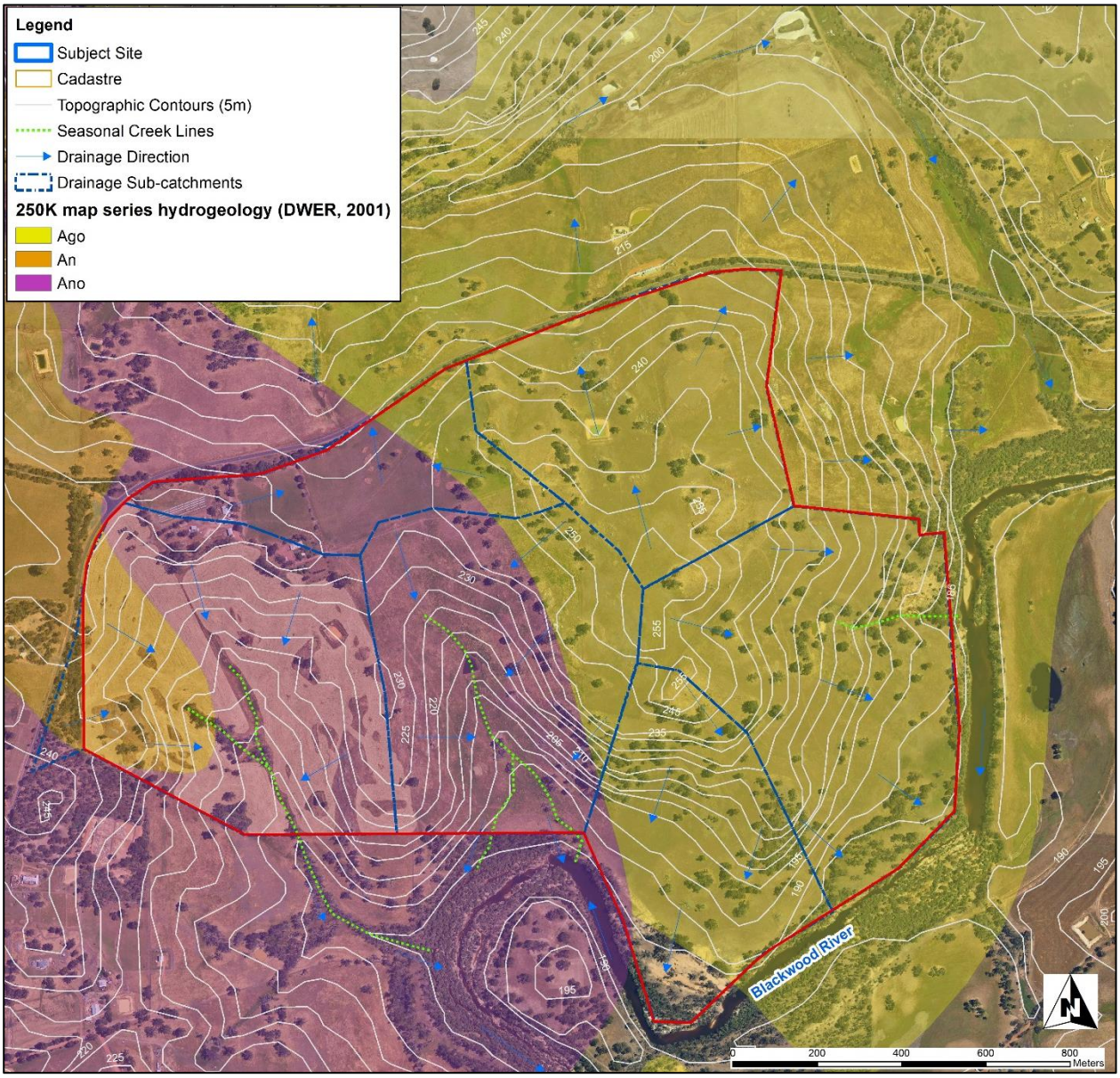

Figure 7: Pre-development Surface Water Hydrology

3.7.1 Surface water site investigation

A hydrological investigation across the site was conducted on the 3rd August 2021 to confirm the surface water hydrology of the site and guide the development to establish a post development surface water management strategy and a suitable onsite effluent disposal management plan focused on waterway protection. Rainfall prior to the site investigation was significantly higher than average for the period between February – July 2021, as shown in Table 7.

Table 7: 2021 monthly rainfall prior to site investigation

Month	Average rainfall for Boyup Brook (mm)	2021 Rainfall for Boyup Brook (mm)
February	15.4	68.0
March	21.6	32.0
April	37.3	92.5
May	83.9	96.0
June	115.9	94.0
July	115.0	139.4
Total (Feb-July)	389.1	521.9

Rainfall taken from BoM Boyup Brook Station (No. 9504) Feb - May.
Rainfall taken from BoM Newbicup Station (No. 9587) Jun – Jul.

Seasonal Creek Lines

The presence of three seasonal creek lines was confirmed across the site, all discharging to the Blackwood River (Figure 8). The western and eastern creeks at the time of the investigation had a trickle flow of water discharging to the Blackwood River. The central creek was not flowing, it did have standing water within its lower reaches. Photographs of the seasonal creek lines are shown in Photographs 1 to 6. There were no other waterways, water bodies (other than farm dams) or seasonally inundated areas found across the site.

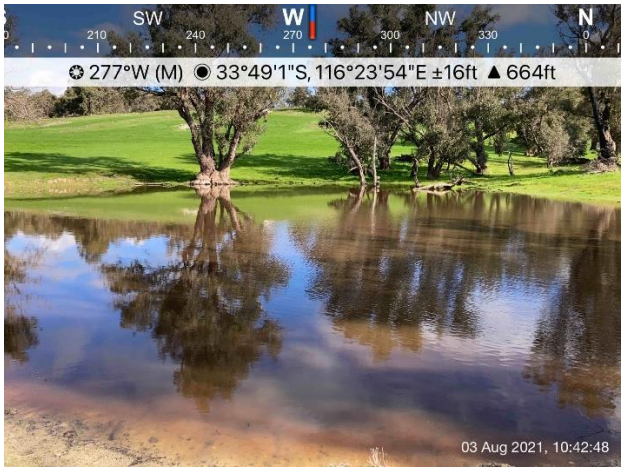

Photo 1: A dam located in the upper reaches of the western creek line, which provided a trickle flow of water to the lower reaches of the creek during the site investigation.



Photo 2: The lower reaches of the western creek, with trickle flow to neighboring property to the south and ultimately the Blackwood River.



Photo 3: Upper reaches of the central creek, not flowing at the time of site investigation.



Photo 4: The lower reaches of the central creek, with standing water adjacent to the Blackwood River.

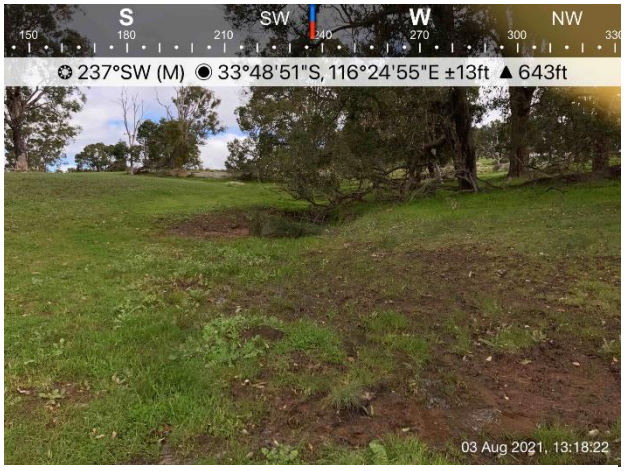

Photo 5: View from downstream to upstream of eastern creek line, with trickle flow towards the Blackwood River.



Photo 6: The lower reaches of the eastern creek line, characterized by deep eroded creek banks and trickle flow towards Blackwood River.

In-situ water quality testing was conducted within the three seasonal creeks using a Horiba-50 Water Quality Meter as part of the August 2021 site investigation. In-situ water quality testing and laboratory analysis was also conducted in Jun/Jul and Oct 2023 as part of the site's pre-development groundwater and surface water monitoring program (discussed in Section 6.4). The in-situ physiochemical water quality testing results for August 21 are shown in Table 8. The creek in-situ and laboratory water quality results for Jun/Jul and Oct 23 are presented and discussed in the Pre-development Surface Water and Groundwater Monitoring Report, included as Appendix B.

Table 8: In-situ water quality results of seasonal creeks (Aug 21)

Parameters	Guideline[1]	Western Creek	Central Creek	Eastern Creek
Physiochemical				
Temperature		10.74	13.73	11.02
pH	6.5 to 8.5	7.99	6.54	7.54
Electrical Conductivity (µS/cm)	120 - 300	1950	2360	1610
Dissolved Oxygen (mg/L)		11.40	5.31	10.90
Dissolved Oxygen (%)	90	105	49	101
Total Dissolved Solids (mg/L)	<1	1.25	1.51	1.25

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for upland river system; target exceedance shaded red.

Physiochemical water quality testing results recorded on the 3rd Aug 2021 found that the surface water within the creeks was slightly saline with a reasonably neutral pH. The electrical conductivity at all three creeks was found to be above the ANZECC and ARMCANZ (2000) upper trigger value for upland rivers in the Southwest of Australia (300uS/cm). The dissolved oxygen in the Central Creek was found to be below the ANZECC and ARMCANZ (2000) trigger value for upland rivers in Southwest Australia (90%). This is likely due to the presence of sediment and decaying organic matter, and the stagnant nature of the water body sitting within the lower reaches of the creek line (not flowing at the time of sampling).

Blackwood River

Flood levels in the Blackwood River during the site investigation were higher than at the same time on an average year due to the higher-than-average rainfall experienced from February – July 2021 in the southwest of the state. Flood levels in the river fronting the Subject Site extended to the outer edge of the river's riparian zone. There was only one location along the river where the flood levels of the river encroached into the Subject Site at the time of the site investigation, this was adjacent to where the eastern creek meets the river. The flood levels seen in the Blackwood River during late

July and early August were the highest seen in recent times according to the longtime local farmer at the Subject Site (M. Hardey 2021 pers. Comms., 3 August). Photographs of the Blackwood River fronting the Subject Site are shown in Photographs 7 and 8.

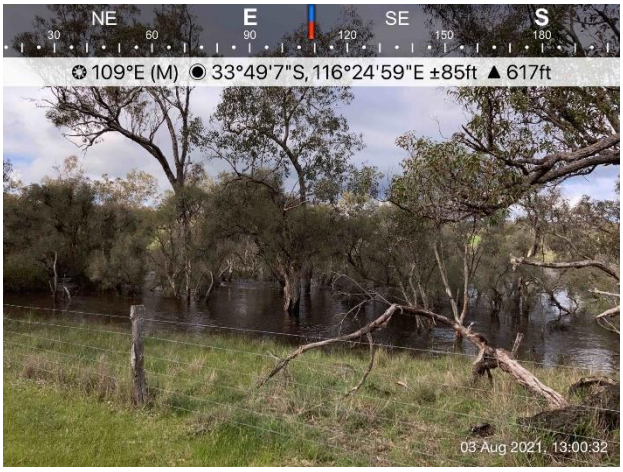

Photo 7: The Blackwood River fronting the Subject Site near the location of soil testing site TP6. Flood levels extend to the outer edges of the riparian zone outside of the Subject Site.



Photo 8: The Blackwood River fronting the Subject Site near the location of TP4. Flood levels extend beyond the river channel to the outer edges of the riparian zone outside of the Subject Site.

In accordance with advice received from Department of Water and Environmental Regulation on the 1st April 2021 the 1982 flood levels recorded within the Blackwood River shall be utilised as the 1% AEP flood level and be utilised to determine building habitable floor levels. The 1982 estimated flood level within the Blackwood River fronting the Subject Site is estimated to be 190m AHD, with a recommended habitable floor level of 190.5 mAHD required to ensure adequate flood protection (DWER, Greening, L. (2021) email to Steve Thompson, 1st April).

In-situ water quality testing was conducted at one location within the Blackwood River, adjacent to soil testing location TP4 (Figure 5). Water quality testing was conducted using a Horiba-50 Water Quality Meter. Testing results are presented in Table 9.

Table 9: Water quality testing of the Blackwood River

	Temperature (°C)	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Total Dissolved Solids (g/L)
Blackwood River	10.96	7.15	3650	8.99	2.38

Water quality testing results found that the surface water within the Blackwood River fronting the Subject Site was slightly saline to brackish with a neutral pH. The dissolved oxygen was consistent with fresh flowing water and the total dissolved solids were found to be elevated, consistent with the EC, when compared to ANZECC and ARMCANZ (2000) water quality guidelines. Impacts to the water quality of the Blackwood River is a primary concern for the development, and the post-development scenario shall ensure maintenance or improvement of the water quality of the river.

3.8 Hydrogeology and Groundwater

Australian Geoscience Mapping and Department of Water 250K Hydrogeological mapping places the Subject Site within three hydrogeological zones, being:

Archaean (Ano) – with the geology described as '*Granitoid gneiss, migmatite and minor schist; subsurface generally weathered to clay (indicated by lighter colour) (outcrop)'* and the aquifer described as; '*Fractured and weathered rocks - local aquifer, very minor or no groundwater resources'.* and

Archaean (Ago) – with the geology described as '*Granitoid rock, porphyritic and even-grained; subsurface generally weathered to clayey sand (indicated by lighter clour) (outcrop)'* and the aquifer described as; *'Fractured and weathered rocks - local aquifer, minor groundwater resources'. and*

Archaean (An) – with the geology described as '*Granitoid gneiss, migmatite and minor schist; subsurface generally weathered to clay (indicated by lighter colour)'* and the aquifer described as; '*Fractured and weathered rocks - local aquifer, very minor or no groundwater resources'.*

Hydrogeological mapping for the Subject Site is shown on Figure 7.

Groundwater levels across the site were measured as part of the BDS site soil investigation. The investigation found groundwater was encountered near surface (<0.5m) in the western portion of the site where medium to dense clays were found to be present. Groundwater levels here ranged between 0.17 and 0.65 m below ground level. The groundwater encountered in the west of the site is not likely an indication of the true local surficial groundwater table rather a perched water table, with recent rainfall perching on the medium - dense clays below. Groundwater was not encountered to 2 metres depth in the southern, eastern or northern portions of the site during the August 2021 investigation further indicating the groundwater encountered in the west is a result of a perched water table.

WML Consulting Engineers installed 11 groundwater monitoring bores as part of the pre-development monitoring program, details of the groundwater monitoring bores are presented in Table 10, with the lithology of the bores to determine aquifer characteristics shown in Table 4. Groundwater was measured initially by WML Consultant Engineers in Oct 21 and again monthly from Jun 22 to Oct 22. Bio Diverse Solutions continued to monitor the bores monthly from Jun 23 to Oct 23. Groundwater levels across the site varied from 0.5 m above ground level at BH8 in Aug 23 to 10.5 m BGL at BH3 and BH7 in Oct 21. Groundwater levels across the site generally fluctuated consistent with seasonal rainfall. The groundwater levels recorded in the bores for the Oct 21 to Oct 23 monitoring period are shown in Table 11, with the highest recorded groundwater level at each bore also added to Figure 8. Groundwater levels are also presented and discussed in the Pre-development Surface Water and Groundwater Monitoring (Appendix B).

Groundwater was found to be above ground level or close to ground level at BH8 in the north of the site during each monitoring event. The ground surface here was not found to be waterlogged (groundwater <0.5m BGL) and therefore it is assumed that the high groundwater levels at BH8 are a result of a deeper confined aquifer and/or a preferred groundwater flow path.

The Subject Site is not located within a Public Drinking Water Source Area (PDWSA; DWER, 2018). The nearest PDWSA is the Boyup Brook Dam Catchment Area which is located approximately 3.3km southeast of the Subject Site. The Subject Site does not form part of the Boyup Brook Dam catchment area.

Table 10: Details of monitoring wells (WML Consultant Engineering, 2021)

Monitoring well	Co-ordinates		Monitoring well Screening depth (m)	Depth of hole (m)
	Easting	Northing		
BH1	444344.1	6257799.7	2.2-5.2	5.95
BH2	444101.9	6257932.5	0.5-2.0	3.34
BH3	444034.9	6258303.2	4.3-7.3	8.47
BH4	444516.5	6258065.0	2.0-3.0	3.97
BH5	444742.8	6258308.2	1.0-4.0	5.10
BH6	444874.4	6257783.5	1.6-2.6	3.97
BH7	445140.9	6258561.9	1.9-4.9	5.88
BH8	445087.5	6258910.6	6.0-9.0	10.0
BH9	445987.9	6258107.7	0.6-2.6	3.93
BH10	445652.3	6257980.3	7.5-10.5	11.14
BH11	445458.5	6257503.9	0.6-2.6	3.99

Table 11: Groundwater level readings (WML Consultant Engineering, 2021)

Monitoring Bore	Groundwater level (m BGL)									
	Oct 21	Jun 22	Jul 22	Aug 22	Oct 22	Jun 23	Jul 23	Aug 23	Sep 23	Oct 23
BH1	4.9	2.5	3.3	2.8	3.0	3.5	dry	2.8	3.0	3.2
BH2	2	dry	dry	dry	1.5	dry	dry	dry	dry	dry
BH3	10.5	3.0	dry	dry	dry	dry	dry	dry	dry	dry
BH4	0.2	dry	2.3	2.3	1.5	2.5	dry	0.99	1.0	dry
BH5	1.4	3.0	1.8	3.0	1.8	3.2	3.3	0.6	1.4	2.0
BH6	1.5	dry	dry	dry	2.3	dry	dry	dry	dry	dry
BH7	10.5	dry	dry	dry	dry	4.8	4.8	4.8	4.8	dry
BH8	0.1	-0.2*	-0.3*	-0.3*	-0.5*	0.1*	0.1*	-0.5*	-0.3*	dry
BH9	dry	dry	dry	dry	dry	dry	dry	3.4	dry	dry
BH10	3.3	3.9	4.1	3.9	3.2	4.1	4.3	3.6	3.8	4.0
BH11	dry	dry	dry	dry	2.5	dry	dry	dry	1.3	dry

Notes: * Groundwater level is above ground level

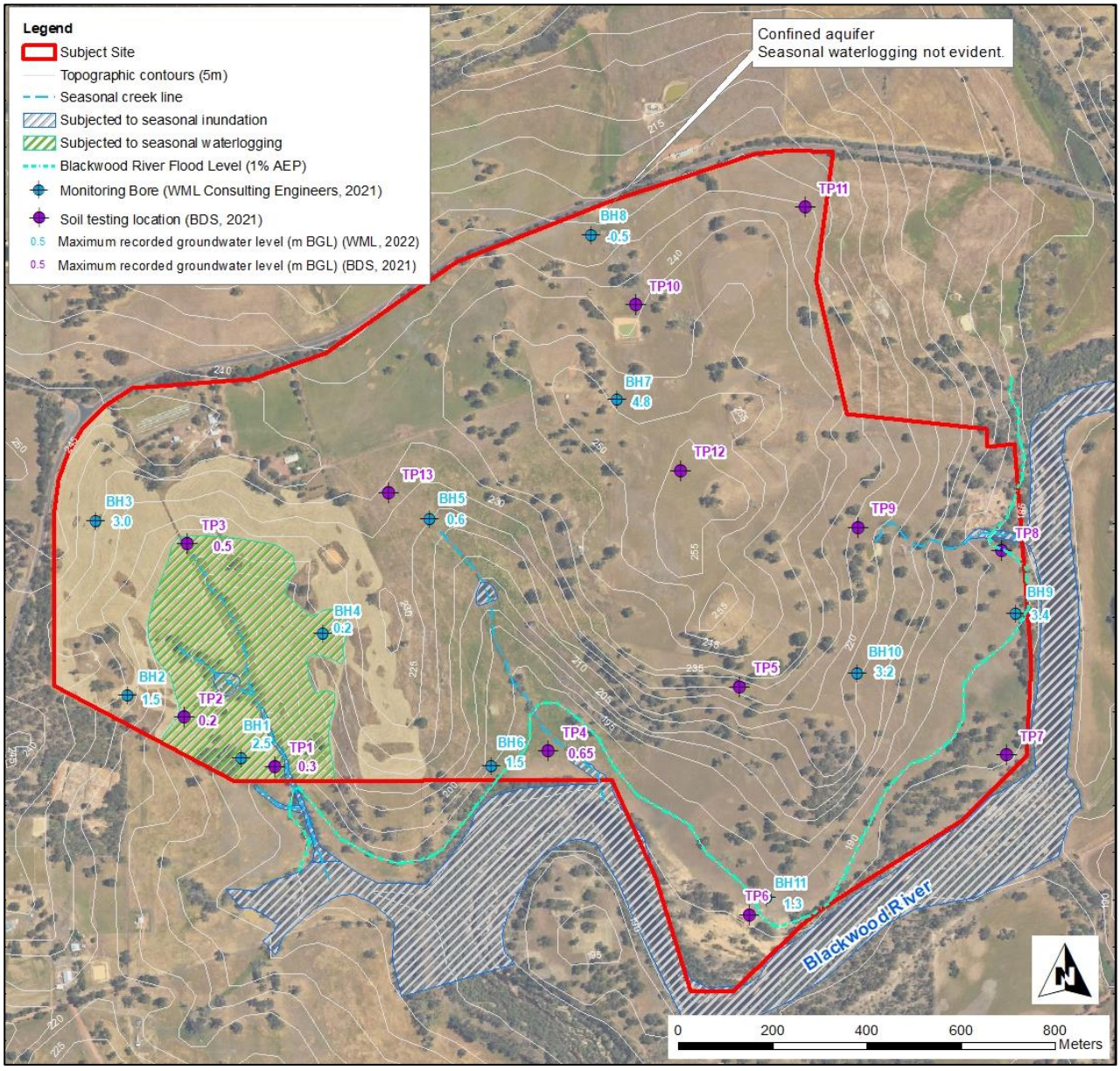

Figure 8: Maximum groundwater levels, waterlogging and seasonal inundation

3.9 Wetlands

There are no Conservation Category Wetlands (CCW) or classified Environmentally Sensitive Areas (ESA) within the Subject Site or within the vicinity of the Subject Site. The Blackwood River, whilst not classified by Government Departments as a CCW or ESA is a major drainage network and resource that passes through much of the southwest of the state. Long-term maintenance of the river's biological diversity, soil structure and water quality and quantity shall be a primary consideration.

4 Wastewater Management

The Subject Site is situated in an area that does not have access to deep or reticulated sewerage. The health and environmental requirements for wastewater treatment and disposal for developments not serviced by deep sewerage systems are contained in the *Government Sewerage Policy*, (DPLH, 2019). The *Government Sewerage Policy* (DPLH, 2019) states minimum requirements apply for all on-site sewage disposal systems.

A Site Soil Evaluation (SSE) (BDS, 2023) has been prepared for the Subject Site. The SSE details the site soils under late winter conditions and assesses the suitability and constraints for on-site effluent disposal across the site in relation to the proposed rezoning and future development.

In summary, the SSE identifies the majority of the site as suitable for onsite effluent disposal (BDS, 2023). Given the shallow depth to clay in the west of the site special design requirements and distribution techniques or soil modification procedures are necessary to ensure the rate of percolation of effluent through the soil is less than the effluent generation rate. Several areas of exposed granite outcrop were identified at the subject Site, these areas shall be avoided for effluent disposal.

The minimum required separation to groundwater was achievable across the majority of the Subject Site. There was a perched water table evident in the west of the site following winter rainfall which did not achieve the minimum separation requirements, as such special consideration and potentially imported fill will be required to achieve minimum requirements here.

A 100m setback to the outer edges of the riparian zone of the Blackwood River shall be established for future Land Application Areas (LAAs). A setback of 100 m between LAAs and the western or central creek line shall generally be established, where lots encompassing the western or central creek line cannot achieve a 100m setback, a reduced setback between 70 and 100m may be sought to achieve site feasibility, with the approval of the reduced setback to be at the discretion of approving government agencies. The downstream reaches of the shorter eastern creek line are highly eroded, likely contributing to sedimentation within the Blackwood River. It is proposed the eastern creek line be stabilised and runoff redirected to an engineered drainage system. The stormwater storage and storage outlet pipe proposed adjacent to the eastern creek line will convey runoff up to the 20% AEP from the incoming sub-catchment, with a strategic break conveying storm events greater than the 20% AEP storm event. Therefore a 100 m setback is not required to the eastern creek, instead a 30 m setback to all strategic breaks shall apply.

Typical leach drains or irrigation systems (surface or subsurface) have been identified as the most suitable systems for future lots depending on the soil category determined for each lot. The soil category for each future proposed lot shall be confirmed at subdivision application stage.

Secondary treatment systems shall be utilised on lots within the Subject Site in alignment with the Government Sewerage Policy, this includes;

- All lots less than 4000m^2 located in Soil Category 5 – Light Clays; and
- All lots located within Soil Category 6 – Medium/Heavy Clays.

More information relating to effluent disposal management at the Subject Site is presented in the SSE (South Environmental, 2024).

5 Local Water Management Strategy

5.1 Water Sustainability Initiatives

5.1.1 Water Supply

Water supply to households is to be via an extension of the Boyup Brook scheme water system. The project civil engineer shall negotiate the extension of the scheme water system with Water Corporation Western Australia.

WCWA have indicated that an extension of the existing scheme water system is achievable and will require the following infrastructure:

- 2.2km of DN100 water main;
- 80kL elevated tank on a 12m stand on ground at 255m AHD; and
- 7L/s transfer pump connecting pipework to the existing scheme water system.

Funding for the above infrastructure shall be provided by the developer. There is also potential for Infrastructure Development Fund assistance given the development allows for significant regional benefits in facilitating new housing for key workers and benefitting the Boyup Brook townsite.

5.1.2 Water Efficiency Measures

To achieve water efficiency targets, households are to be built consistent with current BCA water efficiency standards. Water efficiency initiatives are proposed to reduce potable water demand for irrigation of residential lots. These include encouragement of:

- Selection of predominantly local native, drought tolerant plants;
- Use of waterwise gardens, restricted lawn areas and water wise lawn varieties;
- Use of rainwater tanks, and
- Community education initiatives on water conservation and reuse.

5.1.3 Public Open Space

Based on the Shire of Boyup Brook's direction to limit on-going maintenance costs to the Shire, the proposed foreshore reserve and POS areas are modest in scale. The foreshore reserve is expected to remain in a largely natural state with limited landscaped areas. There are opportunities for the installation of a bore to irrigate the foreshore POS, with watering here limited to the establishment of native vegetation. There are also opportunities to utilise a bore and/or to capture surface water runoff to irrigate the small centrally located area of POS. Other than a possible modest playing field within the central POS, it is expected that most of the public POS at the Subject Site will comprise of native vegetation.

5.2 River Foreshore Management

As part of the LWMS the following key measures will be implemented to ensure the adjacent Blackwood River will not be negatively impacted by the proposed development;

- The general post-development hydrology of the site will be consistent with the pre-development hydrology;
- Up to the 20% Annual Exceedance Probability (AEP) storm event from the internal road network and Subject Site will be retained and treated within the Subject Site outside of the Blackwood River and its riparian zone;
- Post development outflows from storm events up to the peak 20% AEP will be maintained to pre-development outflows;
- Building envelopes shall be situated a minimum of 50m from the outer edges of the riparian zone of the Blackwood River; and

- Land application areas for onsite effluent disposal will be located a minimum of 100m from the outer edges of the riparian zone of the Blackwood River.

5.3 Stormwater Management

5.3.1 Design Capacity

The stormwater management system for the development has been designed in accordance with the guidelines of the DWER through the Better Urban Water Management framework and the requirements of the Shire of Boyup Brook. The stormwater drainage system has been designed using a major/minor approach.

The stormwater drainage system is designed to manage a range of rainfall events up to 1% AEP. The major drainage system is designed for rainfall events greater than the 20% AEP, up to the 1% AEP.

The minor drainage system has capacity for frequent rainfall events up to the 20% AEP and includes the pipe drainage system, soak wells and bioretention storage areas. The minor drainage system is designed to also provide the structural controls for water quality treatment.

The major system uses overland flow paths, which includes grading the road network to direct flow to the lowest point of the catchment for flood mitigation.

5.3.2 Stormwater Modelling

The stormwater modelling has been completed utilising the Rational Method and the Boyd Equation. A critical design criterion for both these methods includes the runoff coefficients. The pre-development and post-development runoff coefficients assumed for the Subject Site are shown in Table 12.

Table 12: Runoff coefficients

LAND USE	RUN OFF COEFFICIENT		
	First 15mm	20% AEP	1% AEP
Agricultural land	0	0.20	0.25
Road Reserve	0.80	0.80	0.90
Lots – <R1	0	0.25	0.30
Lots – R1 to R3	0	0.35	0.40
Lots – R5	0	0.40	0.45
Public Open Space (POS)	0	0.30	0.35

The general pre-development hydrological regime (Figure 7) is maintained in the post-development scenario, with the majority of the Subject Site proposed to discharge towards the Blackwood River either directly, via the internal road network or via the three creek lines.

Future residential/rural residential areas fronting the Blackwood River and the Boyup Brook – Arthur Road will runoff unattenuated consistent with the existing hydrological regime. Lots fronting the Blackwood River and the Boyup Brook – Arthur Road are proposed to be either Rural Residential (<R1) or Residential (R1 - R3) and are likely to remain grassed and/or vegetated with roofed areas connected to rainwater tanks and/or soakwells/rain gardens. Therefore, there is expected to be little change in the runoff coefficient of these areas compared to the pre-development scenario. Where lots are upgradient of the internal road network, the road network will intercept runoff from the lots and direct it to the road's drainage system. Lot areas that discharge to the internal road network therefore form part of the site's post-development drainage sub-catchments, as shown in Figure 9. The total area of each sub-catchment and the estimated land use area for each sub-catchment is presented in Table 13.

Table 13: Post-development sub-catchment areas

Land Use (ha)	Catchment						
	A	B	C	D	E	F	G
Pre-development							
Agricultural land (ha)	39.3	5.2	44.3	11.8	14.8	18.2	15.3
Total Area (ha)	**39.3**	**5.2**	**44.3**	**11.8**	**14.8**	**18.2**	**15.3**
Post-development							
Road Reserve (ha)	4.5	1.2	5.6	0.8	3.0	3.7	3.8
Lots – Rural Residential (ha)	11.9	0	0	0	0	0	0
Lots – R1-R3 (ha)	18.1	0	22.3	11.0	11.3	7.6	0
Lots – R5 (ha)	3.5	4.0	14.4	0	0.5	6.9	11.5
POS/Bushland (ha)	2.0	0	2.0	0	0	0	0
Total Area (ha)	**39.3**	**5.2**	**44.3**	**11.8**	**14.8**	**18.2**	**15.3**

Multiple storm events have been modelled utilising the Rational Method as described in Australian Rainfall and Runoff (AR & R) (Engineering Australia, 2001). Predevelopment outflow rates have been calculated based upon peak flow stream discharge as determined by Section 1.4 of AR & R.

Rainfall intensities for the various storm events and storm durations are calculated and provided by the Bureau of Meteorology (BoM) computerised design IFD Data System (www.bom.gov.au). Calculations have been undertaken utilising up to date IFD charts.

The Boyd equation has been utilised to calculate the stormwater storage volume required for each sub-catchment based on the post-development runoff from each sub-catchment and the allowable outflows set for the stormwater storages based on the peak pre-development outflow. The Boyd equation is considered a conservative estimate of stormwater storage volume calculation.

5.3.3 Drainage System Requirements

Key elements of the minor drainage system strategy are as follows:

Lot Attenuation

- It shall be the landowner's responsibility to manage stormwater runoff from buildings, hard stand (impervious) areas and gardens within the property boundary. In the absence of lot attenuation guidelines for the Shire of Boyup Brook 0.5m³ of storage is required per 100m² of impervious area. Lot stormwater management systems should be assessed and approved by the Shire of Boyup Brook upon Development Application.
- Soakwells shall only be utilised where there is adequate separation to the peak annual water-table from the base of the soakwell (>300 mm), adequate gradient for graduated pipe overflow pipes, and where soils allow suitable infiltration rate (not suitable in medium to heavy clays). In areas with shallow depth to groundwater or medium to heavy clays, as encountered in the west of the Subject Site, attenuation basins integrated into the garden landscaping will provide the most effective attenuation mechanism. When designing lot stormwater management systems, overland flow routes directing runoff away from buildings and adjoining properties shall be considered. Lot stormwater management systems should be assessed and approved by the Shire of Boyup Brook upon Development Application.

Stormwater Conveyance

- Pit and pipe network installed within the road reserve sized to convey runoff from the Subject Site for storm events up to the critical 20% AEP. Alternatively, in lower density areas (R1 to R3) road side swales designed to convey up to the 20% AEP may be utilised.
- Road drainage for storm events greater than the peak 20% AEP event, up to the peak 1% AEP event, will be directed to the lowest point in each catchment via overland flow along the road pavement. The ultimate road low point will be located adjacent to the Blackwood River or the Boyup Brook – Arthur Road to ensure road runoff is directed off site during storm events greater than the 20% AEP. Runoff from storm events greater than the 20% AEP event will be directed off site unattenuated. Attenuation of flows for storm events greater than the peak 20% AEP event, up to the peak 1% AEP event will have negligible impact on the flood regime of the general area, as per comments received from DWER on the 16th December 2023.
- Where the low point of a sub-catchment is not directly adjacent to the Blackwood River a strategic break/flood route allowing runoff from the road to the river shall be provided. The strategic breaks shall be sized to convey up to the 1% AEP storm event from the road network. Measures shall be taken at the downstream end of the strategic breaks all the way to the Blackwood River to ensure scouring and movement of sediment does not occur. This may include rock pitching and stabilisation matting. The Shire of Boyup Brook shall ensure that when the landowners adjacent to the strategic break are developing their lots that the stormwater flood route is not compromised.

Bio-retention and Stormwater Storage

- Drainage treatment train utilising bio-retention storages designed to treat the first 15mm of rainfall, by providing infiltration at source or close to source. Bio-retention storages shall be designed to convey up to the 20% AEP storm event. Storages shall be located at the low point of the sub-catchments (outside of the Blackwood River foreshore area), to direct runoff away from infrastructure in the case that the capacity of the storage is exceeded. The bio-retention storages shall be located outside of the Blackwood River and its flood/riparian vegetation zone.
- The base of the bio-retention storages shall be underlain with 0.4m depth of amended soil, 0.15m depth of a transition layer (coarse sand) and 0.15m depth of a drainage layer with 100mm (maximum) perforated collection pipes (subsoils). The base of the bio-retention storages shall also be planted. The specifications for the amended soil and the planting are provided in Section 5.4.
- Each bio-retention storage shall have a sediment trap at the inlet to the storage. Junction pits may also be used through the development to increase infiltration at source, in hand reducing the size of the bio-retention storage. Junction pits are not proposed in heavy clays or sands with a low PRI and the use of junction pits shall be confirmed in the subsequent Urban Water Management.
- Outflow from the bio-retention storages will be set at the top water level of the first 15mm runoff event, this is set at a maximum depth of 0.4m to allow for adequate water quality treatment across a larger surface area. Outflow from storages will be via an overflow/outflow pit sized to match the peak pre-development outflow from the 20% AEP event.
- The maximum side slopes of the bio-retention storages shall be 1:6, with at least 0.3m of freeboard provided between the 20% AEP top water level and top of bank. A stabilised low point in the bank shall be provided at the 20% AEP top water level, located downstream in the bio-retention storage so that overflow is directed off site when/if the capacity of the storage is exceeded.

ATTACHMENT 6

Site Soil Evaluation

Lot 51, 1007, 1118 Boyup Brook – Arthur Rd, Boyup Brook, WA



8th July 2024

SOUTH ENVIRONMENTAL

Document Control

Title: Site Soil Evaluation: Lot 51, 1007, 1118 Boyup Brook – Arthur Rd, Boyup Brook WA
Author: Chiquita Cramer
Job No.: A002
Client: Leafield Pty Ltd

Revision Record – South Environmental

Revision	Summary	Prepared by	Revised/Comments Received by	Date
Final SSE 08/07/24	SSE updated to include revised Local Structure Plan/Subdivision Concept Plan.	C. Cramer	DPLH & SoBB	08/07/2024

Revision Record – Bio Diverse Solutions

Revision	Summary	Prepared by	Revised/Comments Received by	Date
Draft Id 22/06/23	Internal QA Review	C. Cramer	M. Wearing	22/06/2023
Draft Id 26/06/23	Issued to project team for comment	C. Cramer	S. Thompson	26/06/2023
Draft Id 11/07/23	Technical Review	C. Cramer	K. Kinnear	11/07/2023
Final Id 11/07/23	Final Report issued to client	C. Cramer	-	11/07/2023
Final Id 09/02/23	Updated to address DWER and DoH comments	C. Cramer	C. Cramer	09/02/2023

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1. Introduction

Lots 51, 1007 and 1118 Boyup Brook-Arthur Road Site Soil Evaluation (SSE) has been prepared by South Environmental on behalf of Leafield Pty Ltd (the client) in support of an amendment to the Local Planning Scheme and to provide guidance to the Local Structure Plan (LSP) prepared for the site.

The SSE details the site soils and suitability for on-site effluent disposal across the Subject Site (as defined in Section 1.3) in relation to the planning proposal. The SSE has been prepared in alignment with the Government Sewerage Policy (DPLH, 2019a).

The information presented in this SSE has been derived from the previously prepared *Site Soil Evaluation – Lot 51, 1007, 1118 Boyup Brook-Arthur Road, Boyup Brook* (Bio Diverse Solutions, 2024). The SSE has been updated by South Environmental, upon the direction of the client, to include recent modifications to the Local Structure Plan Concept Plan and to address comments from the Department of Planning, Lands and Heritage (DPLH) and the Shire of Boyup Brook. This SSE prepared by South Environmental supersedes the previously prepared SSE prepared by Bio Diverse Solutions.

1.1. Alignment to Legislation, Policy and Guidelines

South Environmental has prepared this report aligned to the following legislation, policy and guidelines:

- *Government Sewerage Policy (2019);*
- *Health Act (1911)* and the *Public Health Act (2016);*
- *Country Area Water Supply Act 1947;* and
- Australian Standard (AS)1547-2012.

1.2. Suitable Qualified Hydrologist

This SSE has been prepared by Chiquita Cramer, who has 15 years of experience working as a hydrologist, hydrogeologist and environmental consultant.

Chiquita Cramer has the following tertiary qualifications:

- Bachelor of Science in Natural Resource Management (University of Western Australia); and
- Graduate Certificate in Hydrogeology (University of Western Australia).

Chiquita worked as a hydrologist and senior hydrologist at JDA Consultant Hydrologists in Perth for 8 years, during this time she also completed a Graduate Certificate in Hydrogeology. In 2017 she joined Bio Diverse Solutions (BDS) to provide expertise in hydrology and hydrogeology to the company and in 2024 she established South Environmental. Chiquita's experience includes preparation of local and urban water management strategies, hydrological and hydraulic investigations, surface water and groundwater monitoring reports, hydrogeological reports and site soil evaluations for onsite disposal suitability. Chiquita has successfully completed numerous SSE reports for a range of developments at various planning stages. Chiquita also attended a workshop on SSE reporting organised by the Department of Health in 2021.

1.3. Location

Lots 51, 1007 and 1118 Boyup Brook-Arthur Road (herein referred to as the Subject Site) comprises of approximately 221.8 ha and is located approximately 2.5 km northeast of the Boyup Brook town centre. The Subject Site is bound by Boyup Brook-Arthur River Road to the north, the Blackwood River to the east and southeast and adjoins cleared agricultural land to the northeast, west and southwest. The location of the Subject Site is shown in Figure 1.

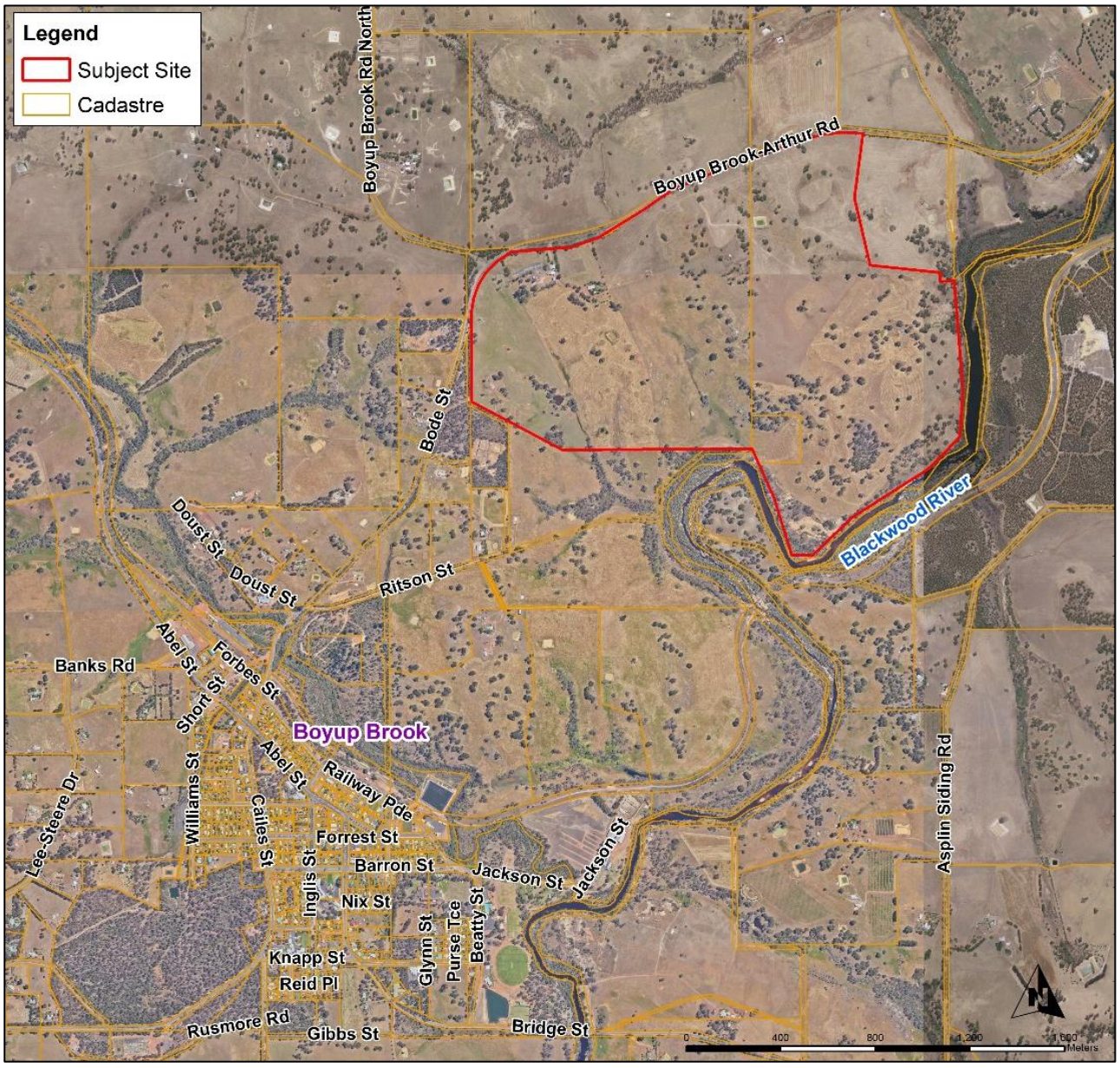


Figure 1: Location Plan

2. Development Proposal

The Subject Site is situated within the Shire of Boyup Brook and zoned *Rural* under the existing Shire of Boyup Brook Local Planning Scheme (No. 2). It is proposed to rezone the Subject Site from *Rural* to *Special Use Zone 2 (SU2)* to allow for residential and rural residential lots ranging in size from 2,000 m^2 up to ~5 ha. A Local Structure Plan and subdivision concept plan showing the planning proposal for the Subject Site is shown in Figure 2.

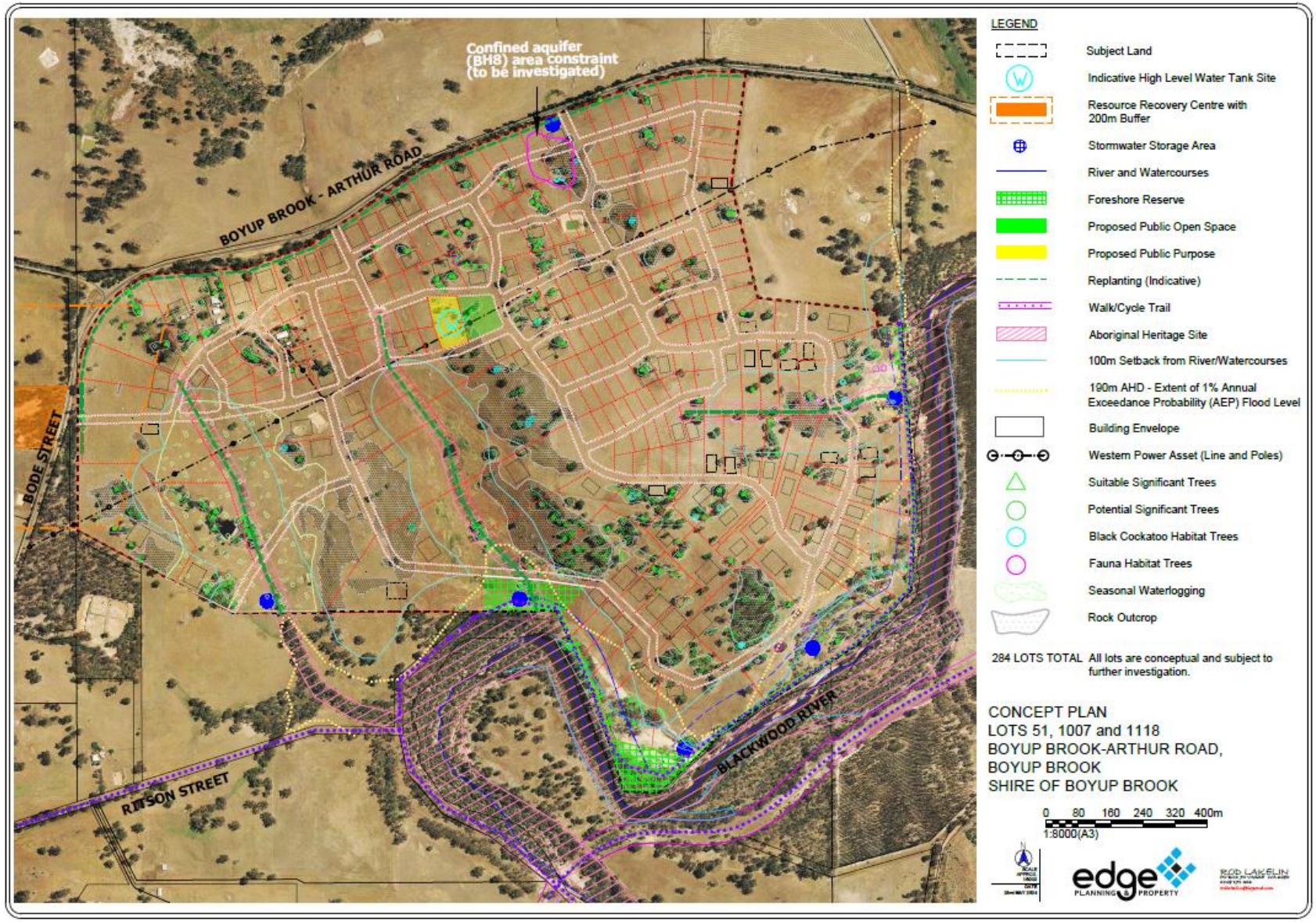


Figure 2: Local Structure Plan & Subdivision Concept Plan (Edge Planning & Property, 2024)

3. Desktop Assessment

3.1. Topography

The Subject Site generally slopes from northwest to southeast towards the Blackwood River, from a high point of 255 m AHD in the central portion of the site to 180 m AHD along the Blackwood River foreshore in the southeast and east of the site. A smaller portion of land in the north of the site slopes back towards the Boyup Brook-Arthur Road which lies at approximately 225 m AHD. Topographic contours (5 metre) for the Subject Site are shown in Figure 3.

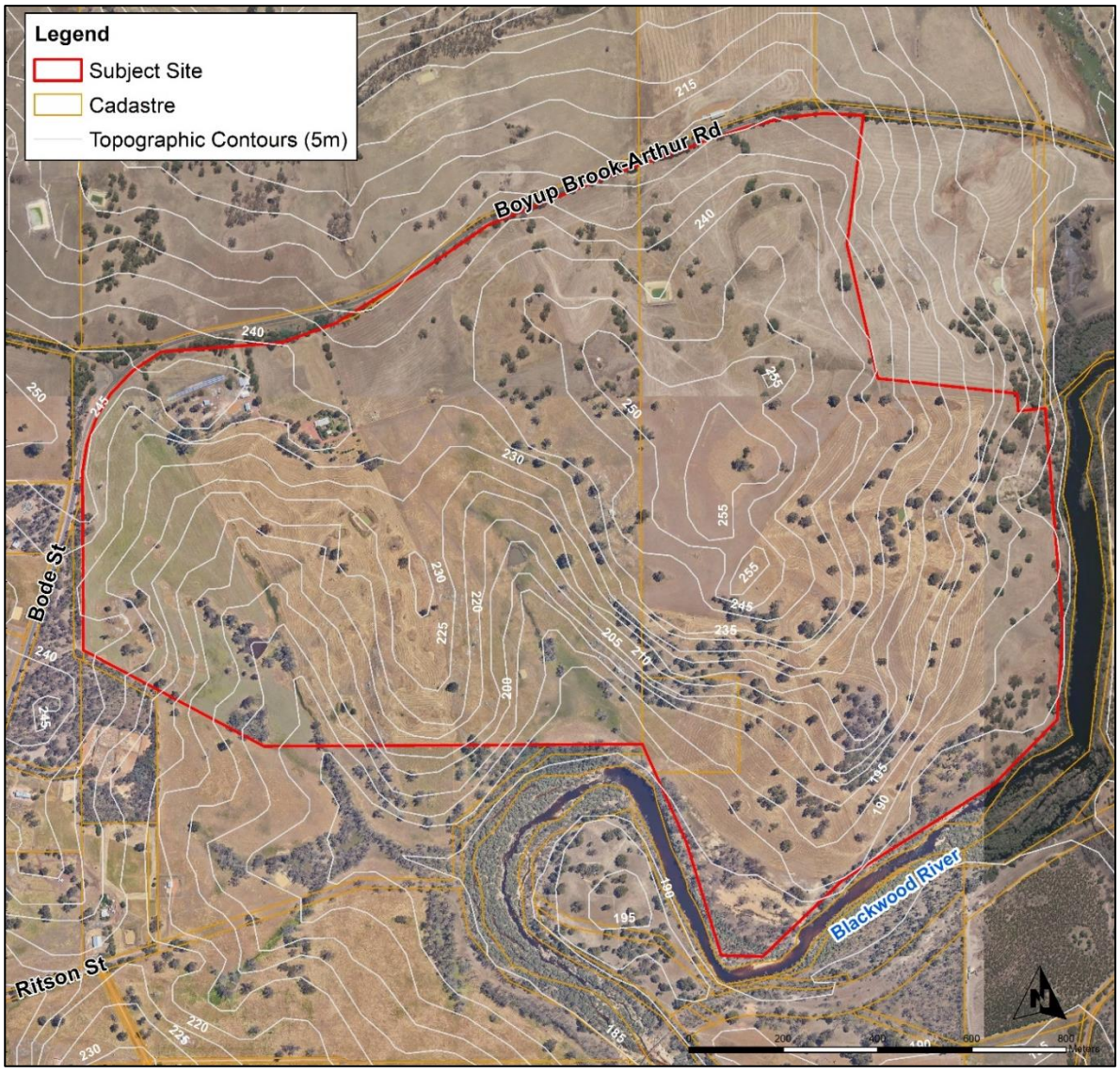


Figure 3: Topography

3.2. Climate

The Boyup Brook area is characterised by a Mediterranean climate with warm dry summers and cool wet winters. Rainfall data is from the nearby Bureau of Meteorology (BoM, 2024) Boyup Brook Station (Site No. 9504). The long-term average annual rainfall is 646mm (1914 to 2020), there was no BoM data available at this site for 2021 to 2023. This average has decreased between 2000 to 2020, to an average annual rainfall of 542 mm, reflecting a 16% reduction compared to the long-term average, consistent with a general drying trend in the Southwest of WA.

The total rainfall distribution has also altered, with a reduction of average winter monthly rainfall, but no significant reduction in average summer monthly rainfall (BoM, 2023).

The average annual pan evaporation for the Boyup Brook area is approximately 1399 mm (Luke et al 1988).

3.3. Remnant Vegetation

The Subject Site predominantly consists of cleared agricultural land with scattered paddock trees (predominantly jarrah and marri), there are small patches/strips of remnant vegetation, predominantly located in the southeast of the Subject Site adjacent to the Blackwood River.

The Subject Site lies within the JF02 – Jarrah Forrest Interim Bio-geographic Regional Area (IBRA).

The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd et al 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics. A GIS search of J.S. Beards vegetation classification places the Subject Site within one System and Vegetation Association (DPIRD, 2017a):

- **System Association Name**: Bridgetown.
- **Vegetation Association Number:** 992 & 3.
- **Vegetation Description:** Mainly jarrah and marri *Eucalyptus marginata*, *Corymbia calophylla*.

There are no Conservation Parks or Class "A" Reserves within the Subject Site or within the vicinity of the Subject Site. A Black Cockatoo Survey of the existing site trees was conducted by Bio Diverse Solutions in June 2023, results of the Black Cockatoo Survey are provided in a separate report.

3.4. Acid Sulphate Soils

Acid sulphate soils (ASS) are naturally occurring soils and sediments containing sulphide minerals, predominantly pyrite (an iron sulphide). When undisturbed below the water table, these soils are benign and not acidic (potential acid sulphate soils). However, if the soils are drained, excavated or exposed by lowering of the water table, the sulphides will react with oxygen to form sulphuric acid. Acid Sulphate Soil (ASS) Risk Mapping indicates the Subject Site does not lie within any known areas of ASS (DWER, 2017).

3.5. Geology and Soils

Soil mapping – Zones (DPIRD, 2017a) shows the Subject Site lies within one soil zone being the Eastern Darling Range Zone (253). The Eastern Darling Range Zone is described as '*Moderately to strongly dissected lateritic plateau on granite with eastward-flowing streams in broad shallow valleys, some surficial Eocene sediments. Soils are formed in laterite colluvium or weathered in-situ granite.'*

Soil mapping – Systems (DPIRD, 2018a) shows the Subject Site lies within one soil system being the Boyup Brook Valleys System (253Bv). The Boyup Brook Valleys System is described as *'Valleys, in the south of the Eastern Darling Range (Blackwood Catchment). Gravel, sandy duplex loamy duplex. Jarrah-marri-wandoo forest and woodland.'*

The Subject Site is also located within four sub-systems of the Boyup Brook Valley System as defined by DPIRD (2017b). The sub-systems are described in Table 1 and shown in Figure 4.

Table 1: Soil Sub-systems

Map Unit Symbol	Map Unit Name	Map Unit Description
253BvNWg	Newlgalup granitic slopes phase	Relief 30-50 m, slopes 5-20%. Soil parent material is granite and gneiss. Soils are deep loamy duplex soils, deep sandy duplex soils, loamy and sandy gravels, with some loamy earths and shallow loamy duplex soils.
253BvNW4	Newlgalup moderate slopes phase	Deeply incised valleys. Relief 60-100 m, slopes 15-35%. Soil parent material is gneiss and granite. Soils are deep loamy duplex soils, and yellow loamy earths with some shallow loamy duplex soils.
253BvDM	Dalmore subsystem	Undulating ridges and hill crests on laterite and granite. Relief 5-20 m, slopes 5-15%. Soils are gravels, loamy duplex and sandy duplex soils.
253BvCP	Condinup subsystem	River channel, flood plain and raised alluvial terraces, soils are brown deep sands.

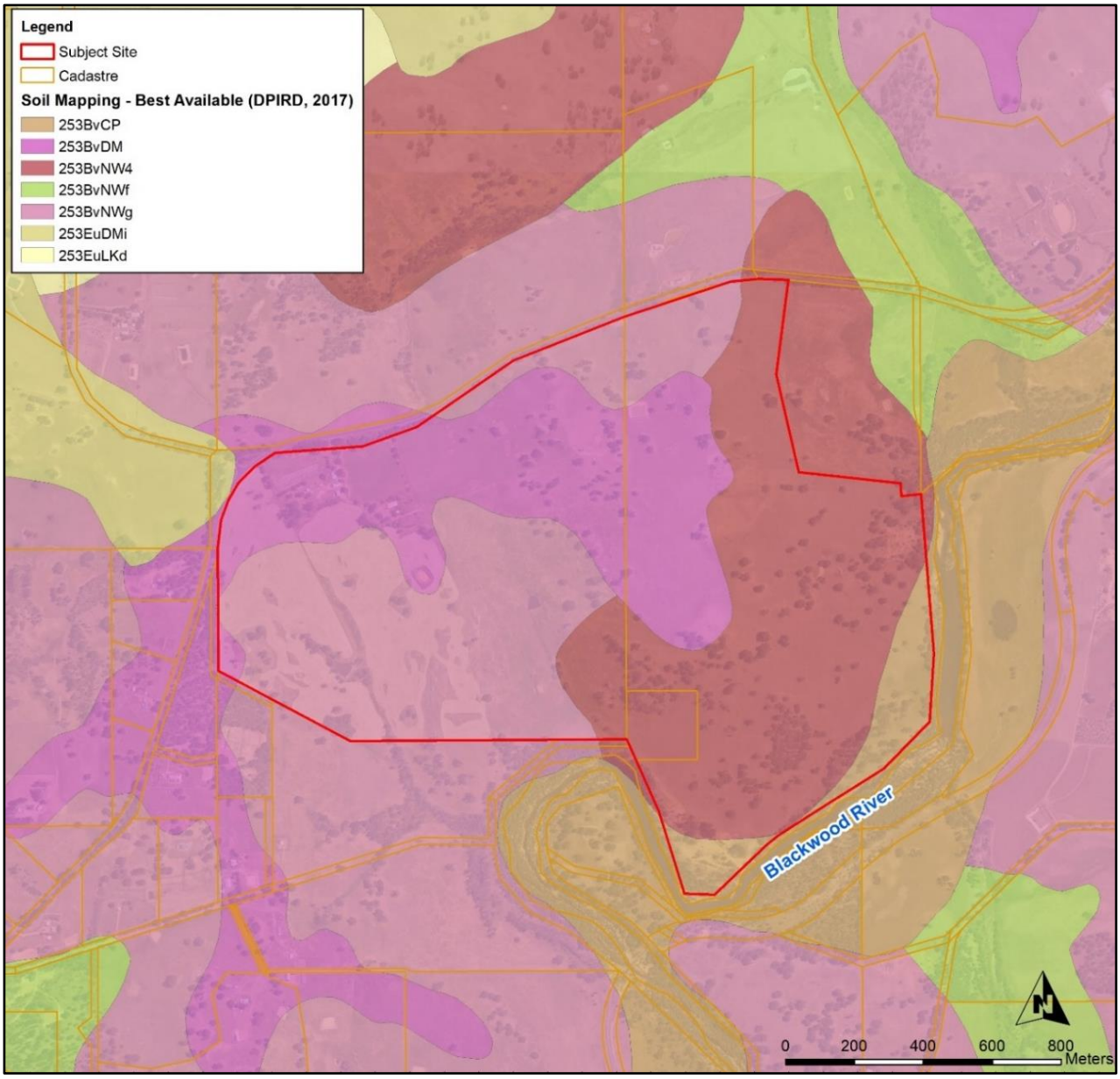


Figure 4: Soil Mapping

3.6. Surface Hydrology

There are no major drainage networks or water bodies within the Subject Site. Surface water generally runs off the site in a southeasterly direction towards the Blackwood River. The Blackwood River is the largest river in the southwest of Western Australia with a catchment area of 28,100 km^2. The river begins near the township of Wagin and flows through many small towns in the southwest prior to discharging to the coast line near Augusta.

There are three seasonal creek lines located across the site that flow in a southeasterly and easterly direction towards the Blackwood River. A relatively smaller portion of the site in the north drains in a northerly direction towards the Boyup Brook-Arthur Road, before discharging to an adjacent agricultural property, with runoff here ultimately draining to the Blackwood River further to the east. The pre-development surface water hydrology of the site and surrounding areas is shown in Figure 5.

The Subject Site is located within the Hardy Estuary – Blackwood River Hydrographic Catchment and the Middle Blackwood Sub-catchment (DWER, 2018a).

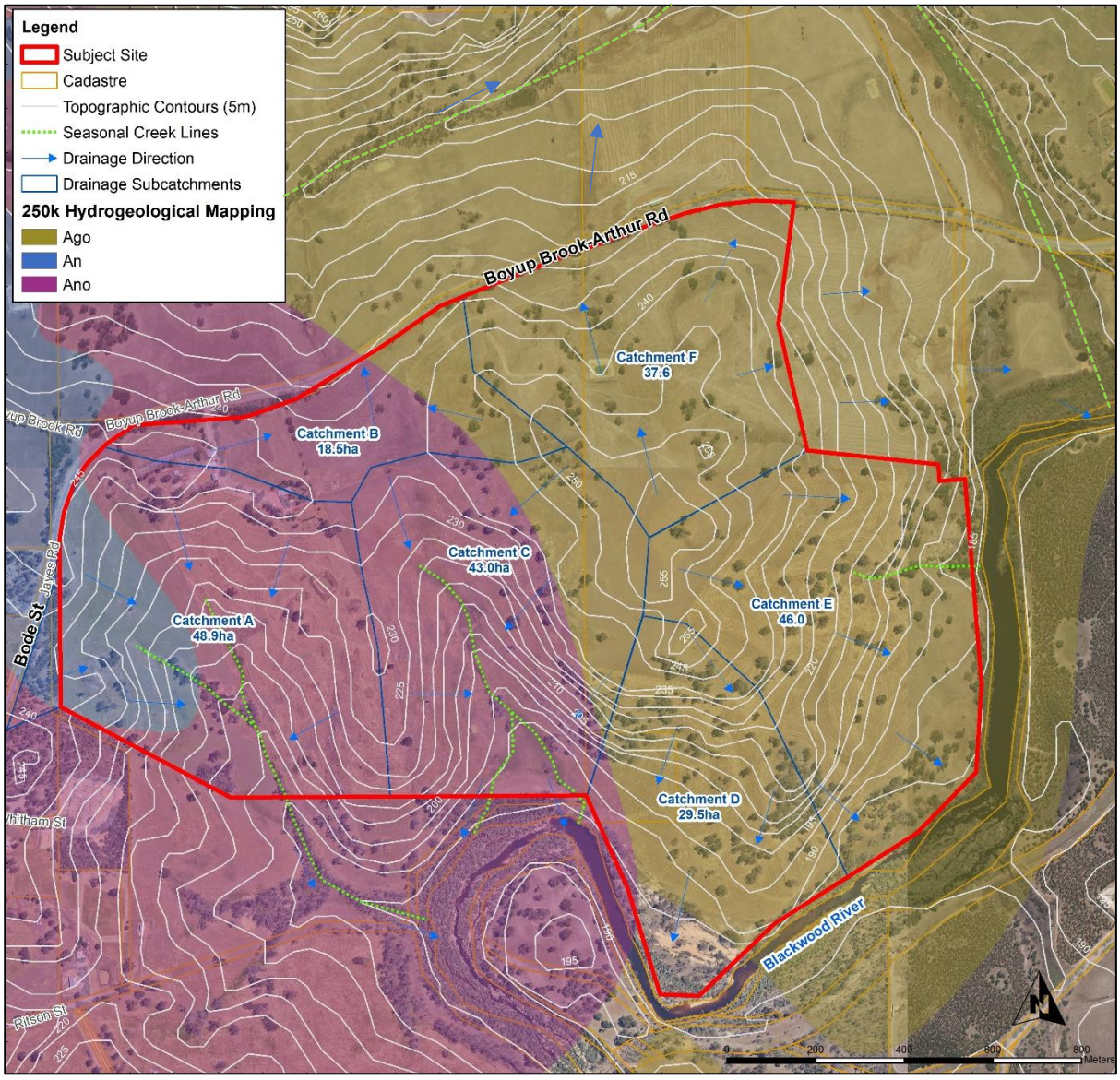


Figure 5: Surface Water Hydrology

3.7. Hydrogeology and Groundwater

Australian Geoscience Mapping and Department of Water and Environmental Regulation 250K Hydrogeological mapping (DWER, 2001) places the Subject Site within three hydrogeological zones as described in Table 2 and mapped in Figure 5.

Table 2: 250K Hydrogeological zones within Subject Site

Geology Unit	Geology Time	Aquifer Description	Geology Description
Ano	Archaean	Fractured and weathered rocks - local aquifer, very minor or no groundwater resources'	Granitoid gneiss, migmatite and minor schist; subsurface generally weathered to clay (indicated by lighter colour) (outcrop).
Ago	Archaean	Fractured and weathered rocks - local aquifer, minor groundwater resources	Granitoid rock, porphyritic and even-grained; subsurface generally weathered to clayey sand (indicated by lighter colour) (outcrop)
An	Archaean	Fractured and weathered rocks - local aquifer, very minor or no groundwater resources	Granitoid gneiss, migmatite and minor schist; subsurface generally weathered to clay (indicated by lighter colour)

3.8. Public Drinking Water Source Area

The Subject Site is not located within a Public Drinking Water Source Area (PDWSA; DWER, 2018b). The nearest PDWSA is the Boyup Brook Dam Catchment Area which is located approximately 3.3 km southeast of the Subject Site. The Subject Site does not form part of the Boyup Brook Dam catchment area.

3.9. Environmentally Sensitive Areas

There are no Environmentally Sensitive Areas (ESA) within the Subject Site or within a 10 km radius of the Subject Site (DWER, 2018c).

3.10. Wetlands

There are no Conservation Category Wetlands (CCW) within the Subject Site or within the vicinity of the Subject Site. The Blackwood River, whilst not classified by government departments as a CCW or ESA is a major drainage network and resource that passes through much of the southwest of the state. Long-term maintenance of the river's biological diversity, soil structure and water quality and quantity shall be a primary consideration in relation to development of the Subject Site.

3.11. Sewage Sensitive Areas

The Subject Site is not located in a Sewage Sensitive Area according to the Department of Planning, Lands and Heritage Sewage Sensitive Area Mapping (DPLH, 2019b).

3.12. Nutrient Modelling

Nutrient modelling showing and discussing the expected impact to nitrogen and phosphorus inputs and exports due to the changes in land use are shown in Appendix C.

4. Site Investigation

4.1. Soils

A site soil investigation was conducted on the 3rd August 2021 by Bio Diverse Solutions. The site investigation included the construction of 13 test holes to a depth of up to 2 metres, logging of soils to the depth of the hole and inspection and measuring of the water table.

The test holes were constructed using a 75 mm diameter hand auger and were left open for 1 hr for inspections of water table depth. The location of the 13 test holes is shown in Figure 6.

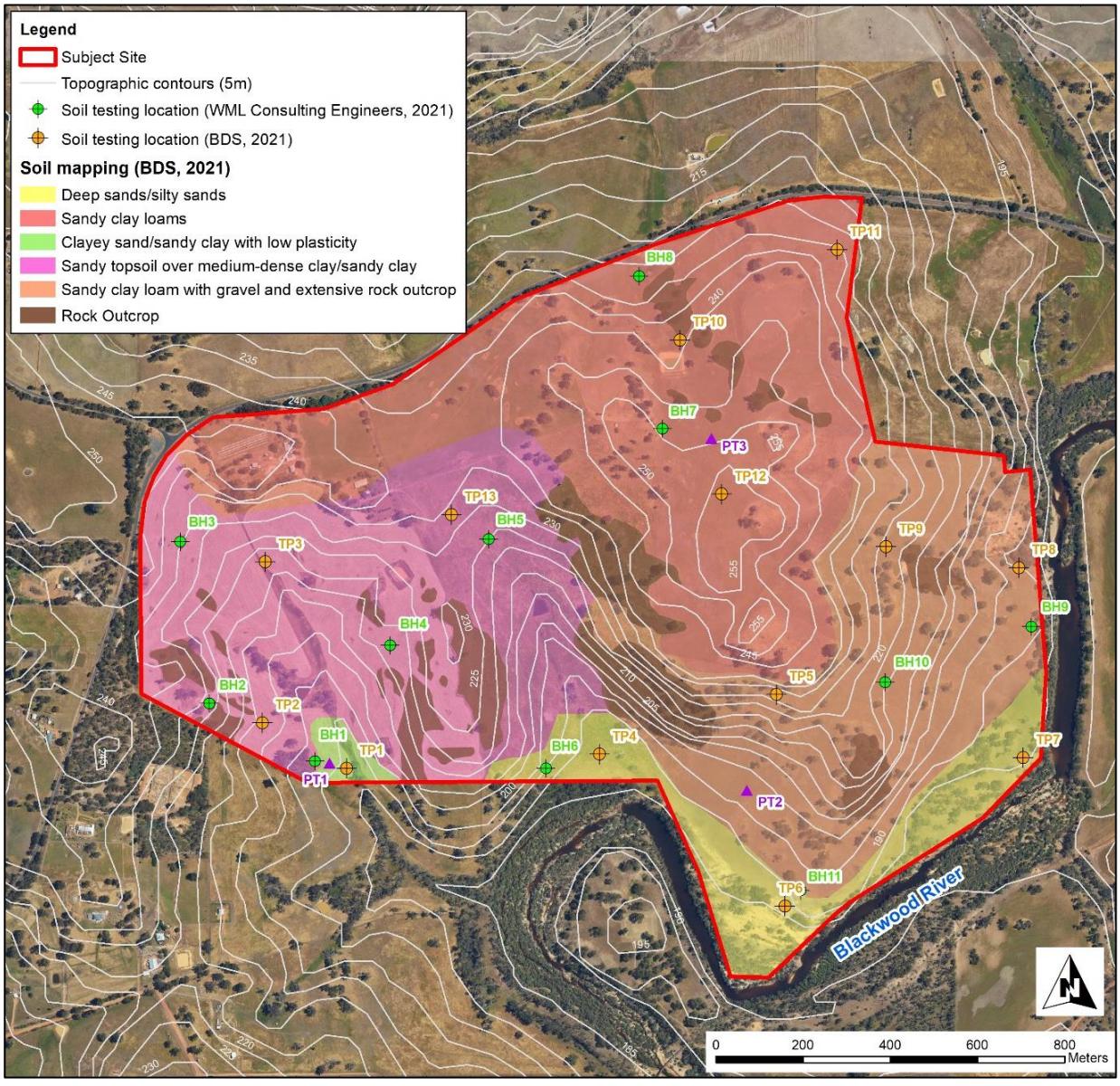


Figure 6: Soil testing and mapping

The site soil investigation by Bio Diverse Solutions revealed that soils across the site comprised of six main soil types:

1. Silty sand topsoil over deep sands, no groundwater encountered to 2 metres (found along the Blackwood River foreshore);
2. Silty sand over clay with medium to high plasticity, a perched water table encountered in the lower reaches following heavy winter rainfall (found in the west and central portion of the site);

3. Silty sand over moderately to poorly sorted sandy loam and sandy clay loam with low plasticity and generally no groundwater encountered to 2 metres (found in the higher elevations in the northeast of the site);
4. Gravelly sandy clays/clayey sands. Low plasticity clays, no groundwater encountered to 2 m (found in the southeast of the Subject Site);
5. Well sorted clayey sand/sandy clay with low plasticity. Includes a small area in the southwest in the lower reaches of the valley system; and
6. Granite outcrop (scattered throughout the site, predominantly situated on the elevated hill slopes).

The estimated boundaries of the six identified soil types are shown in Figure 6 with the Bio Diverse Solutions soil testing results presented in Table 3.

Table 3: Soil Testing Results (Bio Diverse Solutions, 2021)

Test Hole	Depth	Soil Type	Soil Description
TP1	0-150mm 150-1000mm 1000-1300mm 1300-1500mm 1500mm +	Sand with silt Sand with silt Sandy clay Sand with silt Bedrock	Grey, fine, roots and root fibres (Topsoil), moist. Dark grey, medium, well sorted, saturated. Low plasticity, dark grey, medium grained sand, saturated. Orange, fine, well sorted, saturated. Refusal, granite rock. **Water table was encountered 0.3 m BGL.**
TP2	0-150mm 150-500mm 500-800mm 800mm+	Sand with silt Sandy loam Sandy loam Clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, medium, well sorted, moist. Brown, medium, well sorted, saturated. High plasticity, orange brown mottled, saturated. **Water table was encountered 0.17 m BGL.**
TP3	0-150mm 150-500mm 500mm+	Sand with silt Sandy loam Clay	Grey, fine, roots and root fibres (topsoil), moist. Brown, medium, well sorted, moist. High plasticity, red/orange, moist. **Water table was encountered 0.5 m BGL.**
TP4	0-300mm 300-1800mm	Sand with silt Sand with silt	Grey, fine, roots and root fibres (topsoil), moist. Brown/orange, fine, well sorted, moist-saturated. **Water table was encountered 0.65 m BGL.**
TP5	0-300mm 300-1500mm	Sand with silt Gravelly clay	Grey, fine, roots and root fibres (topsoil), moist. Low plasticity, cemented layer, red/brown, coarse gravel, moist. **No water table was encountered.**
TP6	0-300mm 300-2000mm	Sand Sand	Dark brown, fine, well sorted, roots and root fibres (topsoil), dry. Yellow, fine, well sorted, dry. **No water table was encountered.**
TP7	0-300mm 300-2000mm	Sand Sand	Brown, fine, well sorted, roots and root fibres (topsoil), dry. Brown-yellow, fine, well sorted, dry. **No water table was encountered.**
TP8	0-150mm 150-300mm 300-800mm 800-1500mm	Sand with silt Sandy loam Sandy clay Sandy loam	Grey, fine, roots and root fibres (topsoil), moist. Orange/brown, fine, well sorted, moist. Low plasticity, yellow/brown, medium sand, moist. Yellow/brown, medium, well sorted, moist. **No water table was encountered.**

Table 3 continued.

Test Hole	Depth	Soil Type	Soil Description
TP9	0-150mm 150-300mm 300-800mm 800-1500mm	Sand with silt Sandy loam Sandy clay loam Sandy clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, well sorted, moist. Orange/brown, medium, poorly sorted, moist. Low plasticity, orange, medium-coarse sand, moist. **No water table was encountered.**
TP10	0-150mm 150-300mm 300-700mm 700-1300mm	Sand with silt Sandy loam Sandy clay loam Sandy clay loam with gravel Gravelly clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, moderately sorted, moist. Dark brown, fine-coarse, moderately sorted, moist. Red-brown, fine-coarse, poorly sorted, moist. Low plasticity, orange/red, moist. **No water table was encountered.**
TP11	0-150mm 150-300mm 300-700mm 700-1500mm	Sand with silt Sandy loam Sandy loam Sandy clay loam	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, moderately sorted, moist. Orange/brown, fine-coarse, poorly sorted, moist. Orange, fine-coarse, poorly sorted, moist. **No water table was encountered.**
TP12	0-150mm 150-300mm 300-600mm 600-1500mm	Sand with silt Sandy loam Sandy clay loam Sandy clay	Grey, fine, roots and root fibres (topsoil), moist. Dark brown, fine, well sorted, moist. Dark brown, fine, moderately sorted, moist. Low plasticity, orange/brow, moist. **No water table was encountered.**
TP13	0-150mm 150-600mm 600mm+	Sand with silt Sandy clay Clay	Grey, fine, roots and root fibres (topsoil), moist. Moderate plasticity, black, moist. High plasticity, orange, moist. **No water table was encountered.**

A further soil investigation was conducted from the 30th of September to the 1st October 2021 by WML Consulting Engineers as part of the installation of 11 groundwater monitoring bores across the Subject Site, the soil investigation report including bore logs is presented in Appendix A. Generally, the WML Consulting Engineers Soil Investigation showed similar soil types to BDS with deep sands found in a band fronting the Blackwood River and shallow depths (~0.2 m) to medium - dense clay in the west of the site. Unlike Bio Diverse Solutions, WML encountered medium - dense clays across the northeast of the Subject Site whereas Bo Diverse Solutions encountered sandy loams/clay loams with low plasticity, which was also evident through the permeability testing in this area. The WML Consulting Engineers (2021) soil testing results are shown in Table 4.

Table 4: Soil Testing Results (WML Consulting Engineers, 2021)

Bore Hole	Depth	Soil Type	Soil Description
BH1	0 – 200mm	Sand	Moist, dark brown, loose, fine to medium grained, **SAND** with a trace of clay and a trace of fine roots and a trace of organics.
	200 – 4200mm	Clay	Moist, orange brown mottled grey, very stiff, **CLAY** with a trace of fine-grained sand.
	4200 – 5200mm	Clay	Moist, grey, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
			Water-table encountered at 4.9 m BGL
BH2	0 – 200mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 600mm	Sandy clay	Moist, brown mottled orange white, firm, **sandy CLAY**.
	600 – 1600mm	Clayey sand	Dry, orange, very dense, fine to medium grained, **clayey SAND**.
	1600 – 2200mm	Clayey sandy gravel	Dry, grey orange, very dense, fine to medium, **clayey sandy GRAVEL**. *Highly cemented, potentially granite rock.*
			Water-table encountered at 2.0 m BGL
BH3	0 – 300mm	Sand	Dry, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	300 – 1000mm	Clay	Dry, orange, firm, **CLAY** with a trace of fine gravel and some fine to coarse grained sand.
	1000 – 3100mm	Clay	Dry, red brown, very stiff, **CLAY** with a trace of fine to medium grained sand.
	3100 – 3700mm	Clay	Moist, yellow brown, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	3700 – 4200mm	Clay	Moist, red brown, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	4200 – 6600mm	Clay	Moist, pale brown mottled red white, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	6600– 10000mm	Clay	Moist, pale brown grey, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
	10000 - 10800mm	Clay	Wet, pale brown grey, very stiff, **CLAY** with a trace of fine-grained sand. *significant presence of mica.*
			Water-table encountered at 10.5 m BGL
BH4	0 – 300mm	Sand	Moist, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	300 – 2300mm	Clay	Moist, grey, firm, **CLAY** with some fine-grained sand.
	2300 – 2600mm	Clay	Moist, grey, firm, **CLAY** with some fine-grained sand.
			Water-table encountered at 0.25 m BGL
BH5	0 – 300mm	Sand	Moist, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	300 – 800mm	Clayey Gravel	Moist, brown, medium dense, fine, **clayey GRAVEL** with a trace of organics and some fine to coarse grained sand.
	800 – 1300mm	Gravelly clay	Moist, pale brown, firm, **gravelly CLAY** with some fine to coarse grained sand.
	1300 – 1800mm	Clay	Moist, brown slightly mottled dark brown orange, firm, **CLAY** with some fine to coarse grained sand and some fine to medium gravel.
	1800 – 2500mm	Clay	Moist, pale brown, stiff, **CLAY** with some fine to coarse grained sand.
			Water-table encountered at 1.4 m BGL
BH6	0 – 100mm	Sand	Moist, dark brown, loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	100 – 3000mm	Sand	Moist, pale brown, medium dense, fine to medium grained, **SAND**.
			Water-table encountered at 1.5 m BGL

Table 4 continued.

Bore Hole	Depth	Soil Type	Soil Description
BH7	0 – 300mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics and a trace of fine to coarse gravel.
	300 – 1300mm	Clay	Dry, orange, stiff, **CLAY** with some fine to medium gravel and a trace of fine to coarse grained sand.
	1300 – 2600mm	Clay	Dry, orange slightly mottled white red, stiff, **CLAY** with a trace of fine to coarse gravel and a trace of fine to coarse grained sand.
	2600 – 3500mm	Clay	Dry, red cream, stiff, **CLAY** with a trace of fine to medium grained sand.
			Water-table encountered at 10.5 m BGL
BH8	0 – 200mm	Sand	Moist, grey, very loose, fine to medium grained, **SAND** with a trace of clay and a trace of fine gravel.
	200 – 400mm	Sandy Clay	Moist, orange mottled grey, soft, **sandy CLAY** with a trace of fine to medium gravel.
	400 – 600mm	Clay	Moist, orange, firm, **CLAY** with some fine to coarse grained sand and a trace of fine to medium gravel.
	600 – 7000mm	Clay	Moist, orange, stiff, **CLAY** with some fine to medium grained sand.
	7000 – 10000mm	Clay	Moist, grey, stiff, **CLAY** with some fine-grained sand.
			Water-table encountered at 0.1 m BGL
BH9	0 – 200mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 4000mm	Gravelly clay	Dry, brown, very stiff, **gravelly CLAY** with a trace of fine to coarse grained sand.
			No water-table encountered
BH10	0 – 200mm	Sand	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 1500mm	Gravelly clay	Dry, brown red, stiff, **gravelly CLAY** with a trace of fine to coarse grained sand.
	1500 – 4500mm	Clay	Dry, brown orange, very stiff, **CLAY** with some fine to coarse grained sand.
	4500 – 6000mm	Clay	Dry, orange, very stiff, **CLAY** with a trace of fine to coarse grained sand.
	6000 – 10000mm	Clay	Dry, orange, very stiff, **CLAY**.
			Water-table encountered at 3.3 m BGL
BH11	0 – 200mm	Sand	Moist, dark brown, loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	200 – 1700mm	Sand	Dry, yellow grey, medium dense, fine to medium grained, **SAND** with some silt.
	1700 – 3000mm	Sandy clay	Dry, brown orange, stiff, **sandy CLAY**.
			No water-table encountered

Phosphorous Retention Index

Phosphorous Retention Index (PRI) is the ability of soils to absorb nutrients and heavy metals within the soil (i.e. Soil microbe disinfecting ability). Soils with a PRI less than 1 have a very poor ability to retain nutrients and heavy metals, whilst soils with a PRI of >5 having a high ability to retain nutrients and heavy metals. PRI testing was conducted on samples from soil testing holes TP1, TP4, TP6, TP8 and TP11 with analysis conducted by CSBP Soil Laboratories. PRI results are presented in Table 5.

Table 5: Phosphorus Retention Index

Soil Testing Hole	Depth (mm)	Soil Type	PRI
TP1	150-1000	Sand with silt	27.2
TP4	300-1800	Sand with silt	5.9
TP6	300-2000	Sand	3.6
TP8	800-1500	Sandy loam	79.0
TP11	700-1500	Sandy clay loam	129.7

The PRI test results indicate that the site soils have a moderate to very high ability of fixing nutrients and contaminants consistent with soil types found across the site. As expected, the lowest PRI was found at TP4 and TP6 in the south of the site within the deep sands. Whilst the PRI was found to be lowest fronting the Blackwood River the PRI found at TP4 (5.9) and TP6 (3.6) was found to be greater than 1 and considered to provide ability to fix nutrients and contaminants. A higher PRI was found in the clays and loams across the more elevated portions of the site, with the highest PRI found in the sandy clay loam at TP11 in the northeast of the site.

Soil Permeability

Silts and clay soils generally record poor permeability results whereas coarse sands and loose gravels generally record high permeability, as shown in Figure 7.

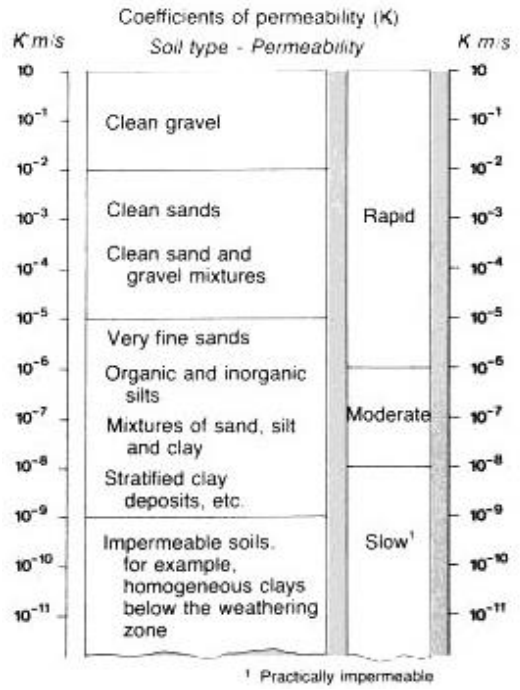


Figure 7: Hydraulic Conductivity of Soil Types (Artiola et al*, 2004)*

In-field permeability testing was conducted at three locations during the site soil investigation by Bio Diverse Solutions, the location of the permeability tests is shown in Figure 6. Permeability testing was conducted using the Talsma-Hallam method. The Talsma-Hallam permeameter is suitable for use in soils with permeability in the range 0.009 to 2.9 metres/day ($1x10^{-7}$ to $3x10^{-5}$m/s). This covers the range of soils to which treated effluent is typically applied. The permeability (hydraulic conductivity) recorded at the three testing locations is shown in Table 6.

Table 6: Permeability Results

Permeability Testing Site	Soil Type	Hydraulic conductivity (m/d)	Hydraulic conductivity (m/s)
PT1	Clayey sand	0.15	1.7×10^{-6}
PT2	Sandy clay loam with gravel	0.12	1.4×10^{-6}
PT3	Sandy loam	0.25	2.8×10^{-6}

Despite the permeability testing conducted in differing soil types including clayey sand, sandy clay loam with gravel and sandy loam, the permeability at all three testing sites was found to be similar, which was a moderate permeability, as shown in Figure 7. The permeability at all three testing locations was also found to be equivalent to that of Soil Category 4 - Clay Loams (weakly structured) as specified in Table L1 of AS/NZS 1547:2012.

4.2. Surface Hydrology

A hydrological investigation across the site was conducted on the 3rd August 2021 to confirm the surface water hydrology of the site and guide the development to establish a suitable onsite effluent disposal management plan focused on waterway protection. Rainfall prior to the site investigation was significantly higher than average for the months of February – July 2021, as shown in Table 7.

Table 7: 2021 monthly rainfall prior to site investigation

Month	Average Rainfall for Boyup Brook* (mm)	2021 Rainfall for Boyup Brook* (mm)
February	15.4	68.0*
March	21.6	32.0*
April	37.3	92.5*
May	83.9	96.0*
June	115.9	94.0^
July	115.0	139.4^
Total (Feb-July)	389.1	521.9

***** Rainfall taken from BoM Boyup Brook Station (No. 9504).

^Rainfall taken from Newbicup Station (No. 9587)

Seasonal Creek Lines

The presence of three seasonal creek lines was confirmed across the site, all discharging to the Blackwood River (Figure 8). The western and eastern creeks at the time of the investigation had a trickle flow of water discharging to the Blackwood River. The central creek was not flowing, it did have standing water within its lower reaches. Photographs of the seasonal creek lines are shown in Photographs 1 to 6. There were no other waterways, water bodies (other than farm dams) or seasonally inundated areas found across the site.

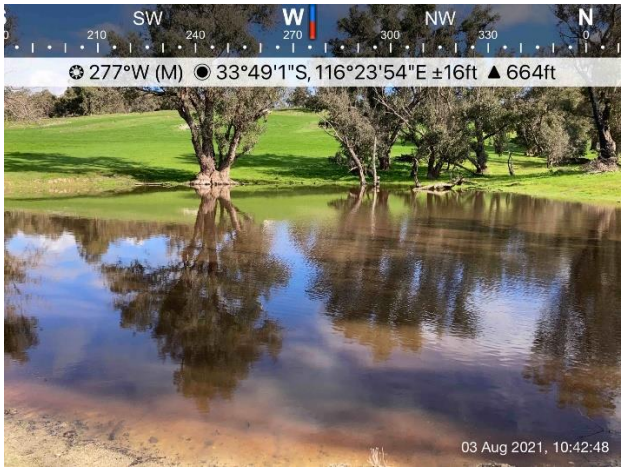


Photo 1: A dam located in the upper reaches of the western creek line, which provided a trickle flow of water to the lower reaches of the creek during the site investigation.



Photo 2: The lower reaches of the western creek, with trickle flow to neighboring property to the south and ultimately the Blackwood River.



Photo 3: Upper reaches of the central creek, not flowing at the time of site investigation.



Photo 4: The lower reaches of the central creek, with standing water adjacent to the Blackwood River.



Photo 5: View from downstream to upstream of eastern creek line, with trickle flow towards the Blackwood River.



Photo 6: The lower reaches of the eastern creek line, characterized by deep eroded creek banks and trickle flow towards Blackwood River.

In-situ water quality testing was conducted within the three seasonal creeks using a Horiba-50 Water Quality Meter as part of the August 2021 site investigation. In-situ water quality testing and laboratory analysis was also conducted in Jun/Jul and Oct 2023 as part of the site's pre-development groundwater and surface water monitoring program (discussed in Section 7). The in-situ physiochemical water quality testing results for Aug 21 are shown in Table 8. The creek in-situ and laboratory water quality results for Jun/Jul and Oct 23 are presented and discussed in the Pre-development Surface Water and Groundwater Monitoring Report, included as Appendix B.

Table 8: In-situ water quality results for seasonal creeks (Aug 21)

Parameters	Guideline[1]	Western Creek	Central Creek	Eastern Creek
Physiochemical				
Temperature		10.74	13.73	11.02
pH	6.5 to 8.5	7.99	6.54	7.54
Electrical Conductivity (µS/cm)	120 - 300	1950	2360	1610
Dissolved Oxygen (mg/L)		11.40	5.31	10.90
Dissolved Oxygen (%)	90	105	49	101
Total Dissolved Solids (mg/L)	<1	1.25	1.51	1.25

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for upland river system; target exceedance shaded red.

Physiochemical water quality testing results recorded on the 3rd Aug 2021 found that the surface water within the creeks was slightly saline with a reasonably neutral pH. The electrical conductivity at all three creeks was found to be above the ANZECC and ARMCANZ (2000) upper trigger value for upland rivers in the Southwest of Australia (300uS/cm). The dissolved oxygen in the Central Creek was found to be below the ANZECC and ARMCANZ (2000) trigger value for upland rivers in Southwest Australia (90%). This is likely due to the presence of sediment and decaying organic matter, and the stagnant nature of the water body sitting within the lower reaches of the creek line (not flowing at the time of sampling).

Blackwood River

Flood levels in the Blackwood River during the site investigation were higher than at the same time on an average year due to the higher-than-average rainfall experienced from February – July 2021 in the southwest of the state. Flood levels in the river fronting the Subject Site extended to the outer edge of the river's riparian zone. There was only one location along the river where the flood levels of the river encroached into the Subject Site at the time of the site investigation, this was adjacent to where the eastern creek meets the river. The flood levels seen in the Blackwood River during late July and early August were the highest seen in recent times according to the longtime local farmer at the Subject Site (M. Hardey 2021 pers. Comms., 3 August). Photographs of the Blackwood River fronting the Subject Site are shown in Photographs 7 and 8.

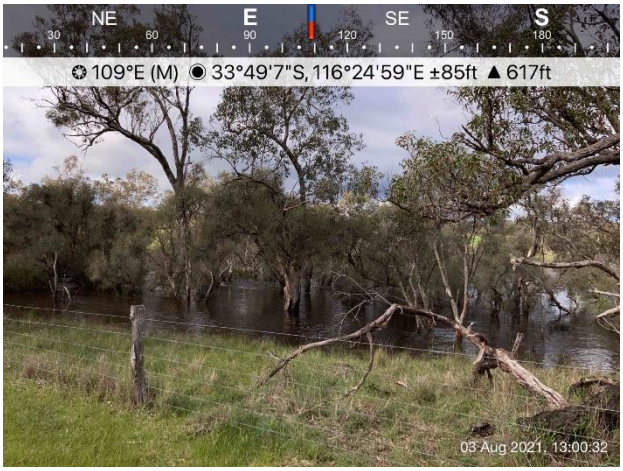


Photo 7: The Blackwood River fronting the Subject Site near the location of soil testing site TP6. Flood levels extend to the outer edges of the riparian zone outside of the Subject Site.



Photo 8: The Blackwood River fronting the Subject Site near the location of TP4. Flood levels extend beyond the river channel to the outer edges of the riparian zone outside of the Subject Site.

In accordance with advice received from Department of Water and Environmental Regulation on the 1st April 2021 the 1982 flood levels recorded within the Blackwood River shall be utilised as the 1% AEP flood level and to determine building habitable floor levels. The 1982 estimated flood level within the Blackwood River fronting the Subject Site is 190m AHD, with a recommended habitable floor level of 190.5 mAHD required to ensure adequate flood protection (DWER, Greening, L. (2021) email to Steve Thompson, 1st April).

In-situ water quality testing was conducted at one location within the Blackwood River, adjacent to soil testing location TP4 (Figure 6). Water quality testing was conducted using a Horiba-50 Water Quality Meter. Testing results are presented in Table 9.

Table 9: Water quality Testing of the Blackwood River

	Temperature (°C)	pH	Electrical Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Total Dissolved Solids (g/L)
Blackwood River	10.96	7.15	3.65	8.99	2.38

Water quality testing results found that the surface water within the Blackwood River fronting the Subject Site was slightly saline to brackish with a neutral pH. The dissolved oxygen was consistent with fresh flowing water and the total dissolved solids were found to be elevated, consistent with the EC, when compared to the ANZECC and ARMCANZ (2000) water quality guidelines. Impacts to the water quality of the Blackwood River is a primary concern for the development, and the post-development scenario shall ensure maintenance or improvement of the water quality of the river.

4.3. Groundwater levels

Groundwater levels across the site were measured as part of the Bio Diverse Solutions site soil investigation. The investigation found groundwater was encountered near surface (<0.5m) in the western portion of the site where medium to dense clays were found to be present. Groundwater levels here ranged between 0.17 and 0.65 m below ground level. The groundwater encountered in the west of the site is not likely an indication of the true local surficial groundwater table rather a perched water table, with recent rainfall perching on the medium - dense clays below. Groundwater was not encountered to 2 metres depth in the southern, eastern or northern portions of the site during the August 2021 investigation further indicating the groundwater encountered in the west is a result of a perched water table.

WML Consulting Engineers installed 11 groundwater monitoring bores as part of the pre-development monitoring program, details of the groundwater monitoring bores are presented in Table 10, with the lithology of the bores to determine aquifer characteristics are shown in Table 4. Groundwater was measured initially by WML Consultant Engineers in Oct 21 and again monthly from Jun 22 to Oct 22. Bio Diverse Solutions continued to monitor the bores monthly from Jun 23 to Oct 23. Groundwater levels across the site varied from 0.5 m above ground level at BH8 in Aug 23 to 10.5 m BGL at BH3 and BH7 in Oct 21. Groundwater levels across the site generally fluctuated consistent with seasonal rainfall. The groundwater levels recorded in the bores for the Oct 21 to Oct 23 monitoring period are shown in Table 11, with the highest recorded groundwater level at each bore also added to Figure 8. Groundwater levels are also presented and discussed in the Pre-development Surface Water and Groundwater Monitoring (Appendix B).

Table 10: Details of monitoring wells (WML Consultant Engineering, 2021)

Monitoring well	Co-ordinates		Monitoring well Screening depth (m)	Depth of hole (m)
	Easting	Northing		
BH1	444344.1	6257799.7	2.2-5.2	5.95
BH2	444101.9	6257932.5	0.5-2.0	3.34
BH3	444034.9	6258303.2	4.3-7.3	8.47
BH4	444516.5	6258065.0	2.0-3.0	3.97
BH5	444742.8	6258308.2	1.0-4.0	5.10
BH6	444874.4	6257783.5	1.6-2.6	3.97
BH7	445140.9	6258561.9	1.9-4.9	5.88
BH8	445087.5	6258910.6	6.0-9.0	10.0
BH9	445987.9	6258107.7	0.6-2.6	3.93
BH10	445652.3	6257980.3	7.5-10.5	11.14
BH11	445458.5	6257503.9	0.6-2.6	3.99

Table 11: Groundwater level readings (WML Consultant Engineering, 2021)

Monitoring Bore	Groundwater level (m BGL)									
	Oct 21	Jun 22	Jul 22	Aug 22	Oct 22	Jun 23	Jul 23	Aug 23	Sep 23	Oct 23
BH1	4.9	2.5	3.3	2.8	3.0	3.5	dry	2.8	3.0	3.2
BH2	2	dry	dry	dry	1.5	dry	dry	dry	dry	dry
BH3	10.5	3.0	dry	dry	dry	dry	dry	dry	dry	dry
BH4	0.2	dry	2.3	2.3	1.5	2.5	dry	0.99	1.0	dry
BH5	1.4	3.0	1.8	3.0	1.8	3.2	3.3	0.6	1.4	2.0
BH6	1.5	dry	dry	dry	2.3	dry	dry	dry	dry	dry
BH7	10.5	dry	dry	dry	dry	4.8	4.8	4.8	4.8	dry
BH8	0.1	-0.2*	-0.3*	-0.3*	-0.5*	0.1*	0.1*	-0.5*	-0.3*	dry
BH9	dry	dry	dry	dry	dry	dry	dry	3.4	dry	dry
BH10	3.3	3.9	4.1	3.9	3.2	4.1	4.3	3.6	3.8	4.0
BH11	dry	dry	dry	dry	2.5	dry	dry	dry	1.3	dry

Notes: * Groundwater level is above ground level.

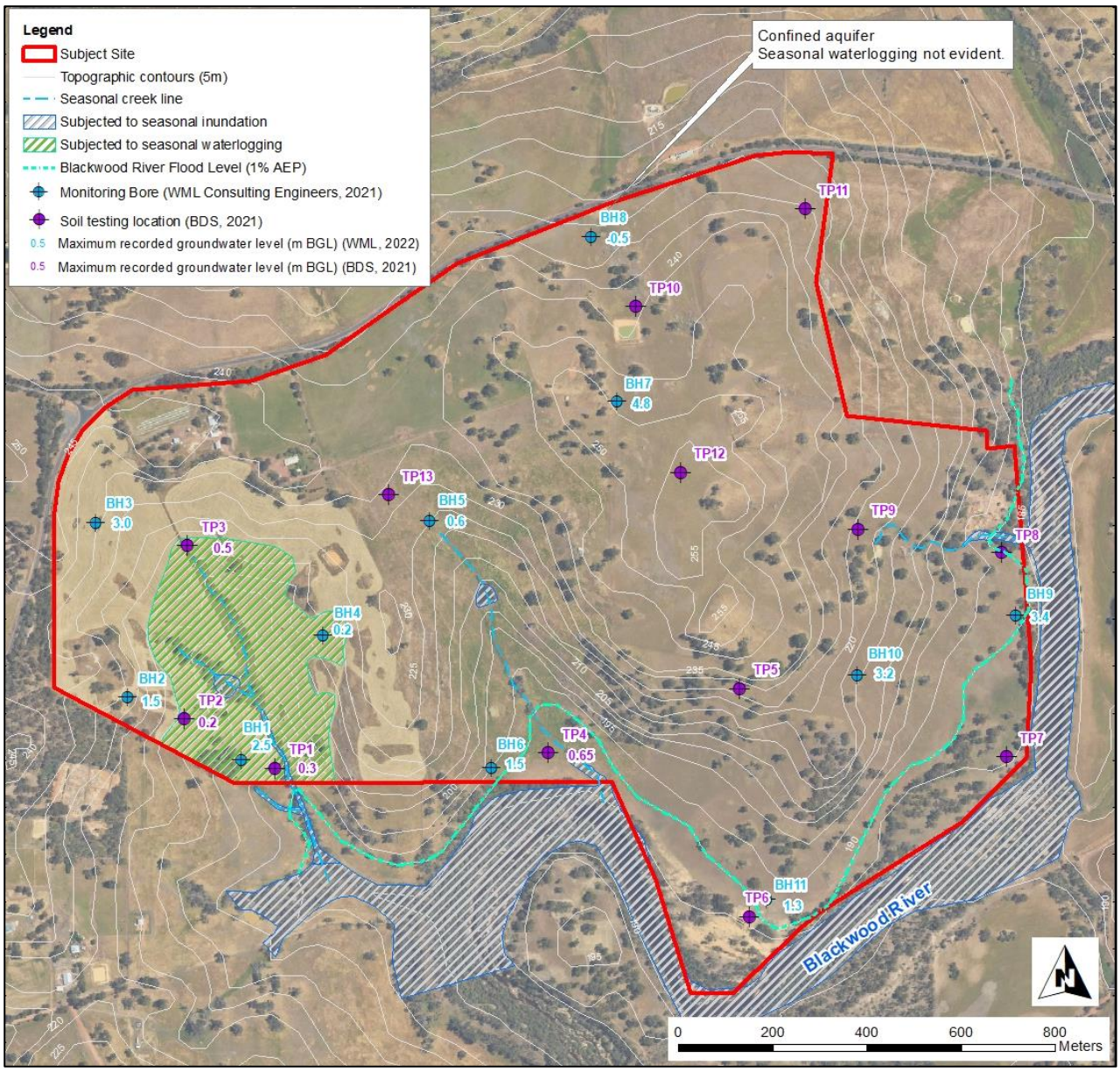


Figure 8: Maximum groundwater levels, waterlogging and seasonal inundation

Groundwater was found to be above ground level or close to ground level at BH8 in the north of the site during each monitoring event. The ground surface here was not found to be waterlogged (groundwater <0.5m BGL) and therefore it is assumed that the high groundwater levels at BH8 are a result of a deeper confined aquifer and preferred groundwater flow path.

5. Site Suitability

The Subject Site is situated in an area that does not have access to deep or reticulated sewerage. The health and environmental requirements for wastewater treatment and disposal for developments not serviced by deep sewerage systems are contained in the *Government Sewerage Policy*, (GSP; DPLH, 2019b). The GSP (DPLH, 2019b) states minimum requirements apply for all on-site sewage disposal systems.

This Site Soil Evaluation (SSE) utilises the findings from the desktop assessment, site investigation (Bio Diverse Solutions, 2021) and the geotechnical investigation (WML Consulting Engineers, 2021) to determine the suitability and constraints for effluent disposal across the Subject Site. The site suitability and constraints for onsite effluent disposal across the Subject Site is discussed in the following sections and shown in Figure 9. Table 12 outlines a summary of policy and compliance of the site to minimum requirements.

5.1. Soils

As discussed in Section 4.1 soils across the Subject Site were found to comprise of:

1. Silty sand topsoil over deep sands (found along the river foreshore);
2. Silty sand over clay with medium to high plasticity (found in the west and central portion of the site);
3. Silty sand over moderate to poorly sorted sandy loam and sandy clay loam with low plasticity (found in the higher elevations in the northeast of site;
4. Gravelly sandy clays/clayey sands (found in the southeast);
5. Well sorted clayey sand/sandy clay with low plasticity (Includes a small area in the southwest in the lower reaches of the valley); and
6. Granite outcrop (scattered throughout the site, predominantly situated on the elevated hill slopes).

Generally, soils across the Subject Site are considered suitable for onsite effluent disposal with proposed lots situated within soils with medium to dense clays requiring special design requirements and consideration (as discussed in Section 6) to achieve effluent disposal in alignment with the GSP (DPLH, 2019b) and AS/NZS 1547:2012. Special design requirements will also be required where there is <1.2m separation to granite rock. Areas of exposed granite outcrop are not considered suitable for effluent disposal and each lot shall ensure it has a sufficient Land Application Area (LAA) away from areas of exposed granite outcrop (as discussed in Section 6).

Despite the soil logs from soil testing locations within Soil Types 3, 4 and 5 (as listed above) showing differing soil types, the soil permeability rate was found to be similar in these areas and equivalent to Soil Category 4 – Clay loams (weakly structured) in accordance with Table L1 of AS/NZS 1547:2012. It is assumed areas within Soil type 1 will have a soil permeability rate equivalent to Soil Category 1 – Gravel/Sands or Soil Category 2 – Sandy loams and areas within Soil Type 2 (as listed above) will have a soil permeability rate equivalent to Soil Category 5 – Light Clays or Soil Category 6 – Medium to Heavy Clays depending on the location within the soil type area.

PRI results were found to be moderate to very high across the majority of the Subject Site. PRI within the deep sands fronting the Blackwood River were found to be lower compared to the remainder of the Subject Site. However, the PRI here is still likely to provide sufficient removal of nutrients and contaminants without the need for the addition of amended soil. Additionally, LAAs are required to be setback a minimum of 100m from the Blackwood River riparian zone where the soil type begins to change, likely having a higher clay content and therefore a higher PRI.

It is recommended that further soil testing including soil logging, soil permeability testing and PRI testing (within proposed lots fronting the Blackwood River) be conducted at subdivision application stage to better define the soil type boundaries and confirm each proposed lot within the Subject Site can support onsite effluent disposal in alignment with the GSP (DPLH, 2019b) and AS/NZS 1547:2012.

5.2. Groundwater and waterlogging

A perched groundwater table/water logging (groundwater less than 0.5 m BGL) was evident in the lower lying areas in the southwest of the Subject Site during the August 2021 Bio Diverse Solutions site investigation. Fill and special design requirements will be required in this area to ensure the minimum separation requirement of 0.6 m (in clay) between groundwater and onsite effluent disposal is achieved. Further investigation shall be conducted at subdivision application stage to further define the area susceptible to waterlogging and quantify the amount of fill required for LAAs proposed in this area. It shall be ensured that, prior to subdivision, lots located wholly within waterlogged areas can achieve adequately functioning LAAs without impacting the surrounding environment. In alignment with advice from the Department of Health lots located wholly within the area deemed as waterlogged shall have a minimum size of 1 ha.

Monitoring of groundwater in the east of the site generally found levels to be greater than 1.5 m BGL with the exception of groundwater levels at BH8 in the northeast of the Subject Site, here levels were found to be higher than or just below ground level. This area was not found to be waterlogged (groundwater <0.5m BGL) during the August 2021 site investigation and it is likely the high groundwater levels are a result of a confined aquifer in the area. Further investigation shall be conducted in the vicinity of BH8 at subdivision application stage to ensure the GSP minimum separation to groundwater requirement is met. Other than the area encompassing BH8 and the area susceptible to waterlogging in the west, it is unlikely significant amounts of fill will be required across the remainder of the site to achieve the minimum separation to groundwater requirement as stipulated in the GSP (DPLH, 2029b).

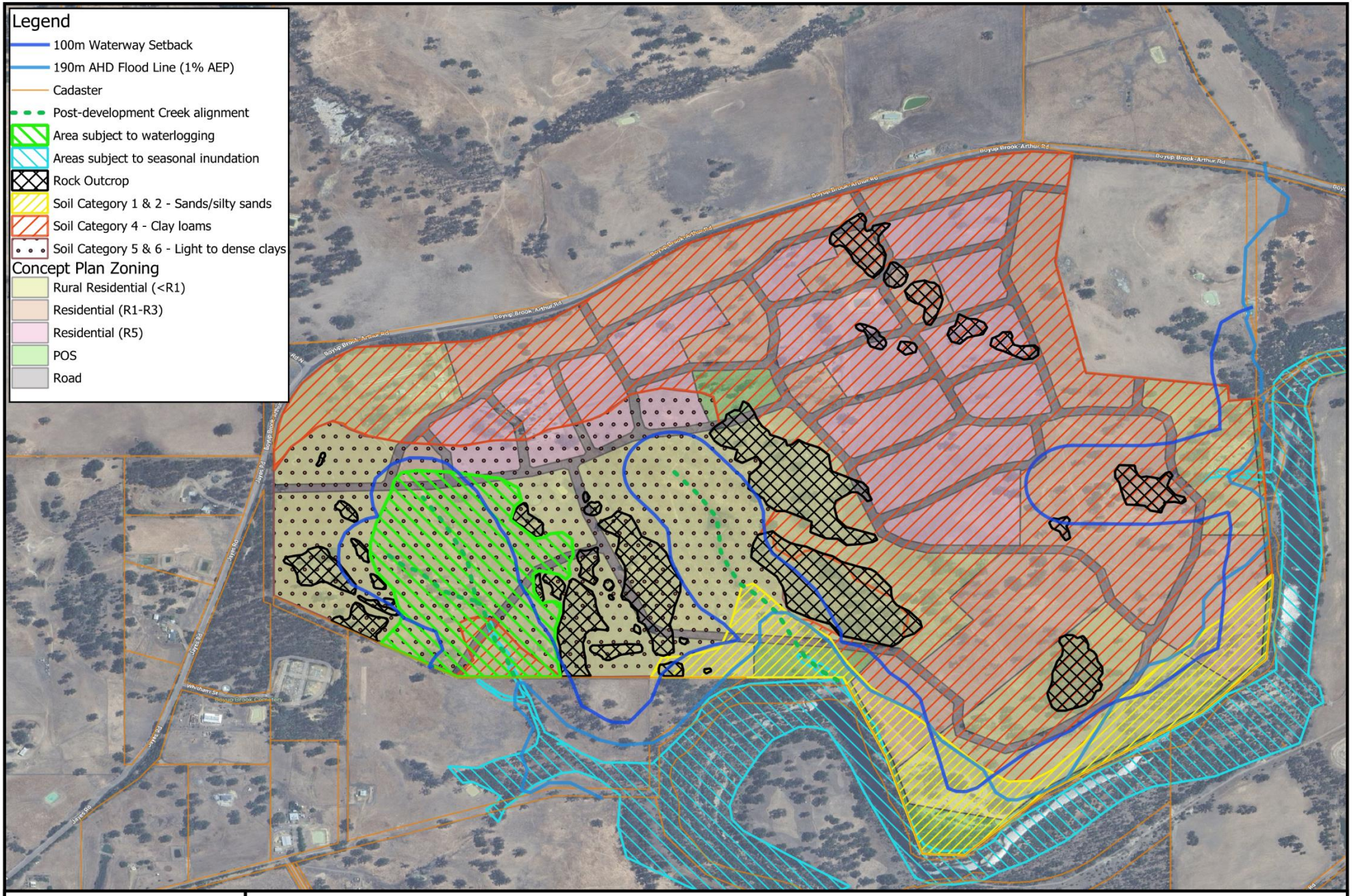
5.3. Setback to waterways/water bodies

A minimum setback of 100 m between LAAs and the outer edges of the Blackwood River riparian zone shall be established. A setback of 100 m between LAAs and the western or central creek line shall generally be established, where lots encompassing the western or central creek line cannot achieve a 100 m setback, a reduced setback between 70 and 100 m may be sought to achieve site feasibility, with the approval of the reduced setback to be at the discretion of approving government agencies.

The downstream reaches of the shorter eastern creek line are highly eroded, with the potential to contribute to sedimentation within the Blackwood River. It is proposed the eastern creek line be stabilised (earth worked, rock pitching and planting) and runoff redirected to an engineered drainage system. The stormwater storage and storage outlet pipe proposed adjacent to the eastern creek line will convey runoff up to the 20% AEP from the incoming sub-catchment, with a constructed strategic break conveying runoff from storm events greater than the 20% AEP storm event. Therefore a setback is not required to the eastern creek as the LAAs will not be hydrologically connected to the drainage system, instead a 30 m setback to all strategic breaks shall apply.

5.4. Topography

The Subject Site whilst undulating in topography generally does not exceed the minimum grade requirements (1:5) for onsite disposal as outlined in Table 3 of the Government Sewerage Policy (2019b). Most areas that do have steep slopes across the site also have exposed granite outcrop and therefore are not suitable for effluent disposal. LAAs shall be avoided on slopes with a grade of 1:5 or more. It shall be ensured prior to subdivision that all lots have a sufficient area to achieve LAA away from slopes with a grade 1:5 or less.



SOUTH ENVIRONMENTAL

Figure 9: Site Suitability & Constraints for LAAs

5th July 2024

0 100 200 300 400 m

Table 12: Minimum requirements for on-site wastewater disposal systems and design specific standards (DPLH, 2019b)

Site Feature	Minimum Requirement	Requirement met
Separation from waterways	A wellhead protection zone or on Crown land within a reservoir protection zone; 100 metres of the high-water mark of a reservoir or 100 metres of any bore used for public drinking water supply where: — a wellhead protection zone or reservoir protection zone has not been assigned; or — where existing lots would be rendered undevelopable by the wellhead protection zone.	Yes The Subject Site is not located within the vicinity of a Priority Drinking Water Source Area (PDWSA) and associated wellheads. The nearest PDWSA is the Boyup Brook Dam Catchment Area which is located approximately 3.3 km southeast of the Subject Site and has no associated wellheads.
	30 metres of a private bore used for household/ drinking water purposes.	Yes According to the Water Information Reporting tool there are no known private production bores at the Subject Site or within the vicinity of the Subject Site. Any bore constructed on site shall be >30 m from LAAs.
	100 metres of a waterway or significant wetland and not within a waterway foreshore area or wetland buffer. The separation distance should be measured outwards from the outer edge of riparian or wetland vegetation.	Yes A 100 m setback shall be established between the outer edges of the Blackwood River and LAAs. A 100 m setback to post-development creek alignment will generally be established, where lots encompassing the western or central creek line cannot achieve a 100 m setback, a reduced setback between 70 and 100 m may be sought.
	100 metres of a drainage system that discharges directly into a waterway or significant wetland without treatment.	Yes Additional to the waterways mentioned above, a 30 m setback to both stormwater storages and strategic breaks shall be established. A reduced setback is considered appropriate between LAAs and stormwater storages/strategic breaks as generally they are not hydrogeologically or hydrologically connected to LAAs and designed to retain and/or infiltrate stormwater runoff.
	Any area subject to inundation and/or flooding in a 10 per cent Annual Exceedance Probability (AEP) rainfall event.	Yes The only areas subjected to possible flooding are those adjacent to the Blackwood River, a 100 m setback between the outer edges of the Blackwood River riparian zone and LAAs shall apply.
Separation from groundwater – outside of public drinking water source areas.	Where land is not within a public drinking water source area or a sewage sensitive area, the discharge point of the on-site sewage system should be located the following distances above the highest groundwater level: • for loams and heavy soils, at least 0.6 metres. • for gravels, at least one metre. • for sands, at least 1.5 metres. Where a nutrient retentive secondary treatment system is used, at least 0.6 metres.	Yes The groundwater was not encountered <1.5 m BGL across the majority of the Subject Site under late winter conditions. A perched water table was encountered <0.6 m BGL in the west of the site, special design requirements including the importation of fill may be required here to achieve the minimum separation to groundwater requirement. Lots wholly within the area deemed as waterlogged shall have a minimum size of 1 ha.

Table 12 continued.

Site Feature	Minimum Requirement	Requirement met
Land Application Area	A LAA should be provided for all development in accordance with tables 2 and 3 of this schedule for the disposal of sewage.	Yes Suitable envelopes for LAAs shall be determined for each proposed lot prior to subdivision and shall be in accordance with the GSP (2019b) and AS/NZS 1547:2012.
	The LAA includes the area restricted to the distribution of treated sewage only and should be kept free of any temporary or permanent structures.	Yes Future proposed LAAs shall be kept free of any temporary or permanent structures. All future LAAs shall be placed in an area so that requirements are met. Site plan to be forwarded to the Shire of Boyup Brook (SoBB) and Department of Health (DoH) prior to Development Application (DA) approval.
	Activities within the LAA shall not interfere with the function of the current and future land application system and people should avoid potential contact with effluent residues. Unless allowed for in the design, the land application area) should: • not be built on or paved in a manner which precludes reasonable access; • not be subject to vehicular traffic (other than a pedestrian-controlled lawnmower); • not be subject to regular foot traffic such as pathways and clothes line areas; and • should be kept in a manner which enables servicing and maintenance of the disposal system.	Yes The future proposed LAAs shall be a sufficient distance to areas that are utilized for activity or pedestrian traffic. Future LAAs shall be placed in an area so that requirements are met. Site plan to be forwarded to the SoBB and DoH prior to DA approval.
Gradient of the land application area	Where slope exceeds one in five (1:5), the LAA should be engineered to prevent run-off from the land application area. Surface contours should be provided on the site plan.	Yes Future proposed LAAs shall be situated on land that does not exceed 1:5 gradient. Natural and finished gradients of LAAs shall not exceed 1:5 gradient. Site plan to be forwarded to SoBB and DoH prior to DA approval.
Location of land application area within building envelope	Local government may approve the location of LAAs outside building envelopes where proposed location meets requirements outlined above.	Noted

6. Implementation

6.1. Subdivision Application Stage

As a condition of subdivision and prior to any subdivision activities this SSE shall be updated to reflect the requirements of an SSE for subdivision approval and demonstrate that each individual lot can achieve adequate LAAs in accordance with the GSP (DPLH, 2019) and AS/NZS 1547-2012.

Further works that are identified for inclusion in the SSE at subdivision application stage include:

- Further soil and groundwater testing to be conducted across the site to determine a soil category and subsequently propose an appropriate LAA system for each proposed lot. The construction and logging of up to 42 additional soil test pits, 4 additional permeability tests and 3 additional PRI tests (along the Blackwood River) are proposed. Soil test pits shall be constructed under late winter conditions to capture the seasonal high water-table. It is also proposed that one groundwater monitoring bore be installed in the location of BH8 (Figure 8) and measured monthly for one wet season to confirm groundwater conditions at this location. The proposed soil test pit plan for the SSE prior to subdivision approval is shown in Figure 10. This SSE shall be updated with the results of the proposed soil testing and each lot shall be allocated a soil category based on the results, and subsequently an appropriate LAA system for each lot recommended.

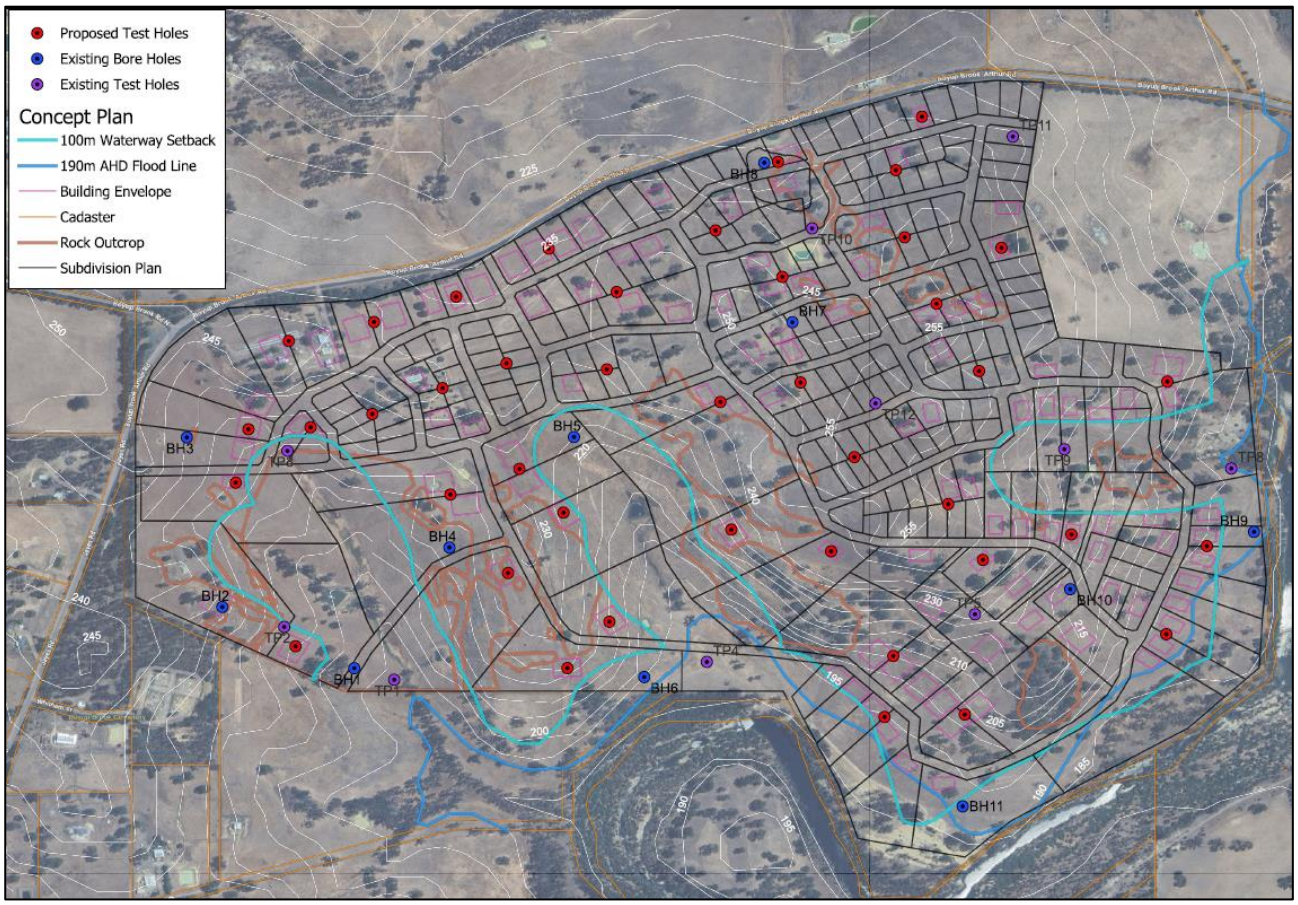


Figure 10: Proposed Soil Test Pit Plan

- An additional site assessment shall be conducted to map the extent of the exposed rock outcrops. The outskirts of the exposed rock outcrops shall be tracked and mapped using satellite technology. This SSE shall be updated to show the mapping of the exposed rock outcrop to ensure that each proposed lot can achieve an adequate LAA outside of the areas of exposed rock outcrop.

- It is proposed that the SSE be updated with a plan of each subdivision stage prior to the release of the relevant stage. Included with each stage plan shall be a list of all proposed lots within the stage and a corresponding list of LAA requirements for each lot. This is to ensure it is easily identifiable to local and government departments which lots require Section 70A notices on titles regarding their LAA requirements.

6.2. LAA Systems

In response to the site soil conditions, depth to groundwater and environmental constraints of the site, it is recommended that Land Application Areas (LAAs) for onsite effluent disposal be located within the areas deemed as suitable to receive effluent disposal as discussed in Section 5. Standard leach drains or subsurface irrigation systems are both suitable land application methods for the Subject Site depending on localised site constraints.

Standard leach drain systems may be utilised at the Subject Site in areas that are found to have a Soil Category from 1-5, in accordance with Table L1 of AS/NZS 1547:2012. This is likely to include the majority of the Subject Site with the exception of lots located within the west/southwest. It is recommended lots located within Soil Category 6 - Medium/Heavy Clays utilise a subsurface irrigation system. In impermeable layers or layers with low permeability, movement of water is restricted and effluent will move away from the disposal field very slowly. In this situation, standard leach drains are subjected to failure because the rate of percolation of effluent through the soil is less than the effluent generation rate.

A subsurface irrigation system utilises shallow trenches laid in a suitable depth of good quality topsoil and perforated pressure lines which are nestled in a distribution pipe within the trenches. The dosed flow into the distribution pipe facilitates the longitudinal distribution of effluent into the soil along the full length of each shallow trench, thus avoiding spot loading of effluent at each perforation. Additional sand fill with appropriate PRI (>5) may be required in the topsoil to improve infiltration and evapotranspiration.

Subsurface irrigation systems are also recommended in areas that do not have adequate separation to the peak annual water-table (including a perched water table). A subsurface irrigation system is installed closer to the surface compared to standard leach drains, therefore less fill is required to achieve the minimum separation to groundwater requirement. In addition, the evapotranspiration of effluent water and uptake of nutrients by plants in the subsurface irrigation system will further prevent the leaching of any potential nutrients and contaminants within the wastewater to the groundwater.

Soil modification/amendment may be required for LAAs within lots fronting the Blackwood River if a PRI of <1 is found. Further soil and PRI testing in this area shall be conducted at the subdivision application stage.

6.3. Secondary Treatment Systems

Secondary treatment systems shall be utilised on lots within the Subject Site in alignment with the Government Sewerage Policy, this includes;

- All lots less than 4000 m^2 located in Soil Category 5 – Light Clays; and
- All lots located within Soil Category 6 – Medium/Heavy Clays.

This is to ensure all lots can accommodate an unencumbered LAA and to reduce the cumulative impacts of onsite effluent disposal given the number of lots proposed in the area. Secondary treatment systems are required to generate wastewater of a secondary standard (BOD <20 mg/L, TSS <30 mg/L & E Coli <10cfu/100 mL). Only secondary treatment systems certified to AS 1546.3:2017 – On-site domestic wastewater treatment units and approved by the Chief Health Officer shall be utilised at the Subject Site. A list of approved systems is available on the DoH's website.

6.4. LAA Sizing

The size of the LAA on each future proposed lot shall be in accordance with Table 3 of the GSP (2019b). The LAA required on individual lots based on a single household (up to 5 bedrooms) using either a secondary or primary treatment system is shown in Table 13. This has been determined in conjunction with loading rates outlined in Table L1 of AS/NZS 1547:2012.

Table 13: Land application areas for single houses

Soil category	Soil texture	Land Application Area (m^2)	
		Primary Treatment (Includes area required for setback)	Secondary treatment (Excludes setbacks)
1	Gravels and sands	339	180
2	Sandy loams	339	180
3	Loams	429	225
4	Clay loams	620	257
5	Light clays	1,156	300
6	Medium to heavy clays	Special Design	450

It shall be determined at subdivision application stage that each lot can achieve a LAA in accordance with Table 13 based on the determined Soil Category of the lot. It shall also be ensured that the required LAA for each lot is achievable outside of any waterway setbacks, areas of exposed rock outcrop or areas deemed as unsuitable for LAA, as discussed in Section 6. Given the minimum lot size is 2000 m^2, there will be sufficient space on all lots to accommodate a LAA. Where a Special Design LAA is required, it is expected the lot size will be at least 1 ha.

6.5. Development Application Stage

At Development Application stage, upon final placement of the house and permanent infrastructure the new lot owner is to provide all applicable information (e.g., land application area, on-site effluent system etc.) to the Shire of Boyup Brook and the Department of Health for approval prior to installation of the onsite effluent disposal system (as shown in Figure 11).

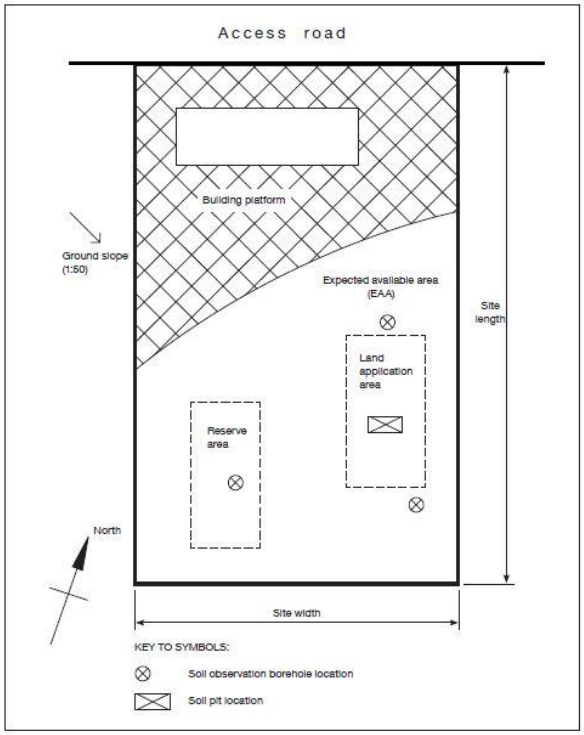


Figure 11: Generalised site plan for a single lot (AS/AZS 1547: 2012)

7. Monitoring

A surface water and groundwater monitoring program has been devised as part of the Local Water Management Strategy for the site, as shown in Appendix B. This program may also assist to determine the effectiveness of the effluent disposal management across the site.

A series of groundwater monitoring wells (BH1-BH11) have been established across the Subject Site to determine pre-development groundwater levels. The location of the monitoring wells is shown in Figure 8 and details of the monitoring wells are summarised in Table 10 with more detail on the wells presented in Appendix A.

Groundwater was measured initially by WML Consultant Engineers in Oct 21 and again monthly from Jun 22 to Oct 22. Bio Diverse Solutions continued to monitor the bores monthly from Jun 23 to Oct 23. Groundwater and three surface water sites (one in each of the three creek lines) was also monitored for water quality. Water quality monitoring was conducted twice annually in Jun/Jul 23 and Oct 23 (likely highest and lowest groundwater levels) to ascertain baseline groundwater and surface water quality conditions for the Subject Site. Groundwater quality monitoring parameters included:

- In-situ: pH, EC and TDS;
- Thermotolerant coliforms & E. coli;
- Nutrient suite;
- Dissolved metals; and
- TRH (C6-C10), MBTEXN & PAH.

Groundwater quality testing was conducted by a certified and NATA accredited laboratory. Pre-development groundwater monitoring results are shown in Appendix B.

Two years of quarterly post-development groundwater level and quality monitoring at the same sample sites as the pre-development monitoring, shall be conducted upon completion of the subdivision or relevant stage of the subdivision. Results shall be compared to pre-development levels, if groundwater levels are found to exceed pre-development groundwater levels by more than 500 mm with no significant change in rainfall, a review of the development design and operations will be required and alterations/modifications to the development will be conducted to reduce groundwater levels accordingly. If groundwater or surface water quality results are found to exceed pre-development water quality results by more than 10%, a review of the development design, land use and if necessary, effluent disposal practices will be required and alterations/modifications to the development will be conducted to reduce water quality parameters accordingly.

6. References

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Luke, G.L, Burke, K.L. & O'Brien, T.M. (1988) *Evaporation data for Western Australia.*

Shepherd DP, Beeston GR, Hopkins AJM (2002) *Native vegetation in Western Australia: extent, type and status*. Department of Primary Industries and Regional Development, Western Australia, Perth. Report 249.

WML Consulting Engineers (2022) Site Soil Investigation – Lot 51, 1007, 1118 Boyup Brook – Arthur Road, Boyup Brook.

Appendix A

Groundwater monitoring bore details and site soil investigation
(WML Consulting Engineers, 2022)

Our Ref: 10189-G-LR-001-0

5 January 2022

Attention: Mark Bombara

Roma Pty Ltd
30 Hutchinson Avenue
MOSMAN PARK WA 6012

Dear Mark

BOYUP BROOK SUBDIVISION GROUNDWATER MONITORING BORES – FACTUAL REPORT

1 INTRODUCTION

Roma Pty Ltd (Client) engaged WML Consultants (WML) to undertake a detailed geotechnical investigation for the proposed Boyup Brook subdivision, including the installation of groundwater monitoring bores. WML installed eleven monitoring bores to provide relevant information on long-term groundwater levels. This factual report presents the results of the geotechnical investigation.

2 SITE SETTING

The Boyup Brook Subdivision is located in the southwest of Western Australia, 270 kilometres south-southeast of Perth and 30 kilometres northeast of Bridgetown.

The current use of the land is for farming, which includes growing crops and rearing cattle. The site is comprised of large paddocks with frequent rocky outcrops and large trees present in uncleared land. The site generally slopes from the northwest to the southeast, with the Blackwood river located to the East and South of the proposed lots forming a natural boundary for the current property and forming the lowest point of the site. A high amount of undulation is present throughout the property, with natural valleys in several locations, along with man-made dams.

3 SITE INVESTIGATION

3.1 Fieldwork

Fieldwork was carried out on the 30th of September and 1st of October 2021, and consisted of:

- Drilling and logging of eleven boreholes at the approximate location of the subdivision lots designated BH1-BH11 to depths of 0.5-11m. The machinery used for drilling was Drillman GT 10, with a 105 mm solid stem auger.

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- 10 Dynamic Cone Penetrometer (DCP) test within the subdivision lots to determine the characteristics of the material to the depth of 1m.
- Installation of monitoring wells and recording preliminary depths to groundwater.

The investigation was undertaken in general accordance with Australian Standard AS 1726:2017 '*Geotechnical Site Investigations*'. A qualified geotechnical engineer from WML completed the fieldwork, logged the materials encountered in the boreholes and took record photographs. The locations of the boreholes were provided to WML by the client and are presented on the site map, 10189-G-001, which is appended to this letter.

As some of the monitoring bores were required to be installed in paddocks where existing crops were present, disturbance to the area was minimised as much as possible. This included tracking around the perimeter of the fields (cleared areas) and only driving through crops at the shortest distance from the fence to the monitoring bore location. The same path taken into the area was also used to leave the area to avoid unnecessary tracks.

Monitoring bores were left high, sticking out the ground so that they could be easily identified within the crops and subsequently avoid damage during harvesting of the crops. Star pickets were placed around each monitoring bore (except monitoring bore 1) as added protection during site works and for the presence of cows as they are rotated through the paddocks.

3.2 Borehole Drilling

Eleven machine excavated boreholes were drilled and installation of eleven monitoring wells within the boreholes was allowed. The boreholes were logged to AS 1726:2017 and photographed. The drilling was done with Drillman GT 10, with a 105 mm solid stem auger. The drilling was undertaken to the target depth or until groundwater levels were reached. This required multiple passes to clear the Boreholes and allow installation of Monitoring wells. The arisings from the boreholes were spread out evenly around the boreholes to prevent mounds of material from being present.

3.3 Dynamic cone penetrometer (DCP) testing

The DCP tests were completed in accordance with AS 1289.6.3.3-1997. DCP blow counts are included on the borehole log profiles, which are appended to this report (Appendix C) and a summary of the results are presented in Table 1 below.

Table 1: Summary of DCP results

Depth (m below existing ground level)	DCP1	DCP2	DCP3	DCP4	DCP5	DCP6	DCP7	DCP8	DCP9	DCP10	DCP11
0.00 - 0.15	-	3	1	1	1	2	5	1	4	3	2
0.15 - 0.30	-	4	1	1	1	2	5	2	5	3	4
0.30 - 0.45	-	4	2	2	4	2	7	2	4	3	4
0.45 - 0.60	-	2	3	6	10	3	6	7	7	5	3
0.60 - 0.75	-	4	6	11	9	3	6	11	5	7	4
0.75 - 0.90	-	7	30	5	6	4	14	14	15	8	6
0.90 – 1.05	-	7	30	3	7	4	14	15	10	11	6

3.4 Personnel

A senior geotechnical engineer and a geotechnical engineer from WML positioned the test locations within the subdivision footprint, logged the soil encountered in the boreholes, carried out the DCP testing and installed monitoring wells.

4 SUBSURFACE CONDITION

4.1 Published Geology

Based on the 1:250,000 Geological Series map sheet 'Collie-Bridgetown', the near-surface geology consists of:

- 'A_{ge}'- comprising even-grained granite rocks- fine to coarse-grained granodiorite, adamellite, and granite
- 'A_m'- Migmatite- banded and nebulitic, often strongly contorted
- 'Q_{ra}'- Alluvium-clay, sand, and loam

4.2 Subsurface Profile

The sub-surface profile can be generally divided into two zones, Zone A and Zone B, as detailed below. Zone A is typically represented by BH1, BH3, BH8 and BH10. Zone B is typically represented by BH6 and BH11. The sub-surface profile is variable across the site due to the topography which includes large rocky outcrops and natural valleys, and therefore each proposed lot should be assessed based on the subsurface profile identified in the nearest borehole and following a detailed geotechnical investigation.

<u>Zone A</u>

1. Topsoil, SP, Poorly graded **SAND**, fine-grained, dark brown, with a trace of fine roots and a trace of organics, Dry, medium dense
2. CL, **CLAY**, low plasticity, orange, with a trace of fine gravel and some fine to coarse-grained sand, dry, firm
3. CL-CI, **CLAY**, low/medium plasticity, red brown tending grey with depth, with a trace of fine-grained sand with presence of mica, moist, stiff

<u>Zone B</u>

1. Topsoil, SP, Poorly graded **SAND**, fine-grained, dark brown, with a trace of fine roots and a trace of organics, moist, medium dense
2. SP, Poorly graded **SAND**, pale brown, fine to medium-grained, moist, medium dense
3. CL, **sandy CLAY**, brown-orange, dry, stiff

4.3 Groundwater

Table 2: Summary of Groundwater Levels

Borehole	Groundwater Depth	Comment
BH1	4.9	-
BH2	2	-
BH3	10.5	-
BH4	0.25	-
BH5	1.4	-
BH6	1.5	-

BH7	10.5	Indicated during drilling, the well was installed to shallower depth due to borehole collapse.
BH8	0.1	Likely due to drilling into an aquifer and creating an artesian well.
BH9	-	Not Encountered
BH10	3.3	-
BH11	-	Not Encountered

5 FINDINGS

This site is generally suitable for further residential development; however, a detailed geotechnical site investigation is recommended to inform detailed design, site classification and site preparation and recommendations.

The lots investigated can be expected to have a site classification vary between an 'M' class and an 'H' class, dependant on the groundwater levels and thickness/presence of clay materials for each specific development area.

The groundwater levels varied across the site and were typically consistent with natural ground formation. Within natural valleys and low points, higher ground water levels were recorded, as represented by BH4, BH5 and BH6. Within higher elevation areas, lower ground water levels were noted, represented by BH3 and BH7. Artisanal groundwater was encountered in BH8, located in a lower area at the base of a rocky outcrop/hill. Ongoing recording of groundwater levels should be conducted over several seasonal changes to determine the peak levels, and typical fluctuations between wet and dry periods.

Areas located within natural depressions/valleys contained superficial soft to firm clays, presenting a geotechnical risk for development. Further investigation of the behaviour and strength of these materials would need to be conducted to assess the extent of remediation required to lower this risk.

6 CLOSURE

We draw your attention to the attached "Report Limitations" included with this letter report. This information sheet is intended to provide additional information about this letter report and information included within it. This information is provided not to reduce the level of responsibility accepted by WML but to ensure that all parties that rely on this report, and the information contained herein, are aware of the responsibilities that each assumes in so doing.

If you have any queries in relation to the above, please contact the undersigned.

Yours faithfully,



Bidhan Bajgain
Civil / Geotechnical Engineer
Author

Pierce Taylor
Geotechnical Engineer
Reviewer

For and on behalf of WML Consultants Pty Ltd

REFERENCES

- Geological Series Map 1:250,000 Scale 'Collie-Bridgetown'
- Standards Australia. 1997. *Determination of the Penetration Resistance of a Soil – 9 kg Dynamic Cone Penetrometer Test*. AS 1289.6.3.2:1997. SAI Global.
- Standards Australia. 2017. *Geotechnical Site Investigations*. AS 1726:2017. SAI Global.

ATTACHED

- Report Limitations
- Appendix A – Site Map
- Appendix B – Photographic Record
- Appendix C – Soil Logs

LIMITATIONS

REPORT LIMITATIONS

WML have undertaken investigations, performed consulting services, and prepared this report based on the Client's specific requirements, documents and information supplied, and previous experience. If changes occur in the nature or design of the project, we should be allowed to review this report and provide additional recommendations, if any. It is the responsibility of the Client to transmit the information and recommendations of this report to the appropriate organisations or people involved in design of the project, including but not limited to developers, owners, buyers, architects, engineers, and designers.

We performed our professional services in accordance with generally accepted geotechnical engineering principles and practices currently employed in the area; no warranty, expressed or implied, is made as to the professional advice included in this report.

Any data provided by third parties including, but not limited to: sub-consultants, published data, and the Client, may not be verified and WML assumes no responsibility for the adequacy, incompleteness, inaccuracies, or reliability of this information. WML does not assume any responsibility for assessments made partly or entirely based on information provided by third parties.

This repot has been prepared based on investigation locations which are explicitly representative of the specific sample or test points. Interpretation of conditions between such points cannot be assumed to represent actual subsurface information and there are unknowns or variations in ground conditions between test locations that cannot be inferred or predicted.

This report is based upon field and other conditions encountered at the time of report preparation. If unexpected subsurface conditions are encountered, WML shall be notified immediately to review those conditions and provide additional and/or modified recommendations, as necessary.

Our services did not include any contamination or environmental assessment of the site or adjacent sites. The nature of geotechnical investigation differs from the environmental investigation practice. If you require any environmental considerations to be applied to your project, WML can advise on further steps to be undertaken.

Geotechnical assessments are typically based on judgment of the investigation data and visual observations of the site and materials.

This document must not be subject to unauthorised use that is, reusing without written authorisation of WML. Such authorisation is essential because it requires WML to evaluate the document's applicability given new circumstances, not the least of which is passage of time.

APPENDIX A

SITE MAP

10189-G-001

Borehole Locations - Boyup Brook Subdivision



APPENDIX B

PHOTOGRAPHS

PHOTOGRAPHIC RECORD

Client:	Roma Pty Ltd
Job Number:	10189
Job Description:	Boyup Brook Subdivision Groundwater Monitoring Bores
Location ID:	54 Boyup Brook, Arthur Road



Figure 1: General view around the site



Figure 2: Installation of monitoring wells

PHOTOGRAPHIC RECORD

Client:	Roma Pty Ltd
Job Number:	10189
Job Description:	Boyup Brook Subdivision Groundwater Monitoring Bores
Location ID:	54 Boyup Brook, Arthur Road



Figure 3: Tip of drill rig auger



Figure 4: Spoil of clay from holes

PHOTOGRAPHIC RECORD

Client:	Roma Pty Ltd
Job Number:	10189
Job Description:	Boyup Brook Subdivision Groundwater Monitoring Bores
Location ID:	54 Boyup Brook, Arthur Road



Figure 5: Installation of monitoring wells



Figure 6: Drill rig used for boreholes

APPENDIX C

LOGS

WML accessible expertise	**BOREHOLE: BH1**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 444344.1 m E 6257799.7 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
	0.0			SP	Moist, dark brown, loose, fine to medium grained, **SAND** with a trace of clay and a trace of fine roots and a trace of organics.
					Moist, orange brown mottled grey, very stiff, **CLAY** with a trace of fine grained sand.
	1.0				
	2.0			CI	
	3.0				
	4.0				
4.9m	5.0			CI	Moist, grey, very stiff, **CLAY** with a trace of fine grained sand. *significant presence of mica.*
					Hole Terminated at 5.20 m Target Depth; Screened from 2.2m - 5.2m below ground level, Top of well 1m above ground level
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH2**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 444101.9 m E 6257932.5 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
		9 kg Dynamic Cone Penetrometer		SP	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
		Depth (m) Blows		CI	Moist, brown mottled orange white, firm, **sandy CLAY**.
	1.0	0.00 - 0.15 3 0.15 - 0.30 4 0.30 - 0.45 4 0.45 - 0.60 2 0.60 - 0.75 4 0.75 - 0.90 7 0.90 - 1.05 7		SP	Dry, orange, very dense, fine to medium grained, **clayey SAND**.
2m	2.0			GP	Dry, grey orange, very dense, fine to medium, **clayey sandy GRAVEL**. *Highly cemented, potentially granite rock.*
	3.0				Hole Terminated at 2.20 m Refusal; Hard digging on highly cemented, potentially granite rock. Screened from 0.5 m to 2.0m bgl. Top of well 1.5m above ground level
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH3**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 444034.9 m E 6258303.2 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 1 0.15 - 0.30 1 0.30 - 0.45 2 0.45 - 0.60 3 0.60 - 0.75 6 0.75 - 0.90 30 0.90 - 1.05 30		CL	Dry, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
				CI	Dry, orange, firm, **CLAY** with a trace of fine gravel and some fine to coarse grained sand.
	1.0			CI	Dry, red brown, very stiff, **CLAY** with a trace of fine to medium grained sand.
	2.0				
	3.0			CI	Moist, yellow brown, very stiff, **CLAY** with a trace of fine grained sand. *significant presence of mica.*
	4.0			CI	Moist, red brown, very stiff, **CLAY** with a trace of fine grained sand. *significant presence of mica.*
	5.0			CI	Moist, pale brown mottled red white, very stiff, **CLAY** with a trace of fine grained sand. *significant presence of mica.*
	6.0				
	7.0			CI	Moist, pale brown grey, very stiff, **CLAY** with a trace of fine grained sand. *significant presence of mica.*
	8.0				
	9.0				
▽ 10.5m	10.0			CI	Wet, pale brown grey, very stiff, **CLAY** with a trace of fine grained sand. *significant presence of mica.*
	11.0				Hole Terminated at 10.80 m Target Depth; Screened from 4.3m - 7.30 m below ground level. Top of well 1.2m above ground level

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH4**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 444516.5 m E 6258065.0 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
0.25m		9 kg Dynamic Cone Penetrometer		SP	Moist, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	1.0	Depth (m) Blows 0.00 - 0.15 1 0.15 - 0.30 1 0.30 - 0.45 2 0.45 - 0.60 6 0.60 - 0.75 11 0.75 - 0.90 5 0.90 - 1.05 3		CL	Moist, grey, firm, **CLAY** with some fine grained sand.
	2.0			CL	Moist, grey, firm, **CLAY** with some fine grained sand.
	3.0				Hole Terminated at 2.60 m Target Depth; Screened from 2.0m - 3.0m below ground level. Top of well 1.25m above ground level
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH5**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 444742.8 m E 6258308.2 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
1.4m ▽	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 1 0.15 - 0.30 1 0.30 - 0.45 4 0.45 - 0.60 10 0.60 - 0.75 9 0.75 - 0.90 6 0.90 - 1.05 7		SP	Moist, dark brown, very loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
				SW	Moist, brown, medium dense, fine, **clayey GRAVEL** with a trace of organics and some fine to coarse grained sand.
	1.0			GC	Moist, pale brown, firm, **gravelly CLAY** with some fine to coarse grained sand.
				CH	Moist, brown slightly mottled dark brown orange, firm, **CLAY** with some fine to coarse grained sand and some fine to medium gravel.
	2.0			CH	Moist, pale brown, stiff, **CLAY** with some fine to coarse grained sand.
	3.0				Hole Terminated at 2.50 m Target Depth; Screened from 1m - 4m below ground level. Top of well 1m above ground level
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

BOREHOLE: BH6

SHEET: 1 OF 1

CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 444874.4 m E 6257783.5 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
1.5m	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 2 0.15 - 0.30 2 0.30 - 0.45 2 0.45 - 0.60 3 0.60 - 0.75 3 0.75 - 0.90 4 0.90 - 1.05 4		SP	Moist, dark brown, loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	1.0				Moist, pale brown, medium dense, fine to medium grained, **SAND**.
	2.0			SP	
	3.0				Hole Terminated at 3.00 m Target Depth; Screened from 1.6m - 2.6m below ground level, Top of well 1.4m above ground level
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH7**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 445140.9 m E 6258561.9 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 5 0.15 - 0.30 5 0.30 - 0.45 7 0.45 - 0.60 6 0.60 - 0.75 6 0.75 - 0.90 14 0.90 - 1.05 14		SP	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics and a trace of fine to coarse gravel.
	1.0			CI	Dry, orange, stiff, **CLAY** with some fine to medium gravel and a trace of fine to coarse grained sand.
	2.0			CL	Dry, orange slightly mottled white red, stiff, **CLAY** with a trace of fine to coarse gravel and a trace of fine to coarse grained sand.
	3.0			CL	Dry, red cream, stiff, **CLAY** with a trace of fine to medium grained sand.
	4.0				Hole Terminated at 3.50 m Hard Digging; Screened from 1.9m - 4.9m below ground level. Top of well 1.1m above ground level
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
▽ 10.5m	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH8**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 445087.5 m E 6258910.6 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
0.1m		9 kg Dynamic Cone Penetrometer		SP	Moist, grey, very loose, fine to medium grained, **SAND** with a trace of clay and a trace of fine gravel.
				Cl	Moist, orange mottled grey, soft, **sandy CLAY** with a trace of fine to medium gravel.
		Depth (m) Blows		Cl	Moist, orange, firm, **CLAY** with some fine to coarse grained sand and a trace of fine to medium gravel.
		0.00 - 0.15 1 0.15 - 0.30 2 0.30 - 0.45 2 0.45 - 0.60 7 0.60 - 0.75 11 0.75 - 0.90 14 0.90 - 1.05 15			Moist, orange, stiff, **CLAY** with some fine to medium grained sand.
	1.0				
	2.0				
	3.0				
	4.0			CH	
	5.0				
	6.0				
	7.0				Moist, grey, stiff, **CLAY** with some fine grained sand.
	8.0			CL	
	9.0				
	10.0				Hole Terminated at 10.00 m Target Depth; Likely spring encountered. Screened from 6.0m - 9.0m below ground level. Top of well 1m above ground level
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH9**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 445987.9 m E 6258107.7 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 4 0.15 - 0.30 5 0.30 - 0.45 4 0.45 - 0.60 7 0.60 - 0.75 5 0.75 - 0.90 15 0.90 - 1.05 10		SP	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	1.0				Dry, brown, very stiff, **gravelly CLAY** with a trace of fine to coarse grained sand.
	2.0			CI	
	3.0				
	4.0				Hole Terminated at 4.00 m Refusal; Screened from 0.6m - 2.6m below ground level. Top of well 1.3m above ground level
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH10**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 445652.3 m E 6257980.3 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 3 0.15 - 0.30 3 0.30 - 0.45 3 0.45 - 0.60 5 0.60 - 0.75 7 0.75 - 0.90 8 0.90 - 1.05 11		SP	Moist, dark brown, medium dense, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	1.0			CI	Dry, brown red, stiff, **gravelly CLAY** with a trace of fine to coarse grained sand.
	2.0			CI	Dry, brown orange, very stiff, **CLAY** with some fine to coarse grained sand.
▽ 3.3m	3.0				
	4.0				
	5.0			CI	Dry, orange, very stiff, **CLAY** with a trace of fine to coarse grained sand.
	6.0			CI	Dry, orange, very stiff, **CLAY**.
	7.0				
	8.0				
	9.0				
	10.0				Hole Terminated at 10.00 m Target Depth; Screened from 7.5m - 10.5m below ground level. Top of well 1.5m above ground level
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

WML accessible expertise	**BOREHOLE: BH11**	SHEET: 1 OF 1
CLIENT: Roma Pty Ltd	CONTRACTOR: WML Consultants	LOGGED: PT
PROJECT: Boyup Brook Subdivision - Groundwater Monitoring Wells	MACHINE: Drill Rig	LOGGED DATE: 01/10/2021
LOCATION: 54 Boyup Brook-Arthur Road	CO-ORD SYSTEM: MGA94 Zone 50	SURFACE RL:
JOB NO.: 10189	POSITION: 445458.5 m E 6257503.9 m N	CHAINAGE:

WATER	DEPTH (m)	SAMPLES OR FIELD TEST	GRAPHIC LOG	CLASSIFICATION SYMBOL	SOIL/ROCK MATERIAL DESCRIPTION
	0.0	9 kg Dynamic Cone Penetrometer Depth (m) Blows 0.00 - 0.15 2 0.15 - 0.30 4 0.30 - 0.45 4 0.45 - 0.60 3 0.60 - 0.75 4 0.75 - 0.90 6 0.90 - 1.05 6		SP	Moist, dark brown, loose, fine grained, **SAND** with a trace of fine roots and a trace of organics.
	1.0			SP	Dry, yellow grey, medium dense, fine to medium grained, **SAND** with some silt.
	2.0			CI	Dry, brown orange, stiff, **sandy CLAY**.
	3.0				Hole Terminated at 3.00 m Dry Collapse; Screened from 0.6m - 2.6m below ground level. Top of well 1.5m above ground level
	4.0				
	5.0				
	6.0				
	7.0				
	8.0				
	9.0				
	10.0				
	11.0				

WML LIB 1.08.GLB Log WML SOIL 10189 LOGS.GPJ <<DrawingFile>> 05/01/2022 13:55 10.02.00.04 Developed by Datgel

Appendix B

Pre-development Groundwater and Surface Water Monitoring Report
(Bio Diverse Solutions, 2023)

Pre-development Surface Water and Groundwater Monitoring

Leafield Boyup Brook

Lots 51, 1007 & 1118 Boyup Brook Arthur Road,

Boyup Brook WA

EPP0010-003

24/11/2023



BUSHFIRE | ENVIRONMENTAL | WATER | GIS

DOCUMENT CONTROL

Title: Pre-development Surface Water and Groundwater Monitoring

Author (s): C. Cramer & M. Wearing

Reviewer (s): B. Theyer

Job No.: EPP0010-003

Client: Leafield Pty Ltd

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1. Introduction

Pre-development groundwater and surface water monitoring was conducted by Bio Diverse Solutions on behalf of Leafield Pty Ltd at Lots 51, 1007 and 1118 Boyup Brook-Arthur Road (Leafield Boyup Brook) from June 2023 to October 2023. Monitoring included 5 rounds of water level monitoring (Jun, Jul, Aug, Sep and Oct 23) and 2 rounds of water quality monitoring (Jun/Jul and Oct 23), with the Jun/Jul water quality monitoring round conducted over 2 days, one in June and one in July 2023. Three surface water sites and eleven groundwater bores were monitored as part of the monitoring program. The groundwater monitoring bores were installed by WML Consultant Engineers, whom also captured 5 rounds of groundwater level monitoring from Oct 21 until Oct 22. A plan showing the location of the monitoring sites is shown in Appendix A.

This report summarises the findings of the pre-development surface water and groundwater quality and levels results. Water quality results are compared to relevant trigger values where available. Laboratory testing was conducted by NATA accredited laboratory; MPL Laboratories.

Groundwater monitoring bores BH1, BH2, BH3, BH4, BH6, BH9 and BH11 were found to be dry during both the Jun/Jul 23 and Oct 23 water quality monitoring rounds and BH8 was found to be dry during the Oct 23 only water quality monitoring round.

2. Groundwater Levels

2.1. Groundwater levels

WML Consulting Engineers installed 11 groundwater monitoring bores in Oct 21 as part of the pre-development groundwater monitoring program, details of the groundwater monitoring bores are presented in Table 1.

Table 1: Details of monitoring bores (WML Consultant Engineering, 2022)

Monitoring well	Co-ordinates		Stick up (m)	Depth of hole (m)
	Easting	Northing		
BH1	444344	6257800	1.07	5.95
BH2	444102	6257932	1.2	3.34
BH3	444035	6258303	1.3	8.47
BH4	444516	6258065	1.28	3.97
BH5	444743	6258308	0.96	5.1
BH6	444874	6257784	1.38	3.97
BH7	445141	6258562	1.12	5.88
BH8	445088	6258911	0.64	10
BH9	445988	6258108	0.3	3.93
BH10	445652	6257980	0.28	11.14
BH11	445458	6257504	1.37	3.99

Groundwater was measured initially by WML Consultant Engineers in Oct 21 and again monthly from Jun 22 to Oct 22. Bio Diverse Solutions continued to monitor the bores monthly from Jun 23 to Oct 23. Groundwater levels across the site varied from 0.5 m above ground level at BH8 in Aug 23 to 10.5 m BGL at BH3 and BH7 in Oct 21. Groundwater levels across the site generally fluctuated consistent with seasonal rainfall. The groundwater levels recorded in the bores for the Oct 21 to Oct 23 monitoring period are shown in Table 2 and Figure 1, with the highest recorded groundwater level at each bore also added to the monitoring location plan in Appendix A.

Table 2: Groundwater levels Oct 21 to Oct 23

Monitoring bore	Groundwater level (m BGL)									
	Oct 21	Jun 22	Jul 22	Aug 22	Oct 22	Jun 23	Jul 23	Aug 23	Sep 23	Oct 23
BH1	4.9	2.5	3.3	2.8	3.0	3.5	dry	2.8	3.0	3.2
BH2	2	dry	dry	dry	1.5	dry	dry	dry	dry	dry
BH3	10.5	3.0	dry	dry	dry	dry	dry	dry	dry	dry
BH4	0.2	dry	2.3	2.3	1.5	2.5	dry	0.99	1.0	dry
BH5	1.4	3.0	1.8	3.0	1.8	3.2	3.3	0.5	1.4	2.0
BH6	1.5	dry	dry	dry	2.3	dry	dry	dry	dry	dry
BH7	10.5	dry	dry	dry	dry	4.8	4.8	4.8	4.8	dry
BH8	0.1	-0.2*	-0.3*	-0.3*	-0.5*	0.1*	0.1*	-0.5*	-0.3*	dry
BH9	dry	dry	dry	dry	dry	dry	dry	3.4	dry	dry
BH10	3.3	3.9	4.1	3.9	3.2	4.1	4.3	3.6	3.8	4.0
BH11	dry	dry	dry	dry	2.5	dry	dry	dry	1.3	dry

Notes: * Groundwater level is above ground level.

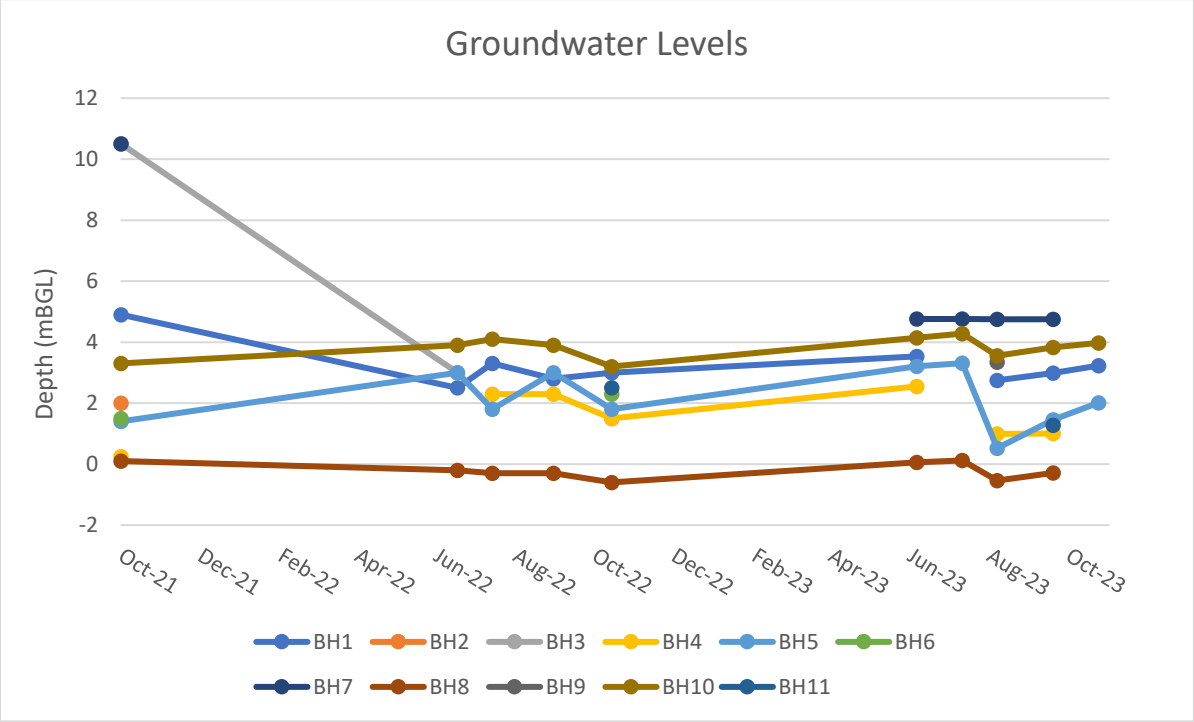


Figure 1: Groundwater levels Dec 21 to Oct 23

3. Water quality

3.1. pH

The pH levels at the surface water sites were generally within the ANZECC and ARMCANZ (2000) trigger value range for upland rivers in the southwest of Australia (6.5 - 8.0), with the exception of CS2, which had a pH reading of 9.23 in Oct 23. The pH levels of the groundwater were found to be neutral to slightly acidic, with pH levels at BH5 (6.3) and BH10 (5.6) in Oct 23 being below the ANZECC and ARMCANZ (2000) lower trigger value. The pH levels for the monitoring sites during the two monitoring rounds are presented in Figure 2, with the pH data shown in Appendix B.

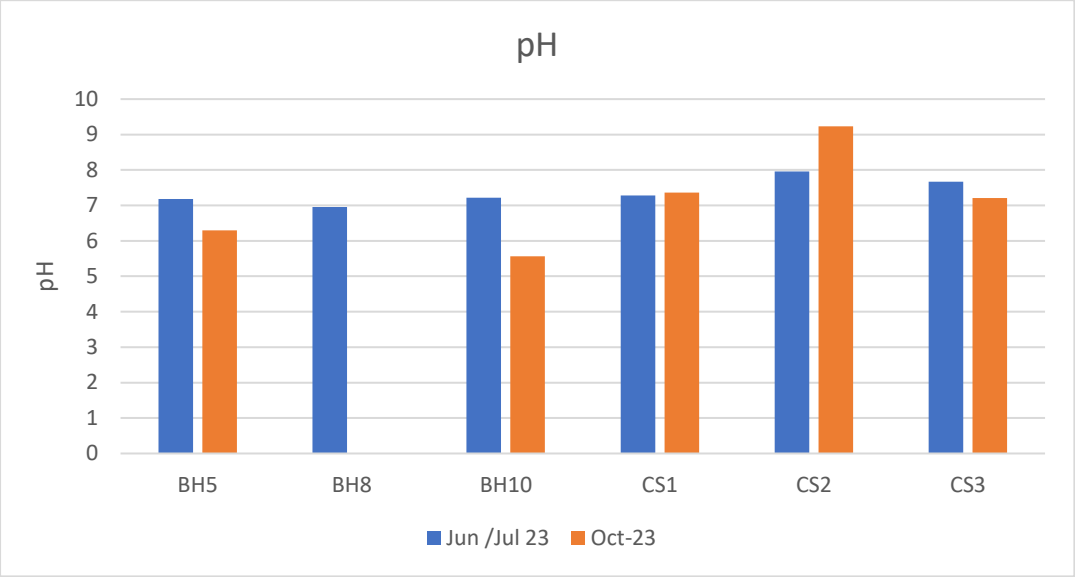


Figure 2: Surface water and groundwater pH

3.2. Electrical Conductivity

The Electrical Conductivity (EC) at the monitoring sites varied with both monitoring location and event. EC levels were found to be slightly elevated at BH5, high at BH10, CS2 and CS3, and very high at BH8 and CS1. EC levels were found to be above the ANZECC and ARMCANZ (2000) upper trigger value for upland rivers in the Southwest of Australia (300uS/cm) at all monitoring sites that had groundwater/surface water. EC levels at each of the monitoring sites during the two monitoring rounds are shown in Figure 3, with the EC data shown in Appendix B.

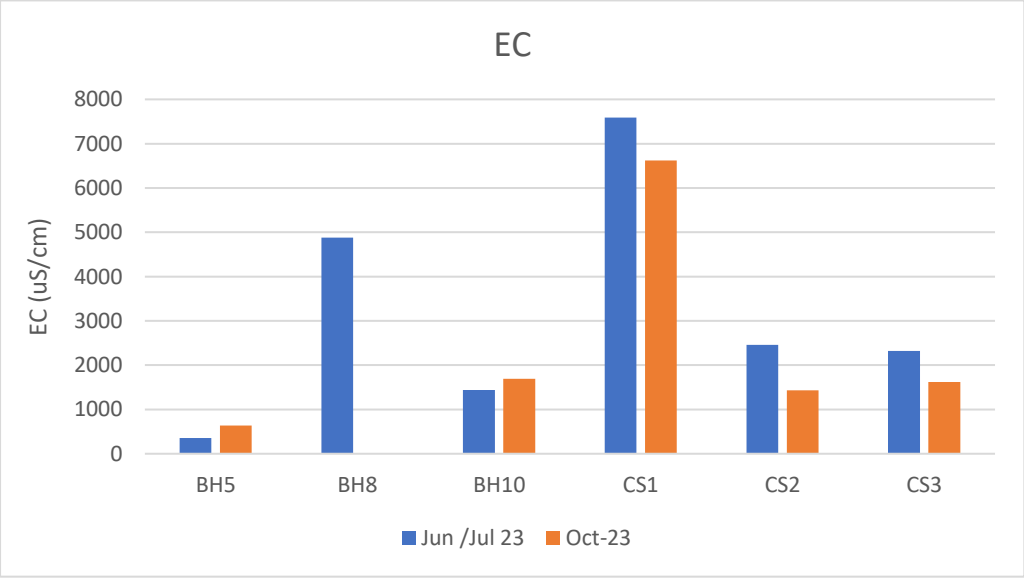


Figure 3: Surface water and groundwater EC

3.3. Total Dissolved Solids

TDS levels across the site were found to be slightly elevated at BH10, CS2 and CS3 and high at BH8 and CS1. TDS levels were found to be above the ANZECC and ARMCANZ (2000) upper trigger value (1 g/L) at all monitoring sites except for BH5, BH10 (Jun/Jul 23 only) and CS2 (Oct 23 only). TDS levels at each of the monitoring sites during the two monitoring rounds are shown in Figure 4, with the TDS data shown in Appendix B.

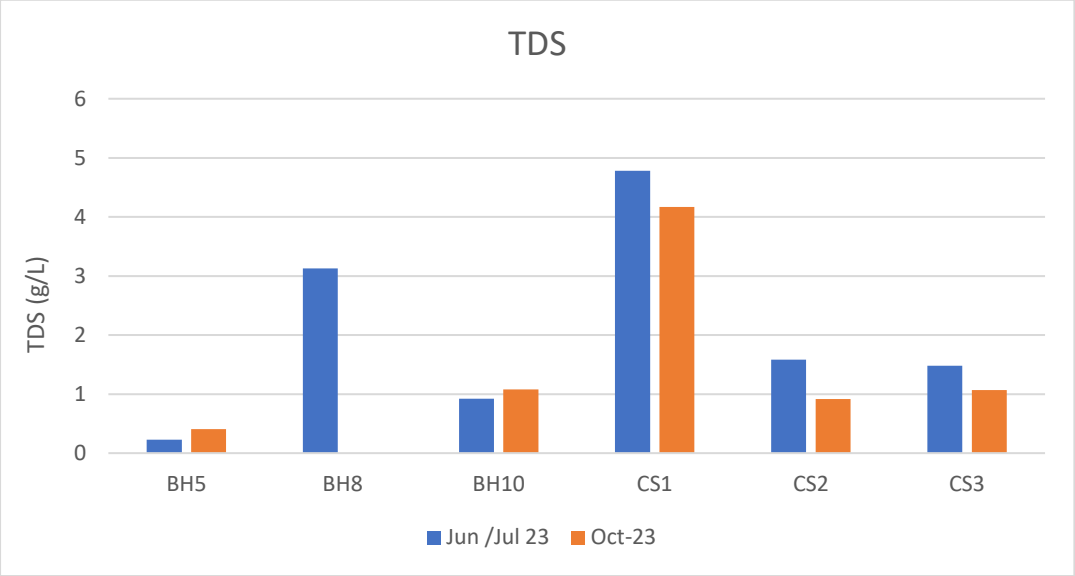


Figure 4: Surface water and groundwater TDS

3.4. Dissolved Oxygen

The Dissolved Oxygen (DO) levels recorded at the surface water sites varied from moderate to low. DO levels were below the ANZECC and ARMCANZ (2000) lower trigger value for upland rivers in the southwest of Australia (90%) at all three surface water sites during the Jun/Jul 23 monitoring round and below the lower trigger value at CS1 and CS3 during the Oct 23 monitoring round. Groundwater typically has a much lower DO compared to that of surface water due to the decreased interface with the atmosphere. The DO levels recorded at the groundwater monitoring bores were low and below the ANZECC and ARMCANZ (2000) lower trigger value. DO levels at each of the monitoring sites for the two monitoring rounds are shown in Figure 5, with the DO data shown in Appendix B.

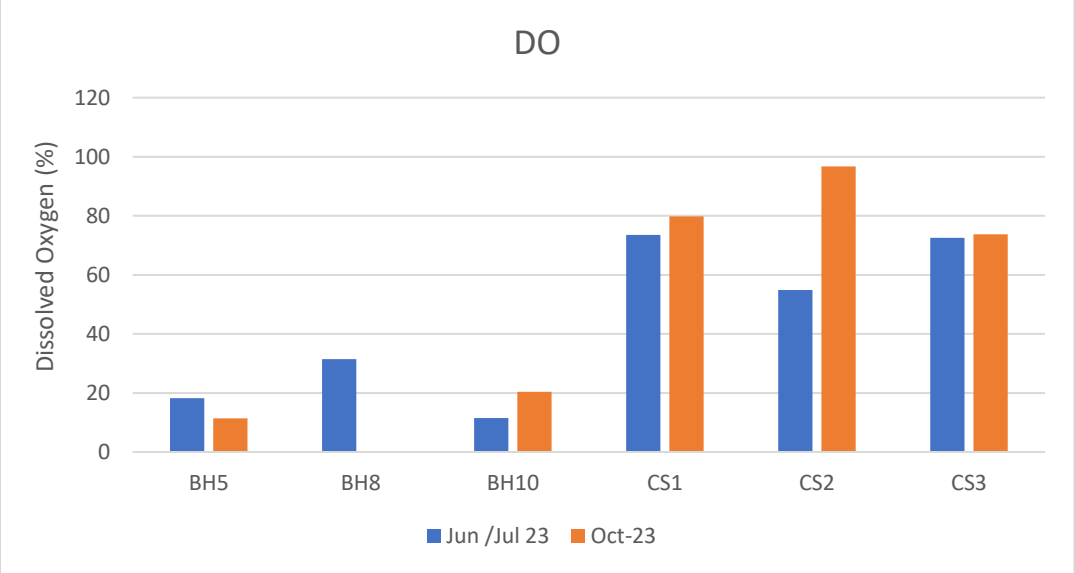


Figure 5: Surface water and groundwater DO

3.5. Nutrients

The Total Nitrogen (TN) levels recorded at the surface water sites were moderate to high and above the ANZECC and ARMCANZ (2000) upper trigger value for upland rivers in the southwest of Australia (0.45 mg/L). The TN levels in the groundwater varied from moderate at BH8 to high at BH10 to extremely high at BH5. Noting, at all monitoring sites, the nitrogen was predominantly in the form of Total Kjeldahl Nitrogen (TKN) and therefore is likely to originate from an organic source. Nitrite/nitrate levels were found to be above the ANZECC and ARMCANZ (2000) upper trigger value (0.2 mg/L) at CS1 and CS2 in Jun/Jul 23. The TN levels at the monitoring sites for the two monitoring rounds is presented in Figure 6, with the nitrogen data shown in Appendix B.

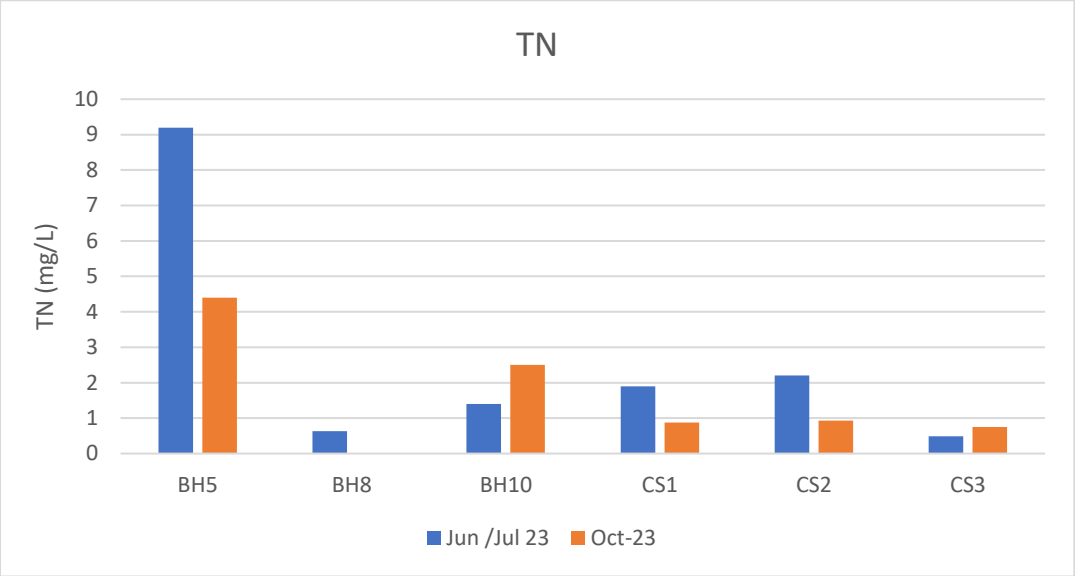


Figure 6: Surface water and groundwater TN

Total Phosphorus (TP) was elevated and above the ANZECC and ARMCANZ (2000) trigger value (<0.02 mg/L) at all monitoring sites, except CS3 in Jun/Jul 23. TP levels were extremely high at BH5 during the Jun/Jul 23 monitoring event (3.9 mg/L). Phosphate (PO_4) levels were generally found to be low at the monitoring sites indicating that most of the phosphorus is from an organic source. The TP levels at the monitoring sites during the two monitoring rounds is shown in Figure 6, with the raw data shown in Appendix C.

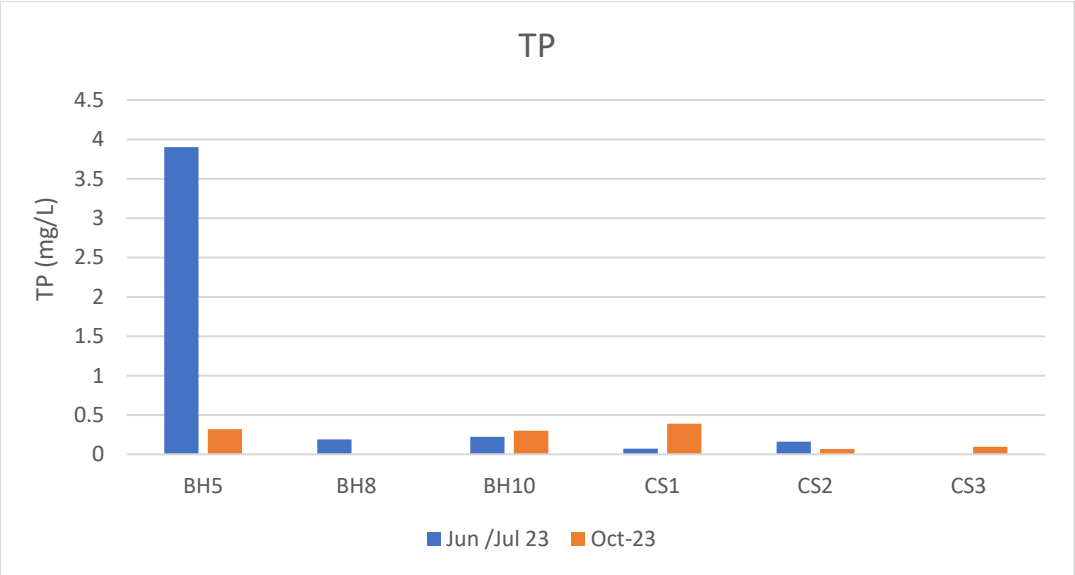


Figure 7: Surface water and groundwater TP

3.6. Dissolved Metals

Dissolved metal (arsenic, cadmium, chromium, copper, mercury, nickel, lead and zinc) levels were generally found to be low and below the ANZECC & ARMCANZ (2000) trigger values for toxicants in freshwater ecosystems at 95% level of protection. There were some exceptions to this with the guideline trigger value for copper being exceeded at BH5, BH8 and BH10 during the Jun/Jul 2023 monitoring round and CS2 during the Oct 23 monitoring round. The guideline trigger value was also exceeded for zinc at BH8 during the Jul 23 monitoring round, BH10 and CS1 during the Oct 23 monitoring round). The dissolved metal levels for each monitoring site for the two monitoring rounds are shown in Appendix B.

3.7. Hydrocarbons

The Volatile Total Recoverable Hydrocarbons (TRH), Methyl tertiary-butyl ether, benzene, toluene, ethylbenzene, xylene and Naphthalene (MBTEXN), and Semi-volatile TRH laboratory results were generally found to be low and below the laboratory detection limit for all parameters at all monitoring sites during each monitoring round. The TRH, MBTEXN and semi-volatile TRH levels for each monitoring site for each monitoring round are shown in Appendix B.

3.8. PAHs in water

Polycyclic Aromatic Hydrocarbons (PAHs) laboratory results were found to be below laboratory detection limits at all monitoring sites during both monitoring rounds. The PAH levels for each monitoring site for the two monitoring rounds are shown in Appendix B.

3.9. Microbial

Thermotolerant Coliform (TC) and E. coli levels across the site were generally high within the surface water and groundwater monitoring bores. TC and E. coli levels were moderately to extremely elevated at BH5, BH10, CS2 and CS3 during both monitoring rounds and below detection limits at BH8 and CS1. The TC and E. coli levels for each monitoring site for the two monitoring rounds are shown in Appendix B.

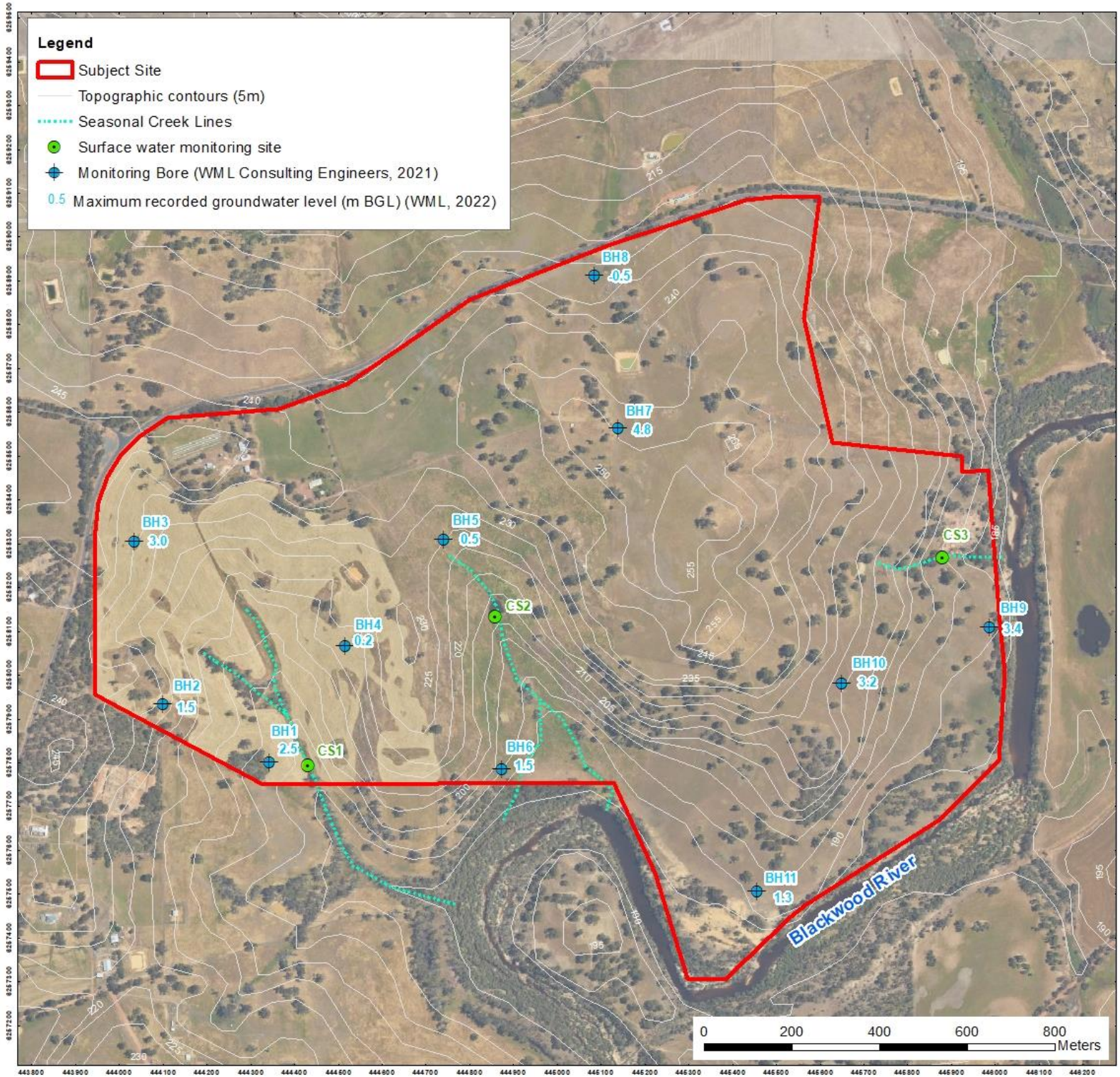
4. References

ANZECC & ARMCANZ (Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand) (2000). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

WML Consultant Engineers (2022) *Boyup Brook Subdivision Groundwater Monitoring Bores – Factual Report.* Unpublished report prepared for client.

Appendix A

Monitoring Location Plan



Albany Office:
29 Hercules Crescent
Albany, WA 6330
(08) 9842 1575

Denmark Office:
7/40 South Coast Highway
Denmark, WA 6333
(08) 9848 1309

Esperance Office:
2A/113 Dempster Street
Esperance, WA 6450

BIO DIVERSE SOLUTIONS



Overview Map Scale 1:100,000

Scale
1:8,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT
Leafield Pty Ltd
Lot 51, 1007 and 1118 Boyup Brook-Arthur Rd
Boyup Brook, WA 6244

Monitoring Location Plan

	QA Check	Drawn by
	CJC	CJC
STATUS FINAL	FILE EPP010 003	DATE 21/11/2023

Appendix B

Water Quality Monitoring Results

BH01

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		Dry	Dry
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (µS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	-	-
TKN_N*		-	-
NH_3_N		-	-
NO_3_N		-	-
NO_2_N		-	-
NOx _N	<0.2[1)]	-	-
TP	<0.02[1)]	-	-
PO_4_P		-	-
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	-	-
VolatileTotal Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volitile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red.**

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH02

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		**Dry**	**Dry**
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (µS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	-	-
TKN_N*		-	-
NH_3_N		-	-
NO_3_N		-	-
NO_2_N		-	-
NOx_N	<0.2[1)]	-	-
TP	<0.02[1)]	-	-
PO_4_P		-	-
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	-	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatileTotal Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100ml)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH03

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		**Dry**	**Dry**
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (uS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	**-**	-
TKN_N*		**-**	**-**
NH_3_N		**-**	**-**
NO_3_N		-	-
NO_2_N		-	-
Nox_N	<0.2[1)]	**-**	**-**
TP	<0.02[1)]	-	**-**
PO_4_P		-	**-**
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	**-**	**-**
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead Pb	<3.4[2)]	-	**-**
Zinc, Zn	<8.0[2)]	**-**	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH04

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		Dry	Dry
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (µS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	-	-
TKN_N*		-	-
NH_3_N		-	-
NO_3_N		-	-
NO_2_N		-	-
Nox_N	<0.2[1)]	-	-
TP	<0.02[1)]	-	-
PO_4_P		-	-
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead, Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	-	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH05

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		16.25	17.86
pH	6.5 - 8.0[1)]	7.18	**6.3**
Electrical Conductivity (µS/cm)	120-300[1)]	352	639
Dissolved Oxygen (mg/L)		**1.73**	**1.05**
Dissolved Oxygen (%)	90-n/a[1)]	**18.2**	**11.4**
Total Dissolved Solids (g/L)	<1[1)]	0.229	0.409
Nutrients (mg/L)			
TN	<0.45[1)]	**9.2**	**4.4**
TKN_N*		9.1	4.4
NH_3_N		0.69	0.24
NO_3_N		0.08	0.074
NO_2_N		0.017	<0.0050
NO_x_N	<0.2[1)]	0.097	0.079
TP	<0.02[1)]	**3.9**	**0.32**
PO_4_P		0.0062	0.02
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	<1.0	<1.0
Cadmium, Cd	<0.2[2)]	<0.10	<0.10
Chromium, Cr	<1.0[2)]	<1.0	<1.0
Copper, Cu	<1.4[2)]	**4.9**	1.2
Mercury, Hg	<0.6[2)]	<0.050	<0.050
Nickle, Ni	<11[2)]	1.0	<1.0
Lead Pb	<3.4[2)]	<1.0	<1.0
Zinc, Zn	<8.0[2)]	<1.0	2.7
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		<10	<10
TRH C6 - C10		<10	<10
TRH C6 -C10 less BTEX (F1)		<10	<10
MBTEXN (µg/L)			
MTBE		<1.0	<1.0
Benzene	950[2)]	<1.0	<1.0
Toluene		<1.0	<1.0
Ethylbenzene		<1.0	<1.0
m+p-xylene		<2.0	<2.0
o-xylene	350[2)]	<1.0	<1.0
Total Xylene		<3.0	<3.0
Naphthalene		<1.0	<1.0
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		<50	<50
TRH C15 - C28		14000	<100
TRH C29 - C36		3300	<100
Total +ve TRH C10-C36		17000	<50
TRH >C10 - C16		240	<50
TRH >C10 -C16 less N (F2)		240	<50
TRH >C16 - C34		17000	<100
TRH >C34 - C40		590	<100
Total +ve TRH >C10-C40		18000	<50
PAHs in water (µg/L)			
Naphthalene	16[2)]	<0.10	<0.10
Acenaphthylene		<0.10	<0.10
Acenaphthene		<0.10	<0.10
Fluorene		<0.40	<0.10
Phenanthrene		<0.10	<0.10
Anthracene		<0.10	<0.10
Fluoranthene		<0.10	<0.10
Pyrene		<0.10	<0.10
Benzo(a)anthracene		<0.10	<0.10
Chrysene		<0.10	<0.10
Benzo(b,j+k)fluoranthene		<0.20	<0.20
Benzo(a)pyrene		<0.10	<0.10
Indeno(1,2,3-c,d)pyrene		<0.10	<0.10
Dibenzo(a,h)anthracene		<0.10	<0.10
Benzo(g,h,i)perylene		<0.10	<0.10
Total +ve PAH's		<0.10	<0.10
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		1,500	1100
E.coli		1,500	1100

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH06

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		Dry	Dry
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (µS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	-	-
TKN_N*		-	-
NH_3_N		-	-
NO_3_N		-	-
NO_2_N		-	-
NOx_N	<0.2[1)]	-	-
TP	<0.02[1)]	-	-
PO_4_P		-	-
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	-	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatileTotal Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40			-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH07

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		Dry	Dry
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (µS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	-	-
TKN_N*		-	-
NH_3_N		-	-
NO_3_N		-	-
NO_2_N		-	-
NO_x_N	<0.2[1)]	-	-
TP	<0.02[1)]	-	-
PO_4_P		-	-
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead, Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	-	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34 (F3)		-	-
TRH >C34 - C40 (F4)		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH08

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		16.85	**Dry**
pH	6.5 - 8.0[1)]	6.96	-
Electrical Conductivity (µS/cm)	120-300[1)]	**4880**	-
Dissolved Oxygen (mg/L)		**2.92**	-
Dissolved Oxygen (%)	90-n/a[1)]	**31.5**	-
Total Dissolved Solids (g/L)	<1[1)]	**3.13**	-
Nutrients (mg/L)			
TN	<0.45[1)]	**0.63**	-
TKN_N*		0.55	-
NH3_N		0.21	-
NO3_N		0.072	-
NO2_N		<0.0050	-
NOx_N	<0.2[1)]	0.076	-
TP	<0.02[1)]	**0.19**	-
PO4_P		0.030	-
Dissolved Metals ((µg/L)			
Arsenic, As	<13[2)]	<1.0	-
Cadmium, Cd	<0.2[2)]	<0.10	-
Chromium, Cr	<1.0[2)]	<1.0	-
Copper, Cu	<1.4[2)]	**1.8**	-
Mercury, Hg	<0.6[2)]	<0.050	-
Nickle, Ni	<11[2)]	<1.0	-
Lead Pb	<3.4[2)]	<1.0	-
Zinc, Zn	<8.0[2)]	**14**	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		<10	-
TRH C6 - C10		<10	-
TRH C6 -C10 less BTEX (F1)		<10	-
MBTEXN (µg/L)			
MTBE		<1.0	-
Benzene	950[2)]	<1.0	-
Toluene		<1.0	-
Ethylbenzene		<1.0	-
m+p-xylene		<2.0	-
o-xylene	350[2)]	<1.0	-
Total Xylene		<3.0	-
Naphthalene		<1.0	-
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		<50	-
TRH C15 - C28		<100	-
TRH C29 - C36		<100	-
Total +ve TRH C10-C36		<50	-
TRH >C10 - C16		<50	-
TRH >C10 -C16 less N (F2)		<50	-
TRH >C16 - C34		110	-
TRH >C34 - C40		<100	-
Total +ve TRH >C10-C40		110	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	<0.10	-
Acenaphthylene		<0.10	-
Acenaphthene		<0.10	-
Fluorene		<0.10	-
Phenanthrene		<0.10	-
Anthracene		<0.10	-
Fluoranthene		<0.10	-
Pyrene		<0.10	-
Benzo(a)anthracene		<0.10	-
Chrysene		<0.10	-
Benzo(b,j+k)fluoranthene		<0.20	-
Benzo(a)pyrene		<0.10	-
Indeno(1,2,3-c,d)pyrene		<0.10	-
Dibenzo(a,h)anthracene		<0.10	-
Benzo(g,h,i)perylene		<0.10	-
Total +ve PAH's		<0.10	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		<10	-
E.coli		<10	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH09

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		**Dry**	**Dry**
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (uS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	**-**	**-**
TKN_N*		**-**	**-**
NH3_N		**-**	**-**
NO3_N		-	-
NO2_N		-	-
NOx_N	<0.2[1)]	**-**	**-**
TP	<0.02[1)]	**-**	**-**
PO4_P		**-**	**-**
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	**-**	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH10

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		17.43	19.22
pH	6.5 - 8.0[1)]	7.22	**5.56**
Electrical Conductivity (µS/cm)	120-300[1)]	1440	**1690**
Dissolved Oxygen (mg/L)		**1.06**	**1.82**
Dissolved Oxygen (%)	90-n/a[1)]	**11.5**	**20.4**
Total Dissolved Solids (g/L)	<1[1)]	0.920	**1.08**
Nutrients (mg/L)			
TN	<0.45[1)]	**1.4**	**2.5**
TKN_N*		1.3	2.3
NH3_N		0.29	0.38
NO3_N		0.088	0.16
NO2_N		0.015	0.011
NOx_N	<0.2[1)]	0.10	0.17
TP	<0.02[1)]	**0.22**	**0.30**
PO4_P		<0.0050	0.012
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	<1.0	<1.0
Cadmium, Cd	<0.2[2)]	<0.10	<0.10
Chromium, Cr	<1.0[2)]	<1.0	<1.0
Copper, Cu	<1.4[2)]	**2.3**	1.3
Mercury, Hg	<0.6[2)]	<0.050	<0.050
Nickle, Ni	<11[2)]	1.0	<1.0
Lead Pb	<3.4[2)]	<1.0	<1.0
Zinc, Zn	<8.0[2)]	**22**	**44**
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		<10	<10
TRH C6 - C10		<10	<10
TRH C6 -C10 less BTEX (F1)		<10	<10
MBTEXN (µg/L)			
MTBE		<1.0	<1.0
Benzene	950[2)]	<1.0	<1.0
Toluene		<1.0	<1.0
Ethylbenzene		<1.0	<1.0
m+p-xylene		<2.0	<2.0
o-xylene	350[2)]	<1.0	<1.0
Total Xylene		<3.0	<3.0
Naphthalene		<1.0	<1.0
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		<50	<50
TRH C15 - C28		<100	<100
TRH C29 - C36		<100	<100
Total +ve TRH C10-C36		<50	<50
TRH >C10 - C16		<50	<50
TRH >C10 -C16 less N (F2)		<50	<50
TRH >C16 - C34		<100	<100
TRH >C34 - C40		<100	<100
Total +ve TRH >C10-C40		<50	<50
PAHs in water (µg/L)			
Naphthalene	16[2)]	<0.10	<0.10
Acenaphthylene		<0.10	<0.10
Acenaphthene		<0.10	<0.10
Fluorene		<0.10	<0.10
Phenanthrene		<0.10	<0.10
Anthracene		<0.10	<0.10
Fluoranthene		<0.10	<0.10
Pyrene		<0.10	<0.10
Benzo(a)anthracene		<0.10	<0.10
Chrysene		<0.10	<0.10
Benzo(b,j+k)fluoranthene		<0.20	<0.20
Benzo(a)pyrene		<0.10	<0.10
Indeno(1,2,3-c,d)pyrene		<0.10	<0.10
Dibenzo(a,h)anthracene		<0.10	<0.10
Benzo(g,h,i)perylene		<0.10	<0.10
Total +ve PAH's		<0.10	<0.10
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		160	> 1,500
E.coli		160	> 1,500

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

BH11

Parameters	Guideline	11/07/2023	24/10/2023
Physicochemical			
Temperature		Dry	Dry
pH	6.5 - 8.0[1)]	-	-
Electrical Conductivity (µS/cm)	120-300[1)]	-	-
Dissolved Oxygen (mg/L)		-	-
Dissolved Oxygen (%)	90-n/a[1)]	-	-
Total Dissolved Solids (g/L)	<1[1)]	-	-
Nutrients (mg/L)			
TN	<0.45[1)]	-	-
TKN_N*		-	-
NH3_N		-	-
NO3_N		-	-
NO2_N		-	-
NOx_N	<0.2[1)]	-	-
TP	<0.02[1)]	-	-
PO4_P		-	-
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	-	-
Cadmium, Cd	<0.2[2)]	-	-
Chromium, Cr	<1.0[2)]	-	-
Copper, Cu	<1.4[2)]	-	-
Mercury, Hg	<0.6[2)]	-	-
Nickle, Ni	<11[2)]	-	-
Lead, Pb	<3.4[2)]	-	-
Zinc, Zn	<8.0[2)]	-	-
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		-	-
TRH C6 - C10		-	-
TRH C6 -C10 less BTEX (F1)		-	-
MBTEXN (µg/L)			
MTBE		-	-
Benzene	950[2)]	-	-
Toluene		-	-
Ethylbenzene		-	-
m+p-xylene		-	-
o-xylene	350[2)]	-	-
Total Xylene		-	-
Naphthalene		-	-
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		-	-
TRH C15 - C28		-	-
TRH C29 - C36		-	-
Total +ve TRH C10-C36		-	-
TRH >C10 - C16		-	-
TRH >C10 -C16 less N (F2)		-	-
TRH >C16 - C34		-	-
TRH >C34 - C40		-	-
Total +ve TRH >C10-C40		-	-
PAHs in water (µg/L)			
Naphthalene	16[2)]	-	-
Acenaphthylene		-	-
Acenaphthene		-	-
Fluorene		-	-
Phenanthrene		-	-
Anthracene		-	-
Fluoranthene		-	-
Pyrene		-	-
Benzo(a)anthracene		-	-
Chrysene		-	-
Benzo(b,j+k)fluoranthene		-	-
Benzo(a)pyrene		-	-
Indeno(1,2,3-c,d)pyrene		-	-
Dibenzo(a,h)anthracene		-	-
Benzo(g,h,i)perylene		-	-
Total +ve PAH's		-	-
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	-
E.coli		-	-

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

CS01

Parameters	Guideline	6/06/2023	24/10/2023
Physicochemical			
Temperature		10.4	17.05
pH	6.5 - 8.0[1)]	7.28	7.36
pH - lab	6.5 to 8.0[1)]	7.2	-
Electrical Conductivity (µS/cm)	120-300[1)]	**7590**	**6620**
Electrical Conductivity - lab (µS/cm)	120-300[1)]	**7400**	-
Dissolved Oxygen (mg/L)		**7.76**	**7.32**
Dissolved Oxygen (%)	90-n/a[1)]	**73.5**	**79.8**
Total Dissolved Solids (mg/L)	<1[1)]	**4.78**	**4.17**
Nutrients (mg/L)			
TN	<0.45[1)]	**1.9**	**0.88**
TKN_N*		1.0	0.88
NH3_N		0.32	0.0095
NO3_N		0.81	<0.0050
NO2_N		0.062	<0.0050
NOx_N	<0.2[1)]	**0.87**	<0.0050
TP	<0.02[1)]	**0.073**	**0.39**
PO4_P		0.0058	<0.0050
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	<1.0	<1.0
Cadmium, Cd	<0.2[2)]	<0.10	<0.10
Chromium, Cr	<1.0[2)]	<1.0	<1.0
Copper, Cu	<1.4[2)]	<1.0	<1.0
Mercury, Hg	<0.6[2)]	<0.050	<0.050
Nickle, Ni	<11[2)]	<1.0	<1.0
Lead, Pb	<3.4[2)]	<1.0	<1.0
Zinc, Zn	<8.0[2)]	1.5	**13**
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		<50	<10
TRH C6 - C10		<50	<10
TRH C6 -C10 less BTEX (F1)		<50	<10
MBTEXN (µg/L)			
MTBE		<5.0	<1.0
Benzene	950[2)]	<5.0	<1.0
Toluene		<5.0	<1.0
Ethylbenzene		<5.0	<1.0
m+p-xylene		<10	<2.0
o-xylene	350[2)]	<5.0	<1.0
Total Xylene		<15	<3.0
Naphthalene		<5.0	<1.0
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		<50	<50
TRH C15 - C28		<100	<100
TRH C29 - C36		<100	<100
Total +ve TRH C10-C36		<50	<50
TRH >C10 - C16		<50	<50
TRH >C10 -C16 less N (F2)		<50	<50
TRH >C16 - C34		<100	<100
TRH >C34 - C40		<100	<100
Total +ve TRH >C10-C40		<50	<50
PAHs in water (µg/L)			
Naphthalene	16[2)]	<0.10	<0.10
Acenaphthylene		<0.10	<0.10
Acenaphthene		<0.10	<0.10
Fluorene		<0.10	<0.10
Phenanthrene		<0.10	<0.10
Anthracene		<0.10	<0.10
Fluoranthene		<0.10	<0.10
Pyrene		<0.10	<0.10
Benzo(a)anthracene		<0.10	<0.10
Chrysene		<0.10	<0.10
Benzo(b,j+k)fluoranthene		<0.20	<0.20
Benzo(a)pyrene		<0.10	<0.10
Indeno(1,2,3-c,d)pyrene		<0.10	<0.10
Dibenzo(a,h)anthracene		<0.10	<0.10
Benzo(g,h,i)perylene		<0.10	<0.10
Total +ve PAH's		<0.10	<0.10
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	<10
E.coli		-	<10

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

CS02

Parameters	Guideline	6/06/2023	24/10/2023
Physicochemical			
Temperature		11.62	21.77
pH	6.5 - 8.0[1)]	7.96	**9.23**
pH - lab	6.5 to 8.0[1)]	7.9	-
Electrical Conductivity (µS/cm)	120-300[1)]	**2460**	1430
Electrical Conductivity - lab (µS/cm)	120-300[1)]	**2400**	-
Dissolved Oxygen (mg/L)		**5.73**	8.25
Dissolved Oxygen (%)	90-n/a[1)]	**54.9**	96.7
Total Dissolved Solids (mg/L)	<1[1)]	**1.58**	0.915
Nutrients (mg/L)			
TN	<0.45[1)]	**2.2**	**0.93**
TKN_N*		1.4	0.93
NH3_N		0.28	0.0072
NO3_N		0.74	<0.0050
NO2_N		0.074	<0.0050
NOx_N	<0.2[1)]	**0.81**	<0.0050
TP	<0.02[1)]	**0.16**	**0.068**
PO4_P		0.0052	<0.0050
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	<1.0	<1.0
Cadmium, Cd	<0.2[2)]	<0.10	<0.10
Chromium, Cr	<1.0[2)]	<1.0	<1.0
Copper, Cu	<1.4[2)]	1.3	**2.3**
Mercury, Hg	<0.6[2)]	<0.050	<0.050
Nickle, Ni	<11[2)]	<1.0	<1.0
Lead, Pb	<3.4[2)]	<1.0	<1.0
Zinc, Zn	<8.0[2)]	<1.0	5.3
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		<10	<10
TRH C6 - C10		<10	<10
TRH C6 -C10 less BTEX (F1)		<10	<10
MBTEXN (µg/L)			
MTBE		<1.0	<1.0
Benzene	950[2)]	<1.0	<1.0
Toluene		<1.0	<1.0
Ethylbenzene		<1.0	<1.0
m+p-xylene		<2.0	<2.0
o-xylene	350[2)]	<1.0	<1.0
Total Xylene		<3.0	<3.0
Naphthalene		<1.0	<1.0
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		<50	<50
TRH C15 - C28		<100	<100
TRH C29 - C36		<100	<100
Total +ve TRH C10-C36		<50	<50
TRH >C10 - C16		<50	<50
TRH >C10 -C16 less N (F2)		<50	<50
TRH >C16 - C34		<100	<100
TRH >C34 - C40		<100	<100
Total +ve TRH >C10-C40		<50	<50
PAHs in water (µg/L)			
Naphthalene	16[2)]	<0.10	<0.10
Acenaphthylene		<0.10	<0.10
Acenaphthene		<0.10	<0.10
Fluorene		<0.10	<0.10
Phenanthrene		<0.10	<0.10
Anthracene		<0.10	<0.10
Fluoranthene		<0.10	<0.10
Pyrene		<0.10	<0.10
Benzo(a)anthracene		<0.10	<0.10
Chrysene		<0.10	<0.10
Benzo(b,j+k)fluoranthene		<0.20	<0.20
Benzo(a)pyrene		<0.10	<0.10
Indeno(1,2,3-c,d)pyrene		<0.10	<0.10
Dibenzo(a,h)anthracene		<0.10	<0.10
Benzo(g,h,i)perylene		<0.10	<0.10
Total +ve PAH's		<0.10	<0.10
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	820
E.coli		-	820

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

CS03

Parameters	Guideline	6/06/2023	24/10/2023
Physicochemical			
Temperature		11.13	19.73
pH	6.5 - 8.0[1)]	7.67	7.21
pH - lab	6.5 to 8.0[1)]	7.4	-
Electrical Conductivity (µS/cm)	120-300[1)]	**2320**	**1620**
Electrical Conductivity - lab (µS/cm)	120-300[1)]	**2200**	-
Dissolved Oxygen (mg/L)		**7.66**	**6.52**
Dissolved Oxygen (%)	90-n/a[1)]	**72.5**	**73.7**
Total Dissolved Solids (mg/L)	<1[1)]	**1.48**	**1.07**
Nutrients (mg/L)			
TN	<0.45[1)]	**0.49**	**0.75**
TKN_N*		0.49	0.74
NH3_N		<0.0050	0.0082
NO3_N		<0.0050	<0.0050
NO2_N		<0.0050	<0.0050
NOx_N	<0.2[1)]	<0.0050	<0.0050
TP	<0.02[1)]	<0.050	**0.096**
PO4_P		<0.0050	0.020
Dissolved Metals (µg/L)			
Arsenic, As	<13[2)]	<1.0	<1.0
Cadmium, Cd	<0.2[2)]	<0.10	<0.10
Chromium, Cr	<1.0[2)]	<1.0	<1.0
Copper, Cu	<1.4[2)]	<1.0	<1.0
Mercury, Hg	<0.6[2)]	<0.050	<0.050
Nickle, Ni	<11[2)]	<1.0	<1.0
Lead, Pb	<3.4[2)]	<1.0	<1.0
Zinc, Zn	<8.0[2)]	<1.0	<1.0
Volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C6 - C9		<10	<10
TRH C6 - C10		<10	<10
TRH C6 -C10 less BTEX (F1)		<10	<10
MBTEXN (µg/L)			
MTBE		<1.0	<1.0
Benzene	950[2)]	<1.0	<1.0
Toluene		<1.0	<1.0
Ethylbenzene		<1.0	<1.0
m+p-xylene		<2.0	<2.0
o-xylene	350[2)]	<1.0	<1.0
Total Xylene		<3.0	<3.0
Naphthalene		<1.0	<1.0
Semi-volatile Total Recoverable Hydrocarbons (µg/L)			
TRH C10 - C14		<50	<50
TRH C15 - C28		<100	<100
TRH C29 - C36		<100	<100
Total +ve TRH C10-C36		<50	<50
TRH >C10 - C16		<50	<50
TRH >C10 -C16 less N (F2)		<50	<50
TRH >C16 - C34		<100	110
TRH >C34 - C40		<100	<100
Total +ve TRH >C10-C40		<50	110
PAHs in water (µg/L)			
Naphthalene	16[2)]	<0.10	<0.10
Acenaphthylene		<0.10	<0.10
Acenaphthene		<0.10	<0.10
Fluorene		<0.10	<0.10
Phenanthrene		<0.10	<0.10
Anthracene		<0.10	<0.10
Fluoranthene		<0.10	<0.10
Pyrene		<0.10	<0.10
Benzo(a)anthracene		<0.10	<0.10
Chrysene		<0.10	<0.10
Benzo(b,j+k)fluoranthene		<0.20	<0.20
Benzo(a)pyrene		<0.10	<0.10
Indeno(1,2,3-c,d)pyrene		<0.10	<0.10
Dibenzo(a,h)anthracene		<0.10	<0.10
Benzo(g,h,i)perylene		<0.10	<0.10
Total +ve PAH's		<0.10	<0.10
Microbial Testing (cfu/100mL)			
Thermotolerant Coliforms		-	180
E.coli		-	180

1) ANZECC and ARMCANZ (2000) Trigger values for South-west Australia for freshwater lakes and reservoirs; target exceedance printed in **red**.

2) ANZECC and ARMCANZ (2000) Trigger values for toxicants in freshwater ecosystems at 95% level of protection; target exceedance printed in **red**.

* TKN as N by calculation

Appendix C

Nutrient Modelling
(South Environmental, 2024)

Nutrient modelling

Lot 51, 1007, 118 Boyup Brook – Arthur Road

1. Introduction

Changes to land use impacts the nutrient input and has the potential to impact nutrient export from the land. Increasing nutrient export from the land has the potential to adversely affect the receiving environment and biodiversity. This nutrient modelling report estimates the change in nutrient input and export from the Subject Site as a result of changing the land use from agricultural practices to a mixture of rural residential and urban use.

The information presented in this Nutrient Modelling Report has been derived from the Nutrient Modelling Report prepared by Bio Diverse Solutions (2024). The Nutrient Modelling Report has been updated by South Environmental, upon the direction of the client, to include recent modifications to the Local Structure Plan/Subdivision Concept Plan and to address comments from the Department of Planning, Lands and Heritage (DPLH) and the Shire of Boyup Brook.

2. Pre-development nutrient input

The Subject Site area (222 ha) was assigned a pre-development nutrient fertiliser rate (in kg/ha) based on land use. Nutrient input rates have been taken from the Department of Agriculture and Food's fertiliser surveys of rural properties. The fertiliser surveys covered rural properties in the Ellenbrook, Geographe Bay and Peel Harvey catchments and are applicable to land use in the Boyup Brook area (Kelsey *et al*. (2011).

The Subject Site in the pre-development scenario is utilised predominantly for cattle (beef), with some cropping. It is assumed based on current use of the Subject Site land that two thirds of the Subject Site is used for cattle (beef), whilst one third is cropped. The estimated pre-development nutrient input for the site is shown in Table 1.

Table 1: Estimated pre-development nutrient inputs

Land Use	Subject Site Area (ha)	Nitrogen Application rate (kg/ha/yr)	Phosphorus Application rate (kg/ha/yr)	Total Nitrogen Application (kg/yr)	Total Phosphorus Application (kg/yr)
Cattle for beef	148	86.4	12.7	12,787	1,880
Cropping	74	46.7	8.4	3,456	622
Total	**222**	-	-	**16,243**	**2,502**

3. Post-development nutrient input

It is proposed to rezone the Subject Site from Rural to Special Use to allow for residential and rural residential lots ranging in size from 2000m^2 up to ~5 ha. The current subdivision concept plan for the Subject Site proposes 284 lots along with roads and Public Open Spaces (POS). The nutrient input for each proposed post-development land use within the Subject Site has been estimated to determine the overall post-development nutrient input.

<u>Residential/Rural Residential</u>

Nutrient input rates for residential/rural residential land use have been derived from the Department of Water's (now DWER) Urban Nutrient Decision Outcomes (UNDO) tool User Guide (DoW, 2016), which indicates that dwellings of different sizes apply different fertiliser rates. Residential lots larger than 2000m^2 and smaller than 2 ha are categorised together as rural living. The UNDO tool user guide does not stipulate nutrient rates for rural living lots >2 ha, as such lots between 2 and 5 ha within the Subject Site are assumed to have the same nutrient input as lots between 2000m^2 and 2 ha. Nutrient input rates for rural living lots are defined in the UNDO tool User Guide (DoW, 2016) by two categories:

Unrestricted: Unrestricted rural living lots that have livestock which may include horses, sheep, cows, goats, alpacas or other animals. They may be kept as pets or as a small commercial enterprise. Nutrient input is from imported feed, fertilisation and nitrogen fixation. The Department of Agriculture and Food WA have done extensive farm-gate nutrient balance studies in the south-west of WA. Unrestricted rural living lots are assumed to have the same nutrient input rates as having horses (N input = 79.5 kg/ha/yr and P input = 13.2 kg/ha/yr).

It is assumed that the lots >1 ha up to 5 ha in size will have the ability to have livestock and therefore all of the area proposed to be lots >1 ha up to 5 ha will adopt the Rural Living Unrestricted nutrient rates. Lots zoned R5 to R1 (2000m^2 to 1ha) are also permitted under the Shire of Boyup Brooks planning policy to have livestock. However, it is assumed only 50% of the land zoned R3 to R1 will have livestock and 20% of the land zoned R5 will have livestock. This is considered a conservative estimate as generally speaking most lots under ~5000m^2 do not maintain livestock.

No livestock: This land use generally refers to rural developments that have livestock and horse-rearing restrictions. Such developments are assumed to be permitted to undertake other forms of non-intensive agriculture, such as orchards, viticulture and small-scale horticulture (N input = 6.0 kg/ha/yr and P input = 4.1 kg/ha/yr). In this case whilst there are no restrictions on livestock, these nutrient rates are assumed for 50% of the lots zoned R1 to R3 and 80% of lots zoned R5, as discussed above this is considered a conservative estimate of the keeping of livestock for the Subject Site.

Public Open Space

This includes land set aside for unrestricted recreational activities within an urban development. Land uses include gardens, ovals, bicycle paths, remnant native vegetation and stormwater management systems. The nutrient input rates for the POS have been derived from the UNDO tool User Guide (DoW, 2016) and are as follows:

Recreation: Grassed areas used for passive recreation such as picnicking and walking. These areas are generally irrigated and fertilised but not as intensively as active turf (N input = 66 kg/ha/yr and P input = 2 kg/ha/yr). It is estimated that the POS at the Subject Site will comprise of 20% recreation areas.

Native gardens: Areas of POS planted with native species. Inputs are from fertilisation and fixation. These inputs rates are those estimated for residential native gardens (N input = 28.0 kg/ha/yr and P input = 0.9 kg/ha/yr). It is estimated that the Subject Site POS will comprise of 20% native garden areas.

Not-fertilised: Areas of POS that are not maintained or deliberately not fertilised. They are assigned atmospheric fertilisation rates only (N input = 5.23 kg/ha/yr and P input = 0.15 kg/ha/yr). It is estimated that the POS will comprise of 50% not-fertilised areas.

Paved area: Areas of POS with a paved surface, such as car parks, cycle paths, hard playing surfaces and buildings. These areas have atmospheric inputs only (N input = 5.23 kg/ha/yr and P input = 0.15 kg/ha/yr). It is estimated that the POS will comprise of 10% of paved areas.

Road Reserve

This includes the development areas set aside for roads and road verges. Typically, this includes roads, bicycle paths, foot paths, verges and median strips. Nutrient input is similar to POS (paved areas) with the impervious road areas having atmospheric input only (N input = 5.23 kg/ha/yr, P input = 0.15 kg/ha/yr) and similarly to the POS it is assumed the verge areas will be not-fertilised and therefore also have only atmospheric input.

The estimated land use areas for the post-development scenario and corresponding nutrient inputs are shown in Table 2.

Table 2: Estimated post-development nutrient input

Land Use	Subject Site Area (ha)	Nitrogen Application Rate (kg/ha/yr)	Phosphorus Application Rate (kg/ha/yr)	Total Nitrogen Application (kg/yr)	Total Phosphorus Application (kg/yr)
Rural Residential (<R1)	96.7	79.5	13.2	7,688	1,276
Residential (R1 to R3)	55.0	42.8	8.6	2,354	473
Residential (R5)	38.9	20.8	5.9	809	229
POS	7.1	21.9	0.67	155	5
Road	24.3	5.2	0.15	126	3
Total	**222**			**11,133**	**1,987**

Effluent disposal

The adopted effluent disposal nutrient loading rates for the future proposed residential lots is 5.5 kg of nitrogen per person per year and 2.2 kg of phosphorus per person per year, which have been taken from a Western Australian study by Whelan and Barrow (1984a, 1984b).

The current subdivision concept plan shows 284 lots at the Subject Site. The average occupancy per household in Australia is 2.5 persons, taking a conservative approach and assuming that the future lots will be occupied by a mixture of young singles/couples, retirees and families it is assumed the average number of persons per household is 3.

It is assumed that the majority (276) of the future proposed lots will utilise a primary effluent disposal system only and it has been assumed that 8 lots will require the use of a secondary treatment system. These estimates are based on the environmental constraints of the site, with secondary treatment systems being recommended in areas with heavy clays and/or a high water-table in alignment with the GSP (2019), as discussed in more detail in the Site Soil Evaluation (BDS, 2023). In the absence of relevant data showing the expected nitrogen and phosphorus concentrations of effluent disposal following secondary treatment, it is assumed that secondary treatment will result in a 70% reduction in nitrogen and phosphorus in comparison to the effluent disposal from primary treatment only.

Estimates of nutrient input from effluent disposal in the post-development scenario are shown in Table 3.

Table 3: Estimated post-development nutrient input from effluent disposal

Effluent disposal system utilised	Number of lots	Number of people	Nitrogen Loading Rate (kg/yr)	Phosphorus Loading Rate (kg/yr)	Annual Nitrogen Loading (kg/yr)	Annual Phosphorus Loading (kg/yr)
Primary treatment only	276	828	5.5	2.2	4,554	1,822
Secondary treatment	8	24	1.6	0.7	38	17
Total	**284**	**852**	-	-	**4,592**	**1,839**

Bio-retention Storage Systems and Living Streams

All the stormwater runoff from storm events up to the 20% AEP from road reserves will be directed to bio-retention storages for water quality treatment prior to discharge off the site in the post-development scenario, as described in more detail in the LWMS (BDS, 2024). In addition, most of the runoff from the proposed lots and POS areas will also be directed to the bio-retention storages. It is estimated that the planted bio-retention storages, which will be underlain with amended soil, as per Table 15 of the LWMS (BDS, 2024), will remove 70% nitrogen and 89% phosphorus on average (Henderson, 2009). As such, the estimated quantity of nutrients (in kg/yr) that will be removed by the bio-retention storages has been calculated and is shown in Table 4.

Table 4: Estimated removal of nutrients via bio-retention storages

Land Use	Subject Site Area Directed to Bioretention Storage (ha)	Runoff coefficient	Nitrogen Application Rate (kg/ha/yr)	Phosphorus Application Rate (kg/ha/yr)	Total Nitrogen Application (kg/yr)	Total Phosphorus Application (kg/yr)
Rural Residential (>R1)	67.7	0.20	79.5	13.2	1,076	179
Residential (R1 – R3)	38.5	0.35	42.8	8.6	577	116
Residential (R5)	35.0	0.40	20.8	5.9	291	83
POS	1.8	0.30	21.9	0.67	12	1
Road	24.3	0.80	5.2	0.15	101	3
Total nutrient application from post-development runoff					**2,057**	**382**
Total nutrients removed by bio-retention storages (N – 70% & P – 89%)					**1,440**	**340**

In addition to the bio-retention storages it is proposed the western creek line will be converted to a living stream. The creek line will be meandered in strategic locations to reduce the velocity of the incoming flow and allow for the dropping out of sediment. The meandering sections and inlet and outlets of the creek shall have adequate stabilisation such as rock pitching to prevent erosion and further reduce the velocity of the flow. The creek line shall be planted, with plantings to be local native plantings and include both riparian and aquatic vegetation (reeds, grasses and shrubs) to mimic a living stream, which will serve as a biological filter of organic and inorganic material, consequently reducing the nutrient export from the site. A living stream in the west of the site has been assumed in the nutrient modelling using the UNDO tool as discussed in Section 4.

4. Discussion

The nitrogen input in the post-development scenario (N = 11,133 + 4,592 = 15725 kg/yr) is estimated to be marginally lower than in the pre-development scenario (N = 16,243 kg/yr). Whilst the phosphorus input in the post-development scenario (P = 3,772 kg/yr) is estimated to be slightly higher than in the pre-development scenario (P = 2,502 kg/yr). Despite the phosphorus input being higher in the post-development scenario, it is expected that both the phosphorus and nitrogen export loads in the post-development scenario will be lower compared to the pre-development scenario. This is due to the treatment provided by the bioretention storages and the application of effluent disposal being deeper into the soil profile compared to the application of fertiliser in agricultural practices, consequently leading to less nutrient export from the site. Noting, nutrient runoff from agricultural activities is one of the major causes of eutrophication and poor water quality in Western Australia.

In the pre-development scenario stormwater runoff discharges directly off the site carrying with it both organic and inorganic fertiliser that has been applied/deposited at the soil surface. In the post-development scenario most of the stormwater runoff will be directed to bio-retention storages where approximately 70 % of nitrogen and 89 % of phosphorus is expected to be removed.

Unlike the nutrient application from fertiliser use and livestock, which is applied/deposited directly to the land surface or within the top 100 mm of soil, application of effluent disposal is generally much deeper in the soil profile (600-800 mm depth) through the use of leach drains. As such, the export of nutrients off the Subject Site from effluent disposal is expected to be low. The high PRI of the soils encountered at the Subject Site underlying the topsoil will assist with the retention of nutrients. It is proposed the land application areas for effluent disposal will be planted with grasses, sedges and/or ground cover allowing for the uptake of nutrients retained within the soil, as such leaching of nutrients from the effluent disposal systems is expected to be low. Additionally, groundwater levels were generally found to be low (>1.5 m depth) across the Subject Site, with the exception of the western portion of the site. In areas with a groundwater table that is considerably lower than the base of the leach drains it is expected transportation of nutrients to and within the groundwater to be low. In the western portion of the site which is characterised by heavy clays and a perched groundwater table, secondary treatment

systems are proposed and therefore the effluent disposal in this area is expected to have much lower levels of nutrients.

Using the UNDO tool to estimate the export of nutrients from the Subject Site in the post-development scenario showed nutrient export loads to be 721 kg/yr (3.2 kg/ha/yr) of nitrogen and 33 kg/yr (0.15 kg/ha/yr) of phosphorus. The nutrient modelling report using the UNDO tool is shown in Attachment 1. The UNDO nutrient modelling assumes the use of bio-retention storages across the whole site, the use of a living stream in the west of the site and assumes onsite effluent disposal for each proposed lot. The estimated nitrogen and phosphorus export loads for the post-development scenario calculated using the UNDO tool are significantly lower than the estimated average nitrogen and phosphorus export loads per cleared area calculated by Kelsey et al (2011) for catchments within the south-west of Western Australia, which are 4.9 kg/ha/yr of nitrogen and 0.81 kg/ha/yr of phosphorus.

5. References

Department of Water (2016) *Urban Nutrient Decision Outcomes (UNDO) tool User Guide*. Report No. 76, Department of Water, Western Australia.

Henderson, C (2009) *Chemical and biological mechanisms of nutrient removal from stormwater in bioretention systems.* Ph.D. thesis, Griffith Univ., Nathan QLD, Australia.

Kelsey P, King L, Kitsios A (2010) *Survey of urban nutrient inputs on the Swan Coastal Plain*. Water Science Technical Series, Report no. 24, Department of Water, Western Australia.

Kelsey P, Hall J, Kretschmer P, Quinton B and Shakya D (2011) *Hydrological and nutrient modelling of the Peel Harvey catchment.* Report No. 33, Department of Water, Western Australia.

Whelan BR, Barrow NJ (1984a) *The movement of septic tank effluent through sandy soils near Perth*. I. *Movement of nitrogen*. *Soil Research* 22, 283-292.

Whelan BR, Barrow NJ (1984b) *The movement of septic tank effluent through sandy soils near Perth*. *II. Movement of phosphorus*. *Soil Research* 22, 293-302.

Attachment 1

UNDO Analysis Results

Government of **Western Australia**
Department of **Water and Environmental Regulation**

Project: Leafield

Date: 5/07/2024

Version: Version 1.2.0.19289

Subregion name: West

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	0	0.00	0.00	0.00
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	88	48.84	3423.68	644.69
Public open space	4	2.22	41.74	1.29
Road reserve	8	4.44	0.00	0.00

Total area (ha)	Total percent (%)
55.50	25

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
3755.69	654.30

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
890.64	52.75

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	100	48.84
No livestock	0	0.00
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
48.84	88

Nitrogen input (kg)	Phosphorus input (kg)
3423.68	644.69

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	20	0.44
Non-native gardens	0	0.00
Not fertilised	50	1.11
Nature	0	0.00
Sport	0	0.00
Recreation	20	0.44
Golf course	0	0.00
Bowling green	0	0.00
Impervious	10	0.22
Water body	0	0.00

Total area (ha)	Total percent (%)
2.22	4

Nitrogen input (kg)	Phosphorus input (kg)
41.74	1.29

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	3.55
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	20	0.89

Total area (ha)	Total percent (%)
4.44	8

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil - partial lot connection**	**Does it contain imported fill?**	**No**
Soil type	**Yelverton Shelf**	**Does subregion contain onsite sewage diposal sy**	
Depth to groundwater (m)	**0.3**	Type of system installed	**Alternative treatment uni**
Groundwater slope (%)	**0.5**	No. of units installed	**8**
Soil PRI	**22.8**		

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Central and East

Landuse	Percent (%)	Area (ha)	Input load: Nitrogen (kg)	Input load: Phosphorus (kg)
Residential	0	0.00	0.00	0.00
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	85	141.53	8441.97	1174.66
Public open space	3	5.00	93.91	2.90
Road reserve	12	19.98	0.00	0.00

Total area (ha)	Total percent (%)
166.50	75

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
9406.67	1202.53

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
514.43	8.04

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	50	70.76
No livestock	50	70.76
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
141.53	85

Nitrogen input (kg)	Phosphorus input (kg)
8441.97	1174.66

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	20	1.00
Non-native gardens	0	0.00
Not fertilised	50	2.50
Nature	0	0.00
Sport	0	0.00
Recreation	20	1.00
Golf course	0	0.00
Bowling green	0	0.00
Impervious	10	0.50
Water body	0	0.00

Total area (ha)	Total percent (%)
5.00	3

Nitrogen input (kg)	Phosphorus input (kg)
93.91	2.90

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	80	15.98
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	20	4.00

Total area (ha)	Total percent (%)
19.98	12

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage **Infiltration**

Soil type **Yelverton Shelf**

Depth to groundwater (m) **2**

Groundwater slope (%) **0.5**

Soil PRI **22.8**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **Yes**

Type of system installed **Septic tank**

No. of units installed **276**

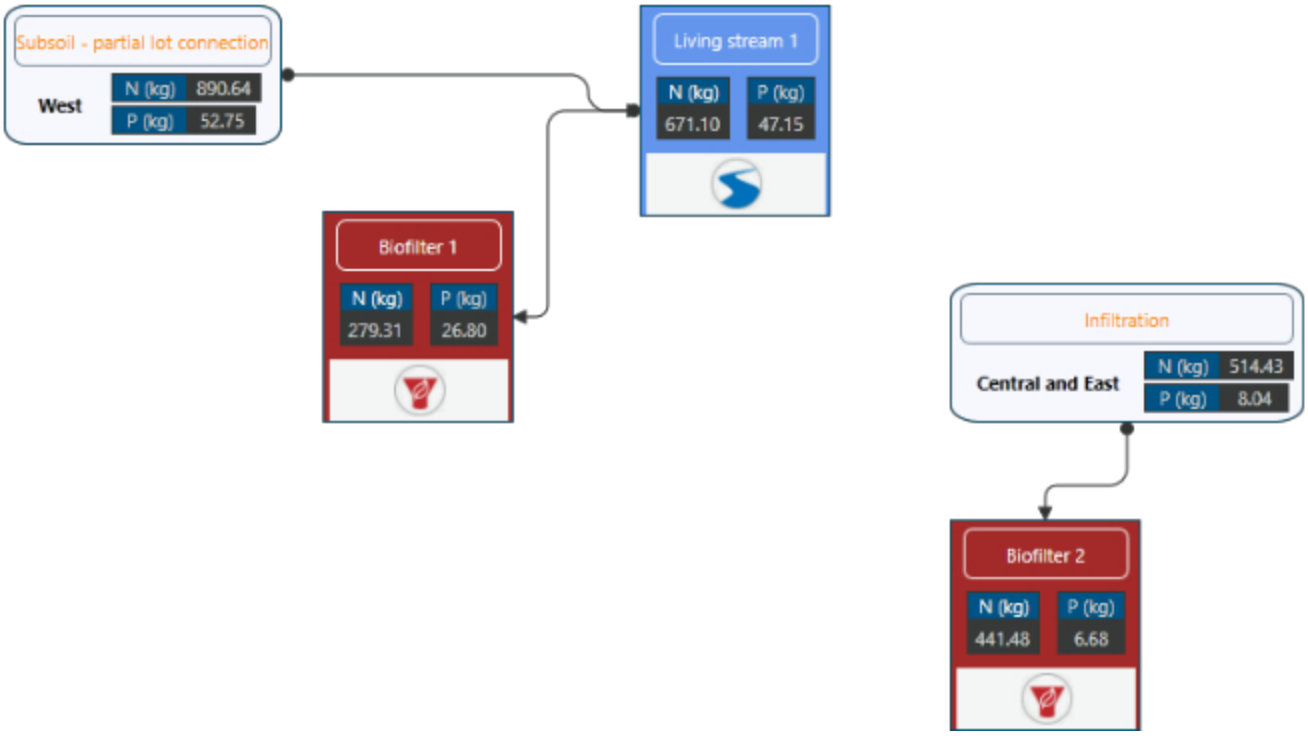
Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices						
Treatment	**Name**	**Size (m²)**	**Treated area (ha)**	**Treating**	**N removed (kg/yr)**	**P removed (kg/yr)**
Biofilter	Biofilter 1	1000.00	55.50	Heavy soils - runoff	391.79	20.35
Living stream	Living stream 1	2800.00	55.50	Sandy soils – runoff, subsoils and groundwater	219.54	5.61
Biofilter	Biofilter 2	4000.00	166.50	Sandy soils – Runoff only (infiltration on lots)	72.95	1.36
Load removed					**684.27**	**27.31**
Net export					**720.79**	**33.48**

Summary: Nutrient load exports			
Region	**Area (ha)**	**P export (kg/yr)**	**N export (kg/yr)**
West	55.50	52.75	890.64
Central and East	166.50	8.04	514.43

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
1405.07	**60.79**	**684.27**	**27.31**	**720.79**	**33.48**

Treatment diagram



ATTACHMENT 7



BUSHFIRE MANAGEMENT PLAN

Lot 51, 1007 & 1118 Boyup Brook-Arthur Road, Boyup Brook

Shire of Boyup Brook

Prepared by Ralph Smith
SMITH BUSHFIRE CONSULTANTS Pty Ltd
BPAD 27541
smith.consulting@bigpond.com
0458 292 280

Site visited 29 March 2021; Report completed 5 December 2022

Bushfire management plan/Statement addressing the Bushfire Protection Criteria coversheet

Site address: Lots 51, 1007 & 1118 Boyup Brook-Arthur Road, Boyup Brook

Site visit: Yes ☑ No ☐

Date of site visit (if applicable): Day 29 Month March Year 2021

Report author: Ralph Smith

WA BPAD accreditation level (please circle):

Not accredited ☐ Level 1 BAL assessor ☐ Level 2 practitioner ☑ Level 3 practitioner ☐

If accredited please provide the following.

BPAD accreditation number: 27541 Accreditation expiry: Month August Year 2023

Bushfire management plan version number: 1.2

Bushfire management plan date: Day 5 Month December Year 2022

Client/business name: Edge Planning & Property Pty Ltd

	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?		✓
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the bushfire protection criteria elements)?		✓

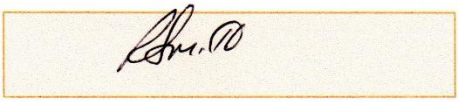
Is the proposal any of the following (see SPP 3.7 for definitions)?	Yes	No
Unavoidable development (in BAL-40 or BAL-FZ)		✓
Strategic planning proposal (including rezoning applications)	✓	
Minor development (in BAL-40 or BAL-FZ)		✓
High risk land-use		✓
Vulnerable land-use		✓

None of the above ☐

Note: Only if one (or more) of the above answers in the tables is yes should the decision maker (e.g. local government or the WAPC) refer the proposal to DFES for comment.

Why has it been given one of the above listed classifications (E.g. Considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

The information provided within this bushfire management plan to the best of my knowledge is true and correct:

Signature of report author  Date 5/12/2022

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Document control

Report Version	Purpose	Author/reviewer and accreditation details	Date Submitted
1	Support the development application	Ralph Smith	28 April 2021
1.1	Support the Structure Plan and Scheme Amendment	Ralph Smith	3 June 2021
1.2	Revised maps and text	Ralph Smith	5 December 2022

DISCLAIMER

This Bushfire Management Plan has been prepared in good faith. It is derived from sources believed to be reliable and accurate at the time of publication. Nevertheless, this plan is distributed on the terms and understanding that the author is not responsible for results of any actions taken based on information in this publication or for any error or omission from this publication.

Smith Bushfire Consultants Pty Ltd has exercised due and customary care in the preparation of this Bushfire Management Plan and has not, unless specifically stated, independently verified information provided by others.

Any recommendations, opinions or findings stated in this report are based on circumstances and facts as they existed at the time Smith Bushfire Consultants Pty Ltd performed the work. Any changes in such circumstances and facts upon which this document is based may adversely affect any recommendations, opinions or findings contained in this plan.

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Section 1: Proposal Details

The site is located within two kilometres of the Boyup Brook townsite. It abuts the Blackwood River. The site is undulating with the maximum slopes being around seven degrees. The vegetation is principally grassland with some pockets of tree overstorey, and the site is currently grazed. The entire site is not declared as bushfire prone and therefore AS 3959 construction standards for the future dwellings do not apply within these areas.

This project is at the structure plan and scheme amendment stage. The proponent will be seeking to rezone the site from 'Rural' to 'Residential R5' and 'Rural Residential'. This will be a staged development where high risk uses are not proposed, and the access issues will be addressed at the subdivision application stage.

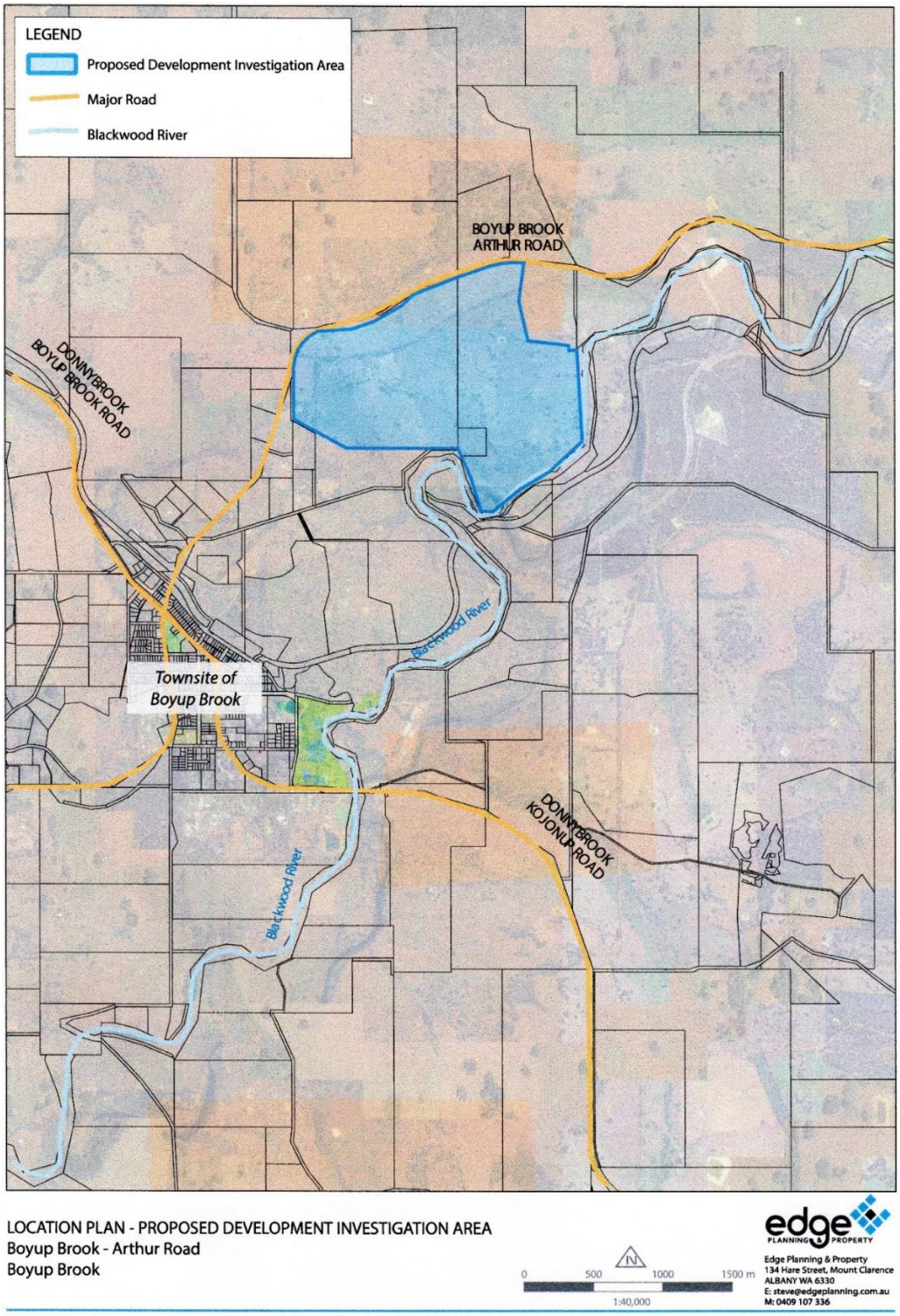


Figure 1. The copy of the site plan as provided with the structure plan/scheme amendment.

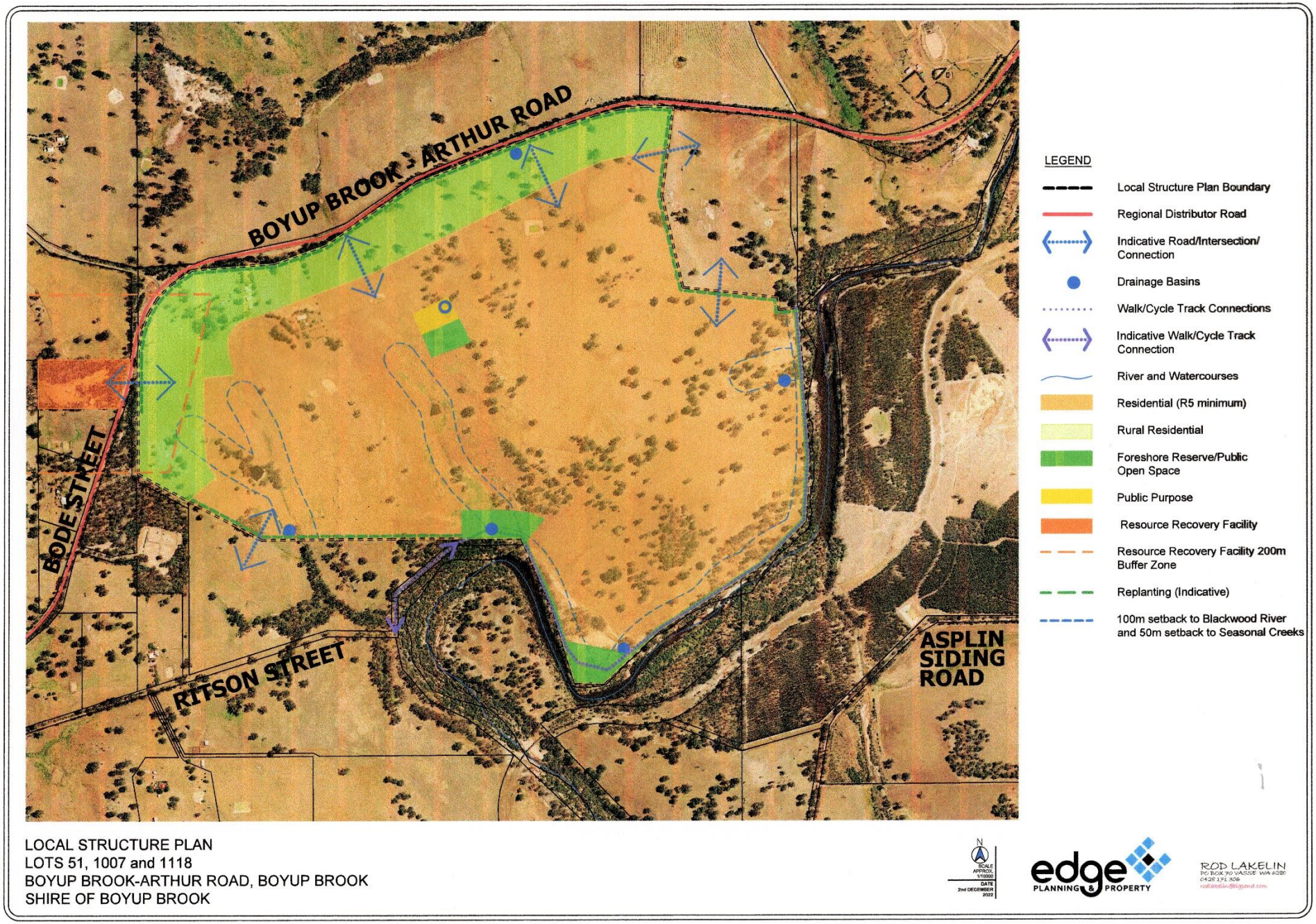


Figure 2. The copy of the local structure plan.



Figure 3. Screen shot of map of bushfire prone areas for the subject site.

The proposal is to develop the current large lots and create a number of smaller new lots. One lot will contain the current house, garage and other built assets. It is proposed that the new lots will also ultimately have new dwellings located on them.

This project is at the structure plan and scheme amendment stage. The proponent will be seeking to rezone the site from 'Rural' to 'Residential R5' and 'Rural Residential'. The scope of this report did not therefore support BAL Contour mapping which will be undertaken at a later stage of planning. Not all of the site is declared bushfire prone.

Section 2: Environmental Considerations

The State Planning Policy 3.7 recognises the need to consider bushfire risk management measures alongside environmental, biodiversity and conservation values. A desktop search has identified that the following are not registered for the development site or immediately surrounding area:

- Threatened and priority flora;
- Threatened and priority fauna;
- Contaminated site registration;
- Clearing Regulation – Environmental Sensitive area.

The desktop search also identified that the following cultural issues are not registered for the development site or immediately surrounding area, except for the Blackwood River and adjacent terrestrial land:

- Aboriginal heritage site;
- Watercourse on the site is impacted by Aboriginal heritage;
- Heritage Council site.

Subsection 2.1: Native Vegetation – modification and clearing

There will not be a need to clear significant areas of native vegetation as a component of this development. Future lots and dwellings will generally adapt to retaining existing native vegetation, with areas of cleared land provided as Asset Protection Zones (APZ) on the 'Rural Residential' lots and 'Residential R5' will probably be cleared and then domestic gardens established. There are significant areas of introduced pasture grass on the site that are currently grazed. The tree overstorey coverage on the site is in the main sparse and constitutes less than 10% overstorey coverage and is principally native species. There are two pockets within the development site, being a woodland area and a forest pocket.

Subsection 2.2: Re-vegetation/Landscape Plans

Relatively small areas of the sparse current overstorey and grass vegetation may be removed during the development and construction of the future dwellings and APZ. There may be cultivated gardens developed once people move into the dwelling, but this will not be a component of a site revegetation plan. There is expected to be some revegetation of water courses and the Blackwood River foreshore with native vegetation. Details to be progressed at the subdivision stage via management plans. Future development is required to take account of revegetation.

It is expected the subdivider will install street trees to enhance the site's amenity. The street trees are expected to be London Plane trees which have lower oil levels and are lower fire risks compared to most native vegetation.

Section 3: Bushfire Assessment Results

Any dwellings located on the new lots have all been assessed as being Bushfire Hazard Level (BHL) rated of moderate, which permits development, and a BAL rating of BAL–12.5 (or BAL–29 depending the slope) as the State requires an APZ. The vegetation that will need to be removed has been assessed as grassland or grassland under a sparse open woodland overstorey.

Subsection 3.1: Assessment Inputs

The assessment inputs are shown in the forthcoming pages and are supported by a vegetation assessment, photographic evidence and text to support the vegetation assessment and a BHL Assessment map.

Site Assessment

The assessment of the proposed subdivision was undertaken on 29 March 2021 for the purpose of determining the Bushfire Attack Level in accordance with AS 3959 (Method 1).

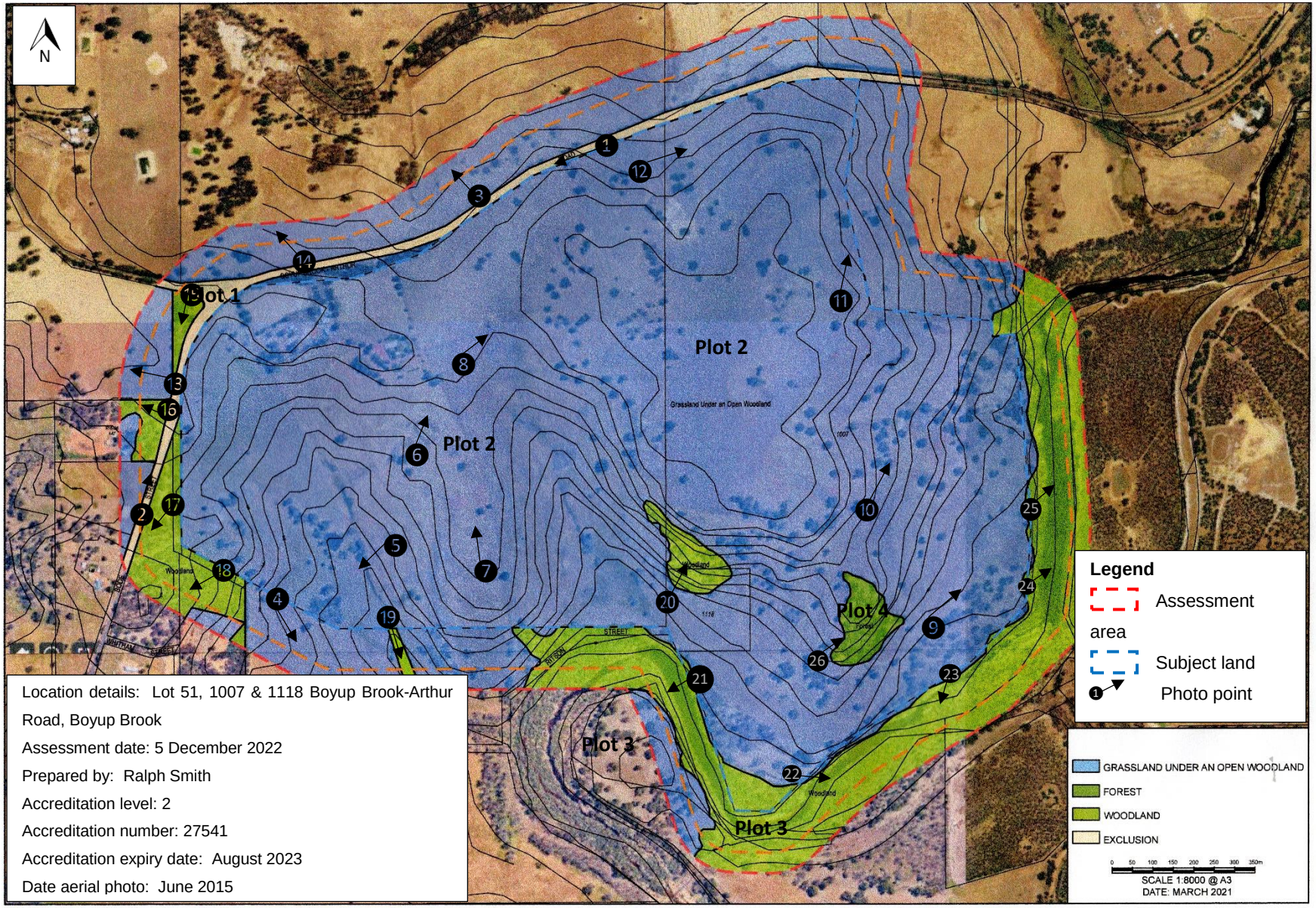


Figure 4. Vegetation Classification Map.

Vegetation Classification

All vegetation within 150 metres of the proposed subdivision as indicated on the site assessment plan was classified in accordance with the Western Australian Government criteria and Clause 2.2.3 of AS 3959 was applied. Each distinguishable vegetation plot with the potential to determine the Bushfire Attack Level is identified below. AS 3959 only requires consideration of 100 metres between vegetation and the building and 50 metres between vegetation and the building for grassland.

Plot 1
Exclusion – Low threat vegetation and non-vegetated areas.
Clause 2.2.3.2 (e).



Photo ID: Photo 1 Looking at the bitumen road that services the development site.



Photo ID: Photo 2 Looking at the bitumen road that services the development site.

Plot 2
Class G – Grassland under an open woodland (AS 3959 classification – G – 06)



Photo ID: Photo 3 Looking at the grassland with shelter trees north of the development site.



Photo ID: Photo 4 Looking at the grassland with shelter trees south-west of the development site.



Photo ID: Photo 5 Looking at the grassland with shelter trees on the subdivision site.



Photo ID: Photo 6 Looking at the grassland on the development site.



Photo ID: Photo 7 Looking at the grassland, granite rock and sparse shade trees on the development site**.**



Photo ID: Photo 8 Looking at the grassland under an open woodland on the development site



Photo ID: Photo 9 Looking at the grass and clump of trees.



Photo ID: Photo 10 Looking at the grassland under an open woodland on the development site.



Photo ID: Photo 11 Looking at the grassland under an open woodland and seeded area to the right.



Photo ID: Photo 12 Looking at the grassland and the single row of trees on the road verge



Photo ID: Photo 13 Looking at the grassland adjacent to the refuse site.



Photo ID: Photo 14 Looking at the grassland north of the development site.

Plot 3

Class B – Woodland (AS 3959 classification – B – 05)



Photo ID: Photo 15 Looking at the isolated pocket of woodland north-west of the development site.



Photo ID: Photo 16 Looking at the pockets of woodland in the refuse site west of the development site.



Photo ID: Photo 17 Looking at the woodland vegetation on the neighbouring property to the west of the development site.



Photo ID: Photo 18 Looking at the woodland west of the development site.



Photo ID: Photo 19 Looking at the narrow strip of woodland south of the development site.

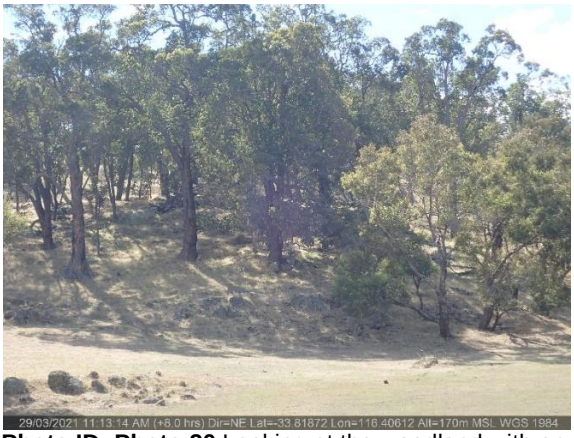


Photo ID: Photo 20 Looking at the woodland with an absence of a scrub understorey.



Photo ID: Photo 21 Looking at the woodland adjacent to the river.



Photo ID: Photo 22 Looking at the woodland in the riparian zone.



Photo ID: Photo 23 Looking at the woodland.



Photo ID: Photo 24 Looking at the woodland with a grass understorey.

Plot 4

Class A – Forest (AS 3959 classification – A – 03)



Photo ID: Photo 25 Looking at the forest with an absence of scrub.

Notes to Accompany Vegetation Classification

1. Plot 1
Exclusion – Low threat vegetation and non-vegetated areas
Clause 2.2.3.2 (e) and (f)

This plot comprises the roads on the boundary of the development site.

2. Plot 2
Class G – Grassland under an open woodland (AS 3959 classification – B – 06).

This plot comprises the pasture grass under an open woodland across the development site and neigbouring lots. This plot contains some relatively steep slopes but the slopes do not exceed 9°. The vast majority of this farm and the neighbouring farms have been used for farming purposes of grazing or cropping.

3. Plot 3
Class B – Woodland (AS 3959 classification – B – 05).

This plot comprises the woodland that is on the proposed development site and on the neighbouring land. It also includes the neigbouring lot to the west and south. The woodland to the south is adjacent to the Blackwood River. There is also a small isolated area of woodland located within the development site. The majority of the woodland plots comprise wandoo and also flooded gum, both recognised as woodland vegetation categories.

4. Plot 4
Class A – Forest (AS 3959 classification – A – 03).

The forest plot is a small area within the development site. It has been classified as a forest solely on the basis of the tree overstorey coverage being greater than 30%. This portion of the forest plot has an absence of the multi-tiered scrub understorey. In applying the precautionary principle it is important to determine the likelihood of the surface vegetation changing, and becoming a scrub vegetation in the short, mid or long term. It is highly improbable that the surface vegetation will be anything other than the grassland or simply leaf litter as there is an absence of seed in the soil and there is no seed source available within the nearby areas.

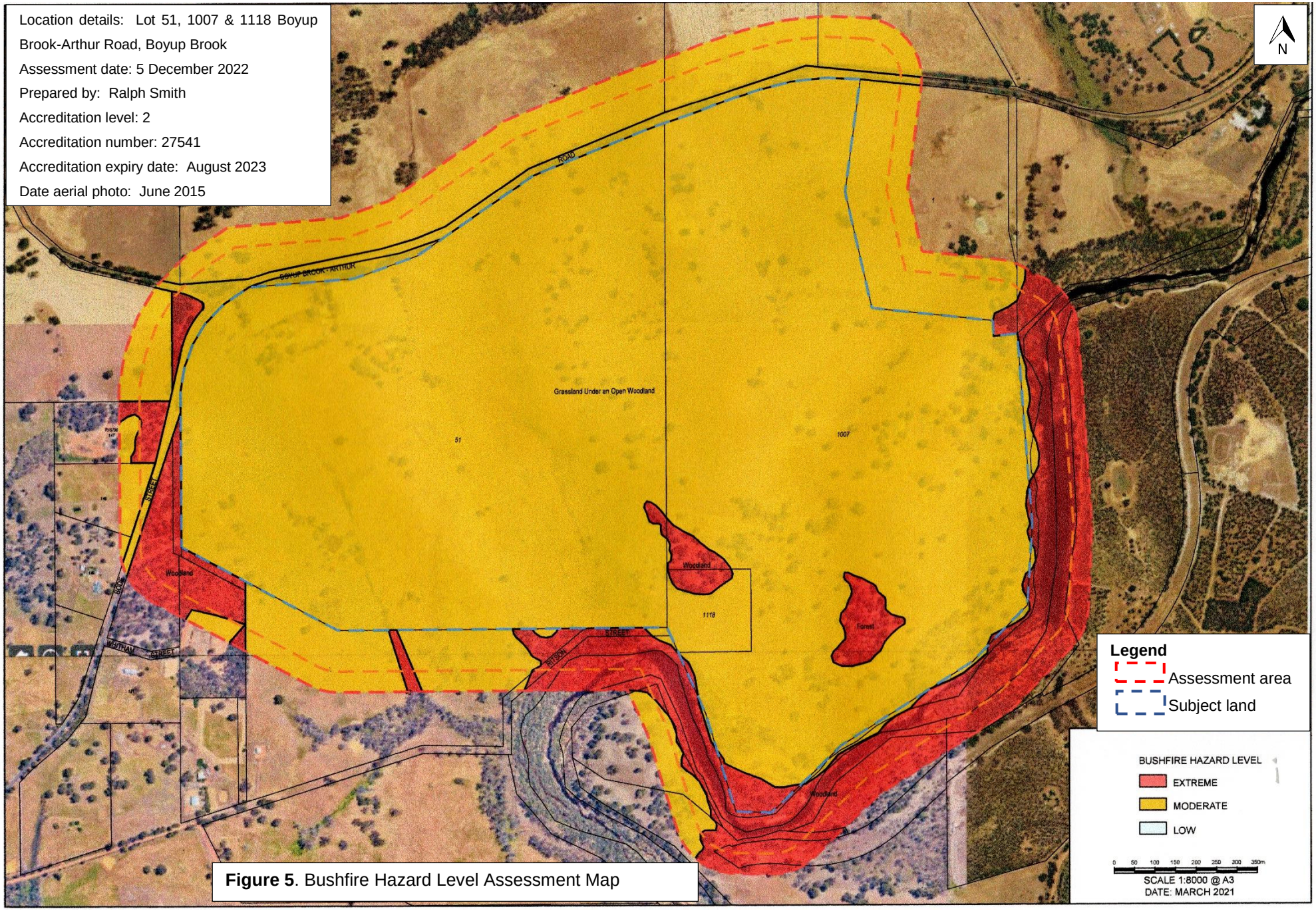


Figure 5. Bushfire Hazard Level Assessment Map

Slope

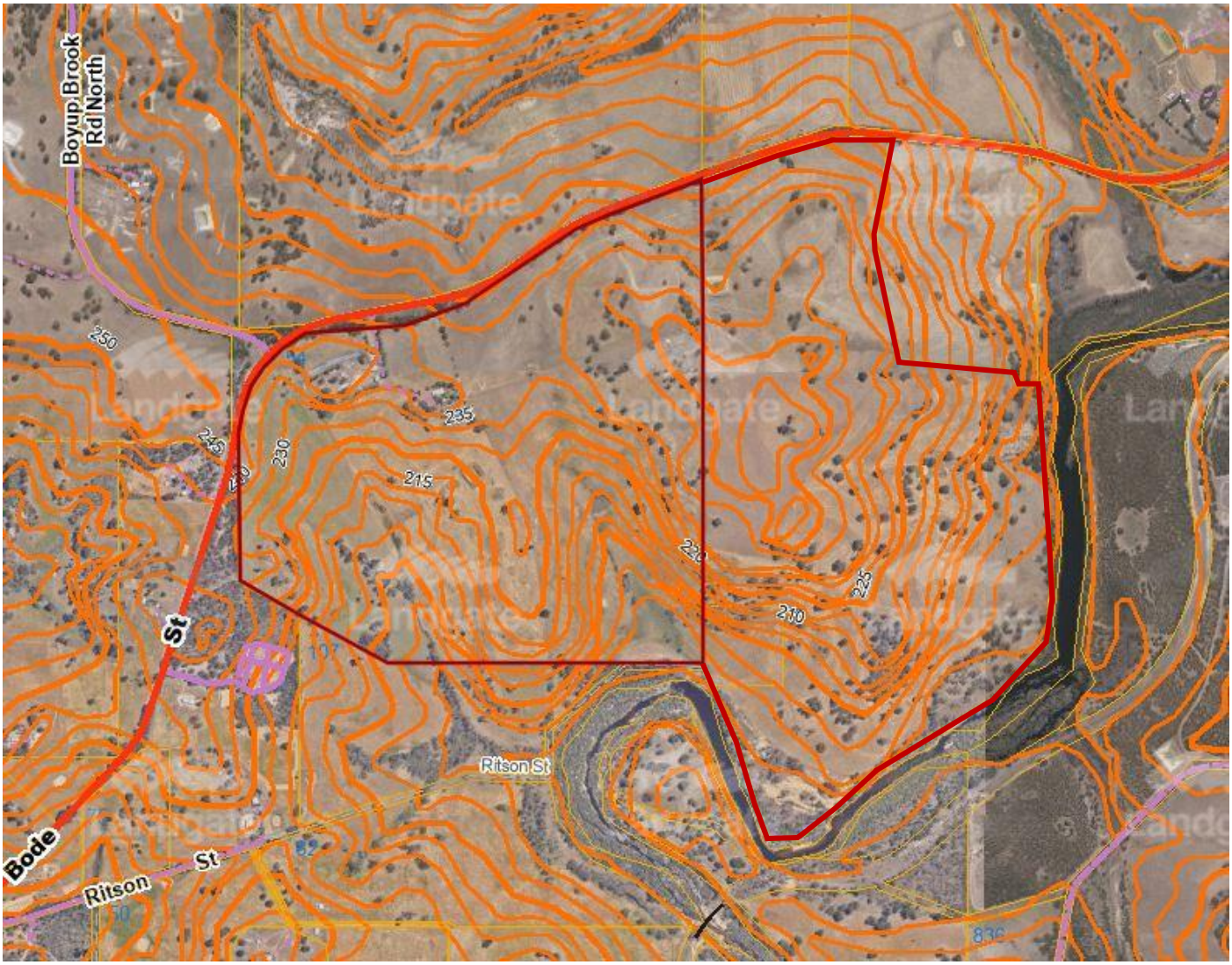


Figure 6. Five-metre contour lines.



70 metre slope over 604 metres = 1:8.6. This equates to 7°

Figure 7. Slope to the north-east of the southern portion of the site.



70 metre slope over 414 metres = 1:5.9. This equates to 9°

Figure 8. Slope in the southern portion of the site.

Subsection 3.2: Assessment outputs

Plot	Applied Vegetation Classification	Effective Slope Under the Classified Vegetation (degrees)	Separation Distance to the Classified Vegetation (metres)	BAL Contour
1	Exclusion – Low threat vegetation and non-vegetated areas Clause 2.2.3.2 (e) & (f)	Not applicable	Not applicable	LOW
2	Class G – Grassland under an open woodland	Slope impact is subject to dwelling location	Minimum 20 m	12.5
3	Class B – Woodland	Slope impact is subject to dwelling location	Minimum 20 m	12.5
4	Class A – Forest	Slope impact is subject to dwelling location	Minimum 21 m*	29

Note - * indicates that to achieve a BAL–29 rating requires a minimum separation between the forest vegetation and dwelling. This distance must increase if the forest is downslope of the dwelling. BAL–29 is the highest BAL rating that is supported by the State Government.

Section 4: Identification of bushfire hazard issues

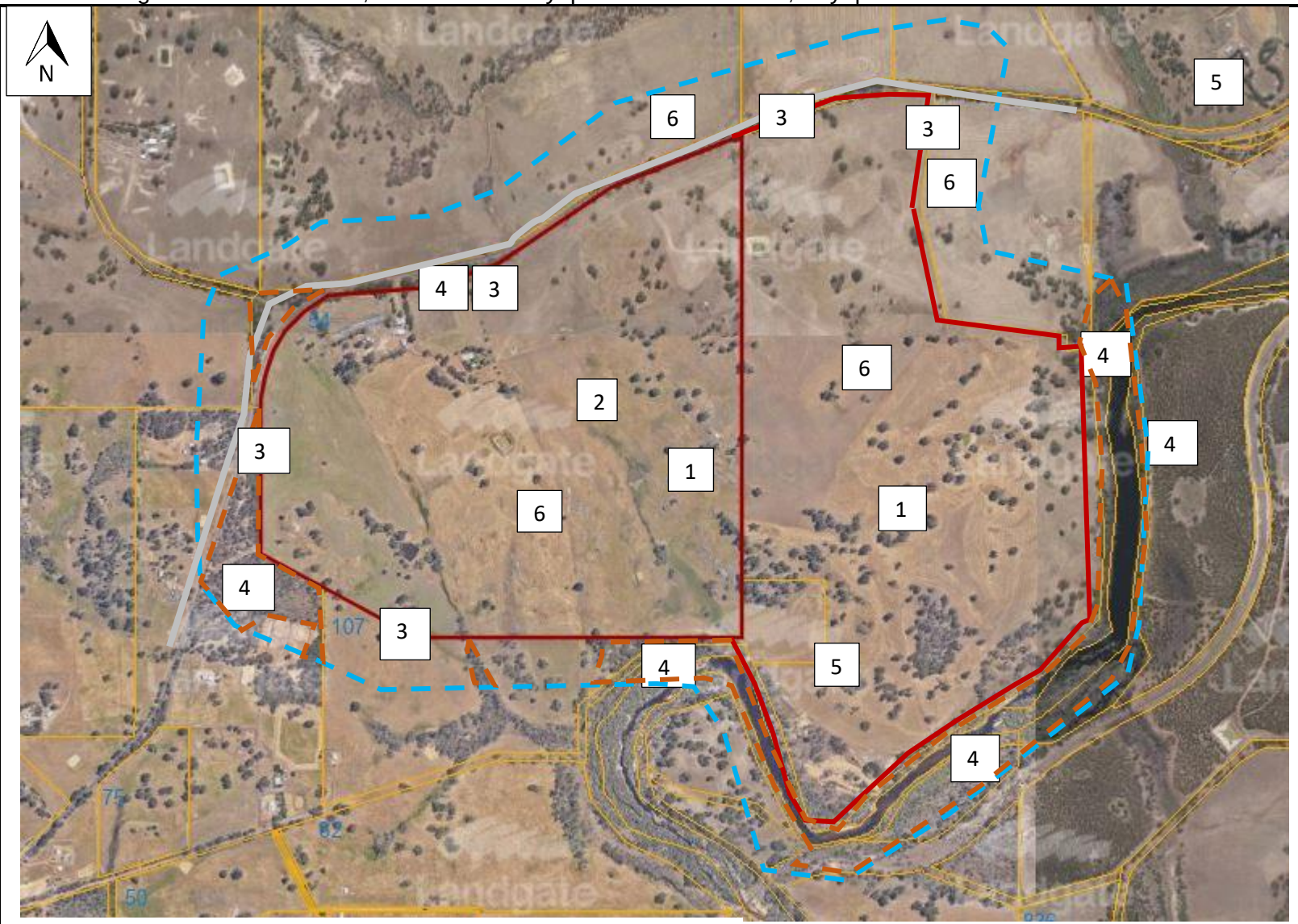
The most significant bushfire hazard is the extensive native vegetation associated with the forest and woodland on land neighbouring the development site. The slope on the development site is a potential bushfire hazard as access will be limited, until the proposed development and associated roads are constructed. The native vegetation could be sufficiently separated from any potential dwelling by ensuring that an APZ on the 'Rural Residential' lots is established and maintained, and the dwelling is constructed to the appropriate standard.

Future lots and dwellings will generally adapt to retaining existing native vegetation, with areas of cleared land provided as dwellings are constructed, new gardens established and APZ surround the dwellings where appropriate.

Section 5: Assessment against the Bushfire Protection Criteria

Subsection 5.1: Compliance Table

Bushfire protection criteria	Method of Compliance Acceptable solutions	Proposed bushfire management strategies
Element 1: Location	A1.1 Development location	The potential future dwellings will be located in an area that is restricted to the BHL rating of moderate and the BAL rating will be BAL–29 or less.
Element 2: Siting and design	A2.1 Asset Protection Zone (APZ)	There is requirement through this BMP for a 20 metre APZ associated with any new dwellings within the subdivision.
Element 3: Vehicular Access	A3.1 Two access routes	Boyup Brook-Arthur Road provides multiple access options for the proposed new lots, and the future development road network.
	A3.2 Public road	Boyup Brook-Arthur Road and Bode Street are constructed. New roads associated with the development will be built to comply with the Guidelines. The indicative locations of the new roads connecting to Boyup Brook-Arthur Road and Bode Street are shown on the LSP.
	A3.3 Cul-de-sac (including a dead-end-road)	All roads will be constructed to comply with the State's Guidelines.
	A3.4 Battle-axe	All roads will be constructed to comply with the State's Guidelines.
	A3.5 Private driveway longer than 50 m A private driveway is to meet detailed requirements contained within the Guidelines.	It is anticipated that there will may be driveways longer than 50 m constructed with this subdivision. If there are they will be compliant with the Guidelines.
	A3.6 Emergency access way	Nil will be constructed with this subdivision.
	A3.7 Fire service access routes (perimeter roads)	A FSAR will be combined with the walk/cycle track along the river foreshore. Firebreaks will continue to be maintained in accordance with the Shire's firebreak order.
	A3.8 Firebreak width	During establishment, and after subdivision, firebreaks will be maintained to comply with the Shire's firebreak order.
Element 4: Water	A4.1 Reticulated areas	A reticulated scheme water system developed to comply with the State's requirements will be connected as a component of this development for the residential R5 areas. This includes fire hydrants. In the rural residential area there will not be reticulated scheme water.
	A4.2 Non-reticulated areas	In the rural residential zone there will not be reticulated scheme water. A firefighting water tank location is identified on the LSP. Each lot will have its own water supply
	A4.3 Individual lots within non-reticulated areas (Only for use if creating 1 additional lot and cannot be applied cumulatively)	Not applicable.



Location details: Lot 51, 1007 & 1118 Boyup Brook-Arthur Road, Boyup Brook
Assessment Date: 5 December 2022
Prepared by: Ralph Smith
Accreditation level: 27541
Accreditation expiry date: August 20213
Date of aerial photo: January 2015
Version No: 1.2

Figure 9. Spatial representation of bushfire management strategies.

LEGEND

Subject land

Hazard vegetation

150m assessment zone

Sealed roads

REQUIREMENTS

1. The residential (R5) component of the site will be serviced by a reticulated scheme water system developed to comply with the State's requirements. It will be connected as a component of this development. This includes fire hydrants.
2. There is a requirement for a 20 m APZ on the new dwellings within the (R5) subdivision but will be required on the 'Rural Residential' larger lots.
3. Alternative bitumen access options are available and will be developed. Idicative locations are shown.
4. This is the principle hazard vegetation.
5. There is no slope of 10° or greater.
6. Grassland vegetation.

Section 6: Responsibilities for Implementation and Management of the Bushfire Measures

This section is to set out the responsibilities of the developer/s, landowner/s and local government with regards to the initial implementation and ongoing maintenance of the required actions.

DEVELOPER – PRIOR TO ISSUE OF TITLES		
No.	**Implementation Action**	**Subdivision Clearance**
1	A notification pursuant to Section 165 of the *Planning and Development Act 2005*, is to be placed on the certificate(s) of title of the proposed lot(s) with a Bushfire Attack Level (BAL) rating or 12.5 or above, advising the existence of a hazard or other factor. Notice of this notification is to be included in the diagram or plan of survey (deposited plan). The notification is to state as follows: "*This land is within a bushfire prone area as designated by an Order made by the Fire and Emergency Services Commissioner and is subject to a Bushfire Management Plan. Additional planning and building requirements may apply to development on this land*" (Western Australian Planning Commission).	
2	Comply with the relevant local government annual firebreak notice issued under s33 of the Bush Fires Act 1954.	
3	The developer will be responsible for extending reticulated scheme water network into the nominated section of the development that is compliant with the State's requirements.	

LANDOWNER/OCCUPIER – ONGOING	
No.	**Management Action**
1	Comply with the relevant local government annual firebreak notice issued under s33 of the Bush Fires Act 1954.

Appendix 1

Vehicle access technical requirements extract from the Guidelines for vehicle access (page 76) and private driveways longer than 50 metres (page 75). This is only applicable if the driveway is longer than 70 metres, which is possible likely to be required.



Table 6: Vehicular access technical requirements

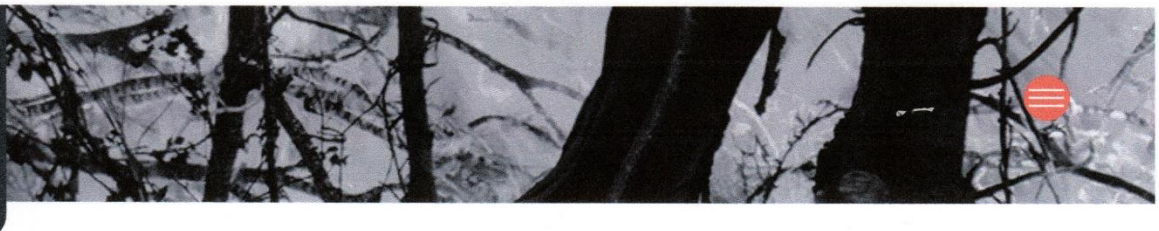
TECHNICAL REQUIREMENTS	1 Public roads	2 Emergency access way[1]	3 Fire service access route[1]	4 Battle-axe and private driveways[2]
Minimum trafficable surface (metres)	In accordance with A3.1	6	6	4
Minimum horizontal clearance (metres)	N/A	6	6	6
Minimum vertical clearance (metres)	4.5			
Minimum weight capacity (tonnes)	15			
Maximum grade unsealed road[3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%)		
Maximum grade sealed road[3]		1:7 (14.3%)		
Maximum average grade sealed road		1:10 (10%)		
Minimum inner radius of road curves (metres)		8.5		

Notes:

[1] To have crossfalls between 3 and 6%.

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision.

[3] Dips must have no more than a 1 in 8 (12.5% -7.1 degree) entry and exit angle.



ELEMENT 3: VEHICULAR ACCESS

PERFORMANCE PRINCIPLE	ACCEPTABLE SOLUTIONS
P3iv Vehicular access is provided which allows emergency service vehicles to directly access all habitable buildings and water supplies and exit the lot without entrapment.	**A3.5 Battle-axe access legs** Sb *Where it is demonstrated that a battle-axe access leg cannot be avoided due to site constraints, it can be considered as an acceptable solution.* There are no battle-axe technical requirements where the point of the battle-axe access leg joins the effective area of the battle-axe lot, is less than 50 metres from a public road in a reticulated water area. In circumstances where the above condition is not met, or the battle-axe lot is in a non-reticulated water area, the battle-axe access leg is to meet all the following requirements: • requirements in Table 6, Column 4; and • passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres). **A3.6 Private driveways** Dd Do There are no private driveway technical requirements where the private driveway is: • within a lot serviced by reticulated water; • no greater than 70 metres in length between the most distant external part of the development site and the public road measured as a hose lay; and • accessed by a public road where the road speed limit is not greater than 70 km/h. In circumstances where all of the above conditions are not met, or the private driveway is in a non-reticulated water area, the private driveway is to meet all the following requirements: • requirements in Table 6, Column 4; • passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres); and • turn-around area as shown in Figure 28 and within 30 metres of the habitable building.

Appendix 2

The following is an extract from the Shire of Boyup Brook "2020-2021 Fire Information and Firebreak Notice."

FIREBREAKS

Under section 33 of the *Bush Fires Act*, you are required to carry out the fire prevention work specified below on any land within the Shire that is owned or occupied by you.

The work must be carried out by 30 November, unless approved otherwise, and maintained throughout the summer months until 1 May.

If an owner or occupier fails to comply with these requirements, he or she may be issued with an infringement notice (penalty $250) or prosecuted, and the Shire may carry out the required work at the cost of the owner or occupier.

If it is impractical for any reason to clear firebreaks, or to take measures in accordance with these requirements, you may apply to the Shire in writing before 11 November, for permission to provide firebreaks in alternative locations, or to take alternative measures to prevent the outbreak or spread of a bush fire. If permission is not granted in writing by the Shire, you must comply with these requirements.

TOWN SITE LAND

On all land located within a town site (except for land zoned Rural and Special Rural as shown in the Shire of Boyup Brook Town Planning Scheme No 2 (**Scheme**)), you must -

1. Where the area of land is 2023m^2 or less, clear the land free of all inflammable matter, except living trees and cultivated plants, shrubs and lawns, that are no greater than 5cm in height.

2. Where the area of the land is in excess of 2023m², clear a 2.5m wide bare earth firebreak immediately inside all external boundaries of the land or immediately surrounding all buildings on the land by removing all inflammable matter and vegetation within the 2.5m wide firebreak between the ground and 4m above the ground.

SPECIAL RURAL LAND

On all land zoned Special Rural under the Scheme, you must -

(a) clear a 2.5m wide bare earth firebreak immediately inside all external boundaries of the land by removing all inflammable matter and vegetation within the 2.5m wide firebreak between the ground and 4m above the ground; and

(b) clear a 10m wide bare earth firebreak around all buildings and fuel storage areas by removing all inflammable matter and vegetation within the 10 metre wide firebreak between the ground and 4m above the ground.

RURAL LAND

1. On land zoned Rural under the Scheme, you must **either** -

   (a) clear a 2.5m wide bare earth firebreak break immediately around all buildings, homesteads, hay sheds, fuel storage areas, caravans and mobile accommodation by removing all inflammable matter and vegetation within the 2.5m wide firebreak between the ground and 4m above the ground; and

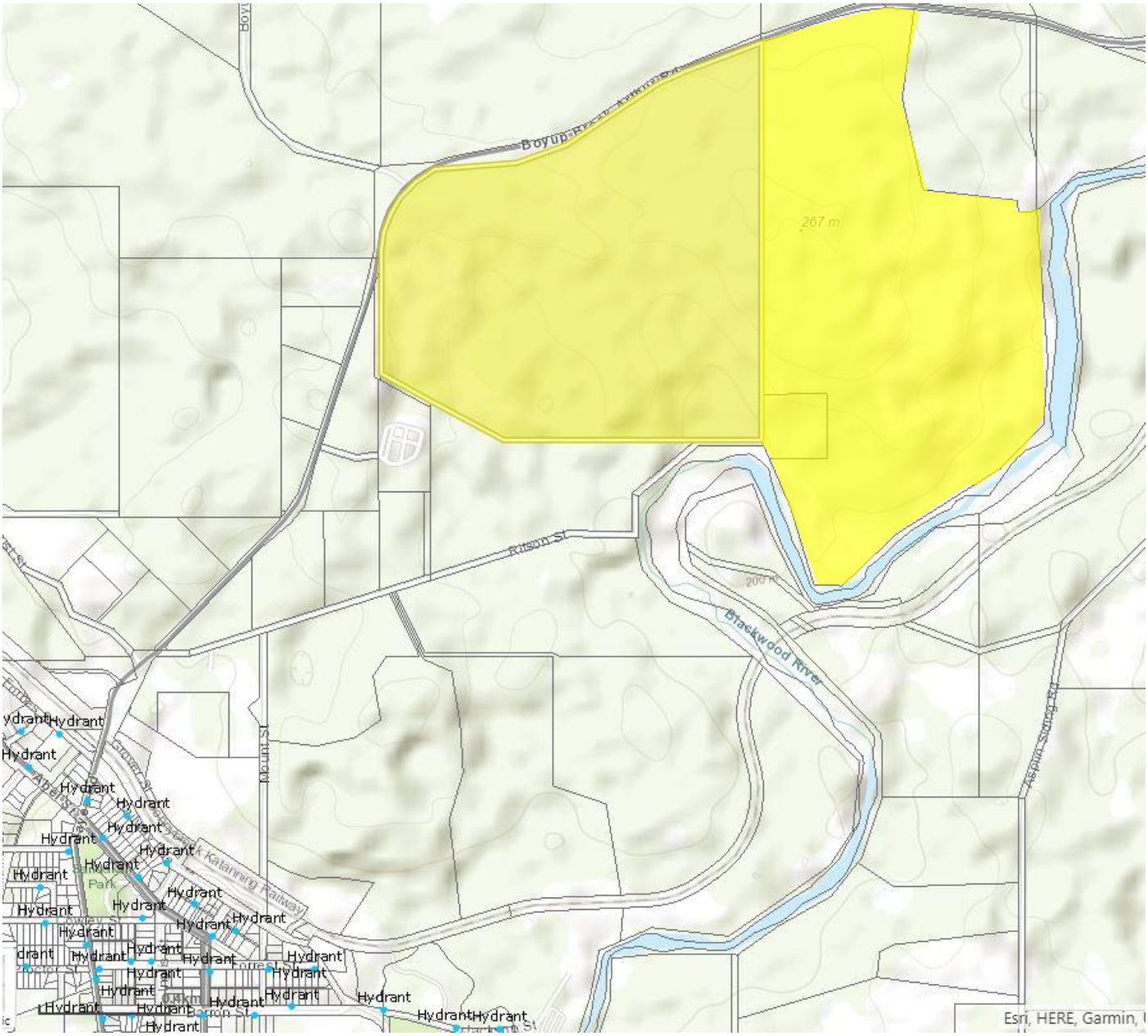
   (b) clear a second 2.5m wide bare earth firebreak break around all buildings, homesteads, hay sheds, fuel storage areas, caravans and mobile accommodation located not less than 20m nor more than 100m from the firebreak in paragraph (a) above by removing all inflammable matter and vegetation within the second 2.5m wide firebreak between the ground and 4 metres above the ground.

OR

2. As an alternative to the two firebreak system described in 1, clear a 10m wide bare earth firebreak immediately around all buildings, homesteads, hay sheds, fuel storage areas, caravans and mobile accommodation by removing all inflammable matter and vegetation within the 10m firebreak between the ground and 4m above the ground.

Appendix 3

Location of the current fire hydrants (blue dots) in the general area of the development and compliant with the Water Corporation standards. The a portion of the site (residential area) will be serviced by the reticulated scheme water system which includes the provision of fire hydrants and will be compliant with the State's requirements.



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Shire of Boyup Brook, (2022). *Fire Break Notice 2020/21*. Retrieved 4 December 2022 from https://www.boyupbrook.wa.gov.au/documents/861/20202021-firebreak-notice (it is noted that this is an outdated Firebreak Notice, but it is the latest on the web site for the Shire of Boyup Brook).

Near map from http://maps.au.nearmap.com/

Slope percentage to degrees conversion from https://www.calcunation.com/calculator/slope-percent-conversion.php

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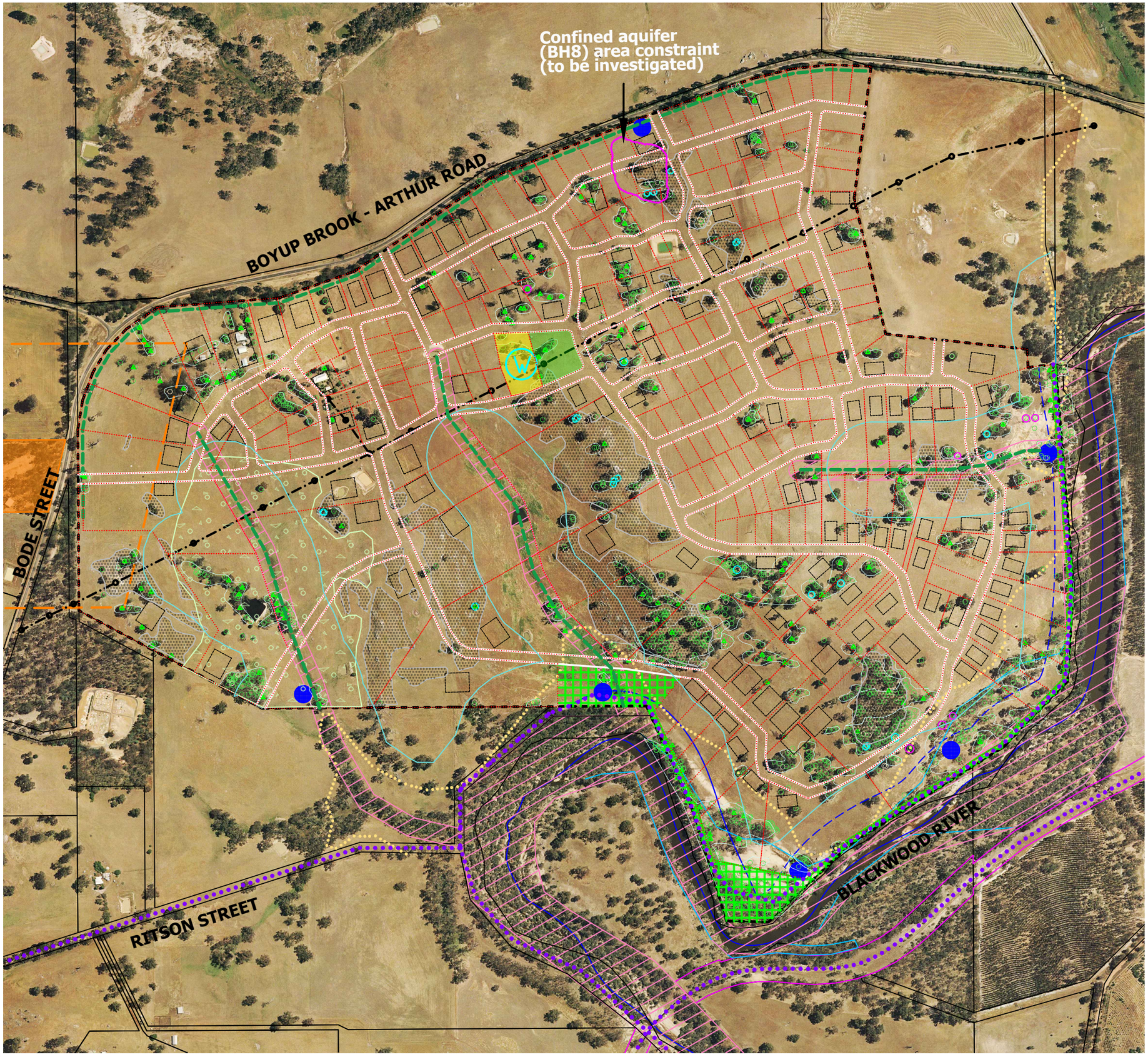
Hydrant and water meter locations from https://espatial.dplh.wa.gov.au/PlanWA/Index.html?viewer=PlanWA

ATTACHMENT 8



LEGEND

- Subject Land
- Indicative High Level Water Tank Site
- Resource Recovery Centre with 200m Buffer
- Stormwater Storage Area
- River and Watercourses
- Foreshore Reserve
- Proposed Public Open Space
- Proposed Public Purpose
- Replanting (Indicative)
- Walk/Cycle Trail
- Aboriginal Heritage Site
- 100m Setback from River/Watercourses
- 190m AHD - Extent of 1% Annual Exceedance Probability (AEP) Flood Level
- Building Envelope
- Western Power Asset (Line and Poles)
- Suitable Significant Trees
- Potential Significant Trees
- Black Cockatoo Habitat Trees
- Fauna Habitat Trees
- Seasonal Waterlogging
- Rock Outcrop

284 LOTS TOTAL — All lots are conceptual and subject to further investigation.

CONCEPT PLAN
LOTS 51, 1007 and 1118
BOYUP BROOK-ARTHUR ROAD,
BOYUP BROOK
SHIRE OF BOYUP BROOK

0 80 160 240 320 400m
1:8000(A3)

N

SCALE APPROX. 1/8000
DATE 23rd MAY 2024

edge PLANNING & PROPERTY

ROD LAKELIN
PO BOX 70 VASSE WA 6280
0428 174 306
rodlakelin@bigpond.com

ATTACHMENT 9

3.0 ISSUES AND OPPORTUNITIES

3.1 Overview

This section provides an overview of the issues and opportunities for land use planning and development throughout the Shire which have been taken into consideration in the preparation of this Strategy.

Consistent with the State Planning Framework, planning issues of relevance to the Shire are presented under the following themes:

- Community, Urban Growth and Settlement
- Economy and Employment
- Environment
- Infrastructure

Each of these themes has been considered individually, with clear planning directions identified and actions attributed to the Shire and other stakeholders, including landowners, developers and State Government agencies.

3.2 Community, Urban Growth and Settlement

3.2.1 Summary of Issues and Opportunities

Community growth and settlement is perhaps the most critical element of the Local Planning Strategy, and the one which requires the greatest focus over the next 5-10 years.

Whilst population growth has been steady over the past 5-10 years, there are a number of issues within the Boyup Brook townsite and surrounds which require further interrogation and proactive measures to be taken by the Shire, including the following (with references in **Figure 1**):

A Opportunities for further urban residential development exist throughout the Boyup Brook Townsite, but require support to bring these opportunities to market, as the very low value of housing makes new land development unviable.

B Boyup Brook has an ageing population and needs to provide opportunities for the development of aged and dependent persons accommodation, but these sites need to overcome the financial constraints required to make them development ready.

C There is an increasing demand for rural residential and rural living development opportunities to leverage the lifestyle benefits of the local natural environment, but these opportunities need to be considered in the context of environmental sustainability, service feasibility/capacity and environmental risk.

D Protection of the character and heritage of Boyup Brook townsite is important to the community, and as such new built form proposals need to reflect and respond to the local character.

The opportunities and issues for community growth and settlement are further explored in **Table 1.**



Image: Example of existing residential character at Rylington Park Farm.

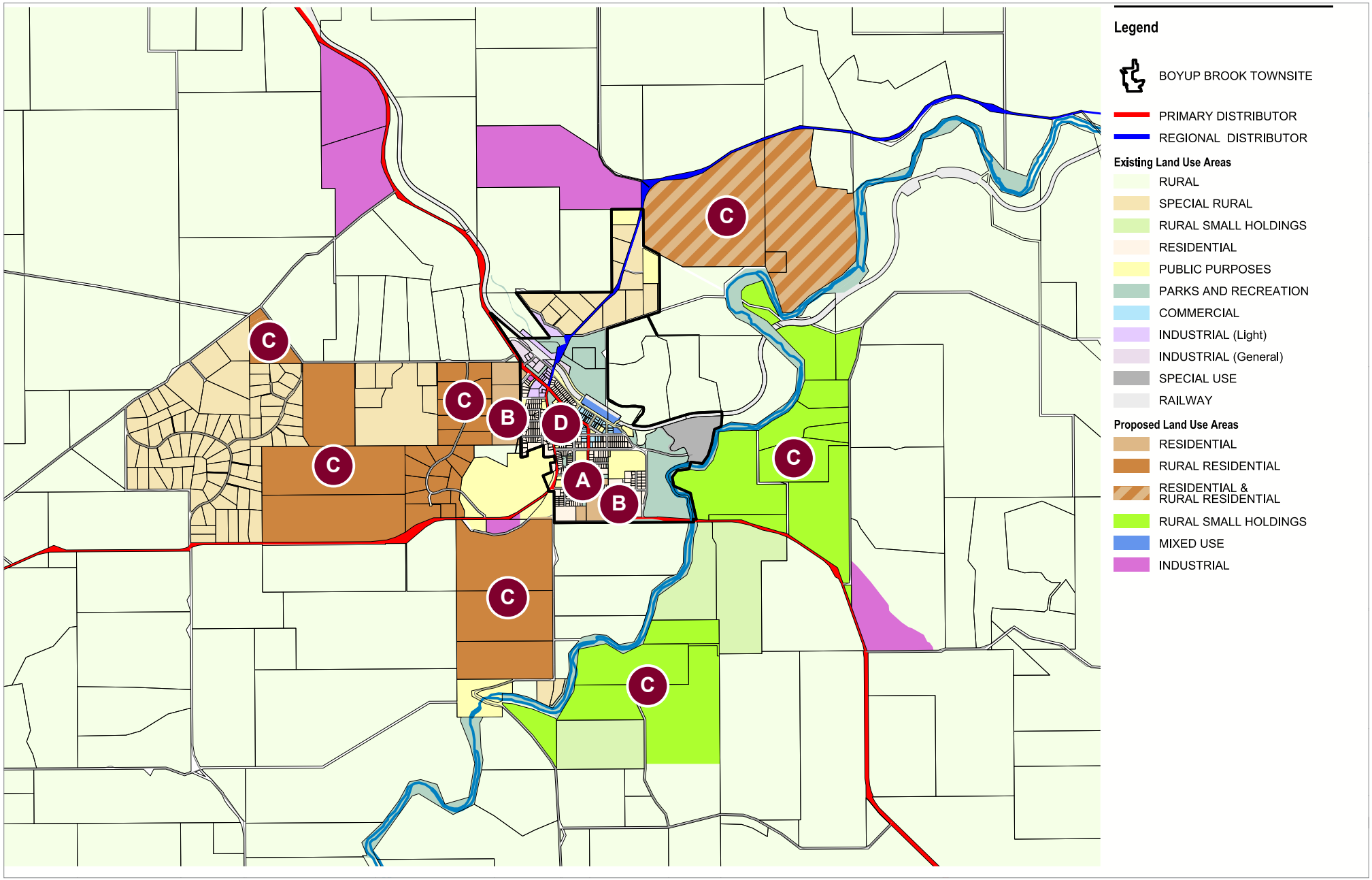


Figure 1: Issues and Opportunities with respect to Community, Urban Growth and Settlement (Boyup Brook Townsite and Surrounds)

3.3 Economy and Employment

3.3.1 Summary of Issues and Opportunities

Economic and employment retention and growth is critical to ensuring the viability of the Shire into the future. The Shire is currently home to a number of economic activities and employment generators, predominantly driven by agriculture and viticulture. There are many opportunities which the Shire may be able to capitalise upon in the future including the potential to expand on existing dominant sectors and use locational advantages to attract new economic and employment investment.

This can be assisted through modifications to the planning framework, along with modifications to planning processes to incentivise and assist businesses in establishing and thriving within the Shire.

In considering economic and employment growth the following opportunities and issues are noted, with references in **Figure 2**:

A With an older and aging population, there is demand and opportunity for the Shire to provide not only aged care accommodation, but associated supporting health services and amenity for retired persons.

B The Shire has a very attractive and diverse natural environment and attracts a significant number of tourists each year, but needs to provide greater short stay accommodation and specific attractions to encourage tourists to stay within the local area (e.g. restaurants, festivals, community infrastructure, outdoor social activities, micro brewery, etc.).

C There is demand for additional industrial land supply given the network of major freight routes throughout the Shire and the need to support local agri-businesses, raw materials production and other industrial needs. The periphery of the Boyup Brook townsite provides many opportunities for additional industrial land supply, but these landowners require support to bring these opportunities to market.

D There is demand for commercial development and redevelopment opportunities within the Boyup Brook townsite, which would aid in not only revitalising local businesses but attracting new business growth and investment.

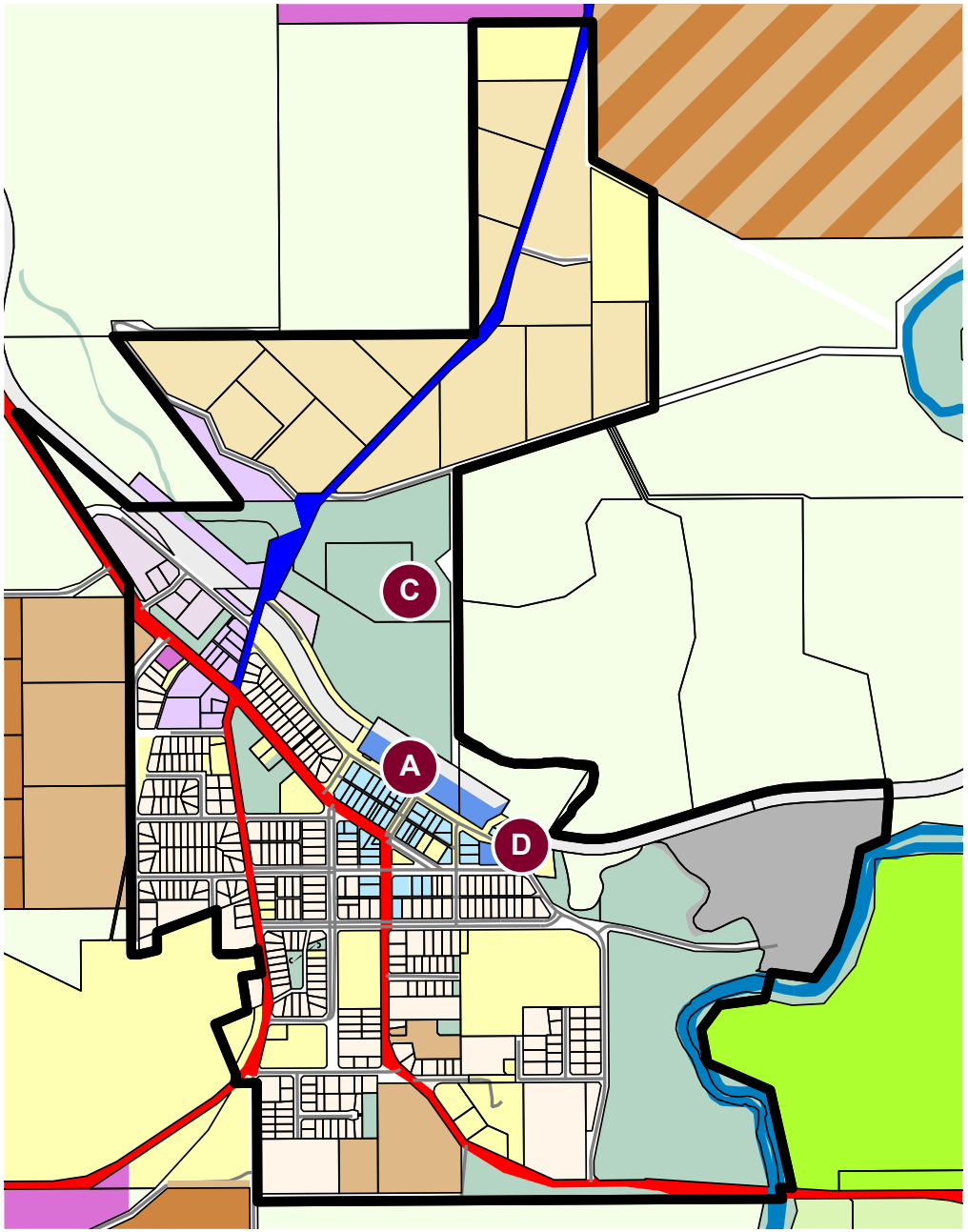


Figure 2: Issues and Opportunities with respect to Economy and Employment (Boyup Brook Townsite subset)

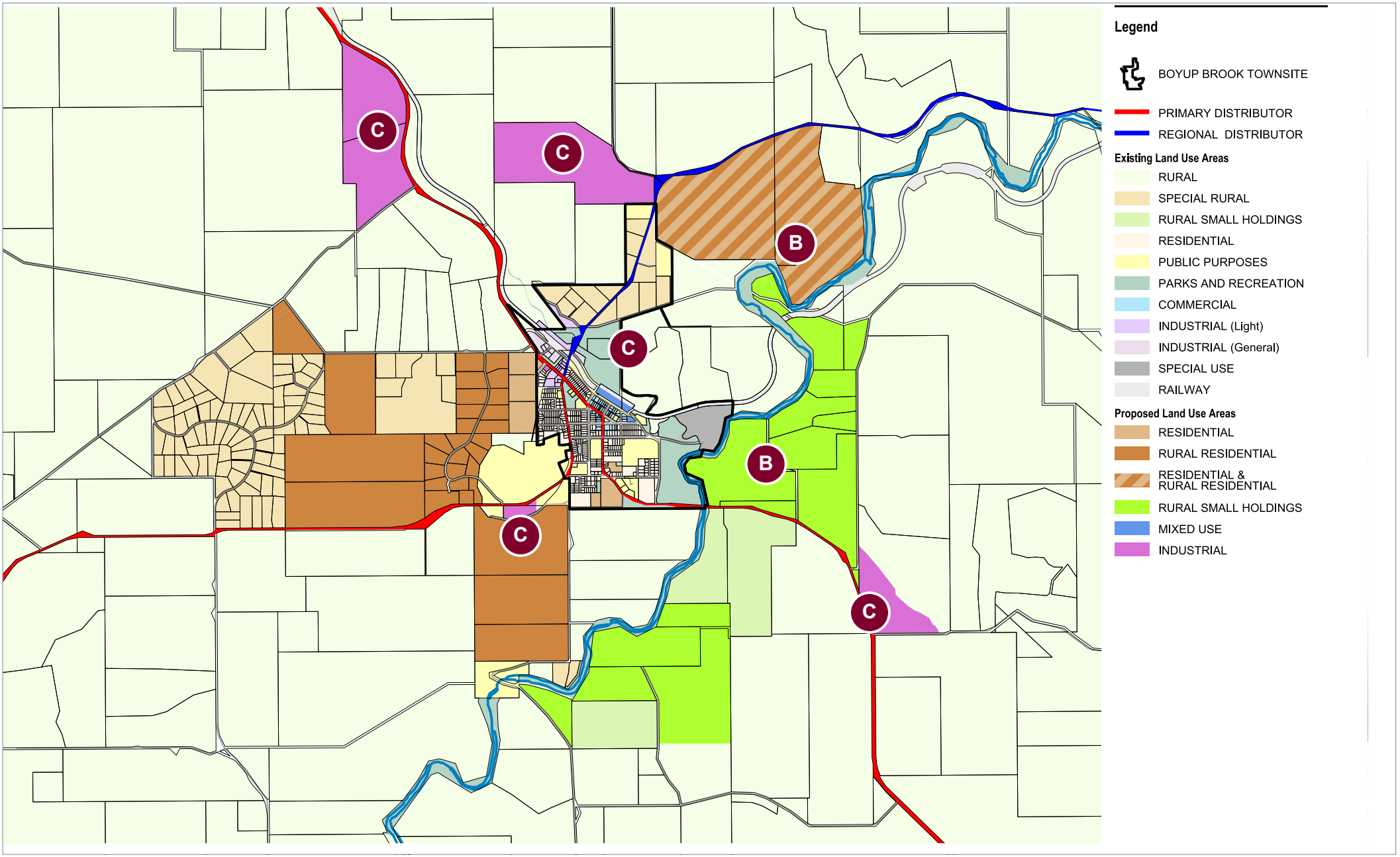


Figure 3: Issues and Opportunities with respect to Economy and Employment (Boyup Brook Townsite and surrounds)

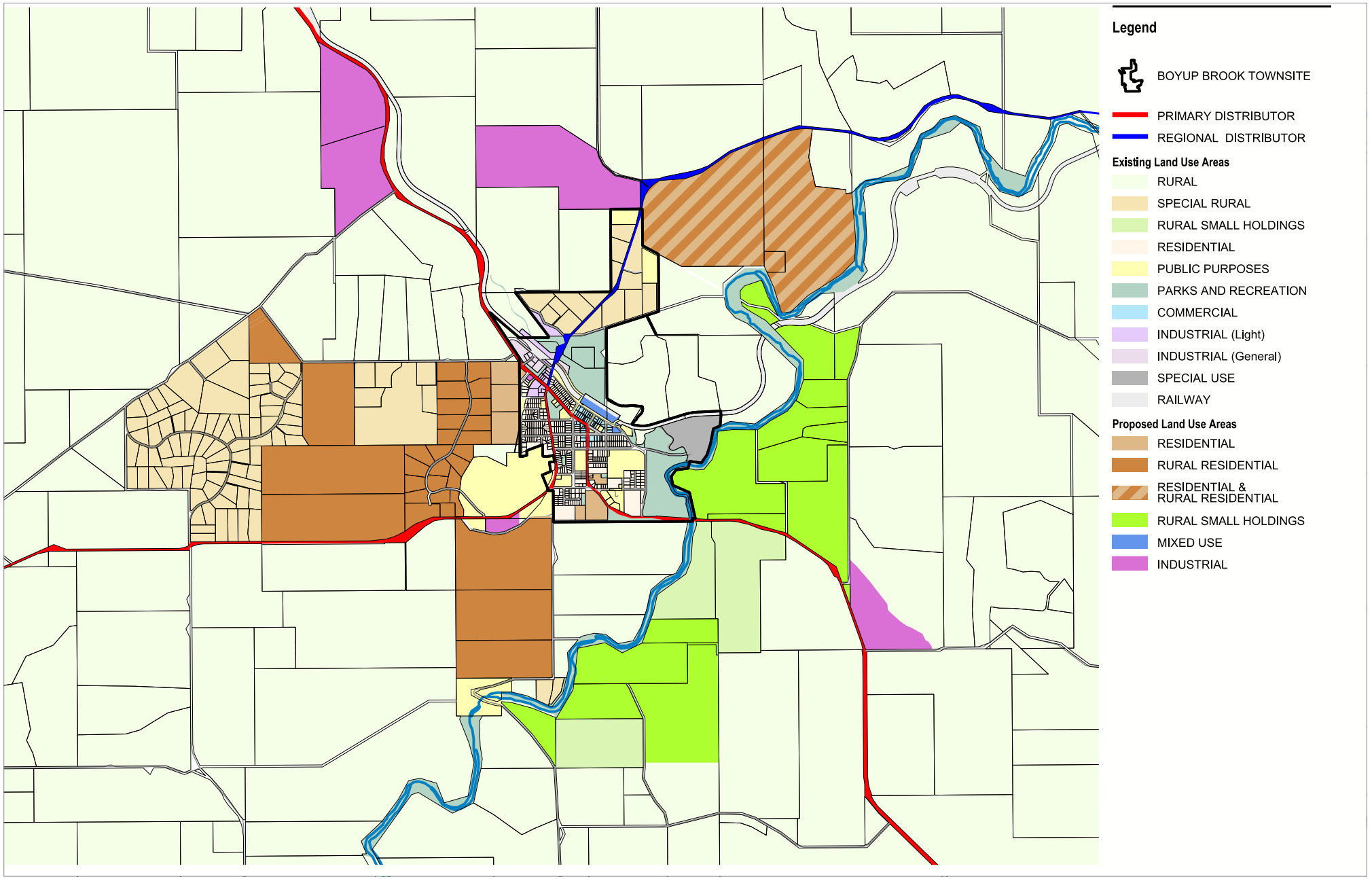


Figure 6: Local Planning Strategy Map for Boyup Brook Townsite and Surrounds

5.0 PLANNING AREAS

5.1 Overview

In addressing the broader issue of growth and regeneration of the local government area, one of the key actions is the identification and facilitation of developable land to accommodate economic and population growth. This section provides a greater level of detail for each of the planning areas, including a spatial plan for each, relevant planning considerations and site specific opportunities and issues.

5.2 Planning Areas

There are a total of 19 identified Planning Areas considered suitable for further detailed investigation for future development. These planning areas are listed below and shown in **Figure 7**, and are divided into five key planning area themes which are further explained in **Table 5.**

Mixed Use

1. Railway Parade
2. Forrest Street

Residential

3. Bridge Street
4. Bridge and Gibbs Street
5. William and Short Street

Industrial

6. Abel & Short Street
7. Bridgetown - Boyup Brook Road
8. Boyup Brook North Industrial
9. Donnybrook-Boyup Brook Road
10. Boyup Brook-Kojonup Road

Rural Residential

11. Banks Road
12. Rusmore Road
13. Bridgetown Boyup-Brook Road & Banks Road
14. Rural Residential Consolidation Area
15. Boyup Brook North Residential Expansion (Residential/Rural Residential)

Rural Small Holdings

16. Stanton, Terry and Fern Valley Rd
17. Asplin Siding Road

Table 5: Planning Area Classification and Key Considerations

PLANNING AREA	PLANNING DIRECTION	ACTION	RATIONALE	TIMEFRAME
Mixed Use	To provide additional commercial and residential opportunities which support the viability of the Townsite	Investigate the potential of the subject land to accommodate development, and undertake planning framework modifications to facilitate this development.	Demand for additional commercial opportunities is difficult to accommodate due to the lack of suitable sites within the Townsite.	**Short Term (1-3 Years)** depending on outcomes of more detailed analysis and review.
Industrial	To facilitate the expansion of existing local business and attract new businesses to the Shire.		Demand for expansion of existing industrial businesses, or new businesses looking to establish, is currently difficult to accommodate due to a lack of suitable land.	
Residential	To facilitate expansion of the local population and encourage local residents to stay within the Shire.		Population retention and growth is essential to the viability of the Shire, and a diversity of options for residential living is necessary to encourage residents to stay within the Shire and people to move to the Shire.	
Rural-Residential				
Rural Small Holdings				

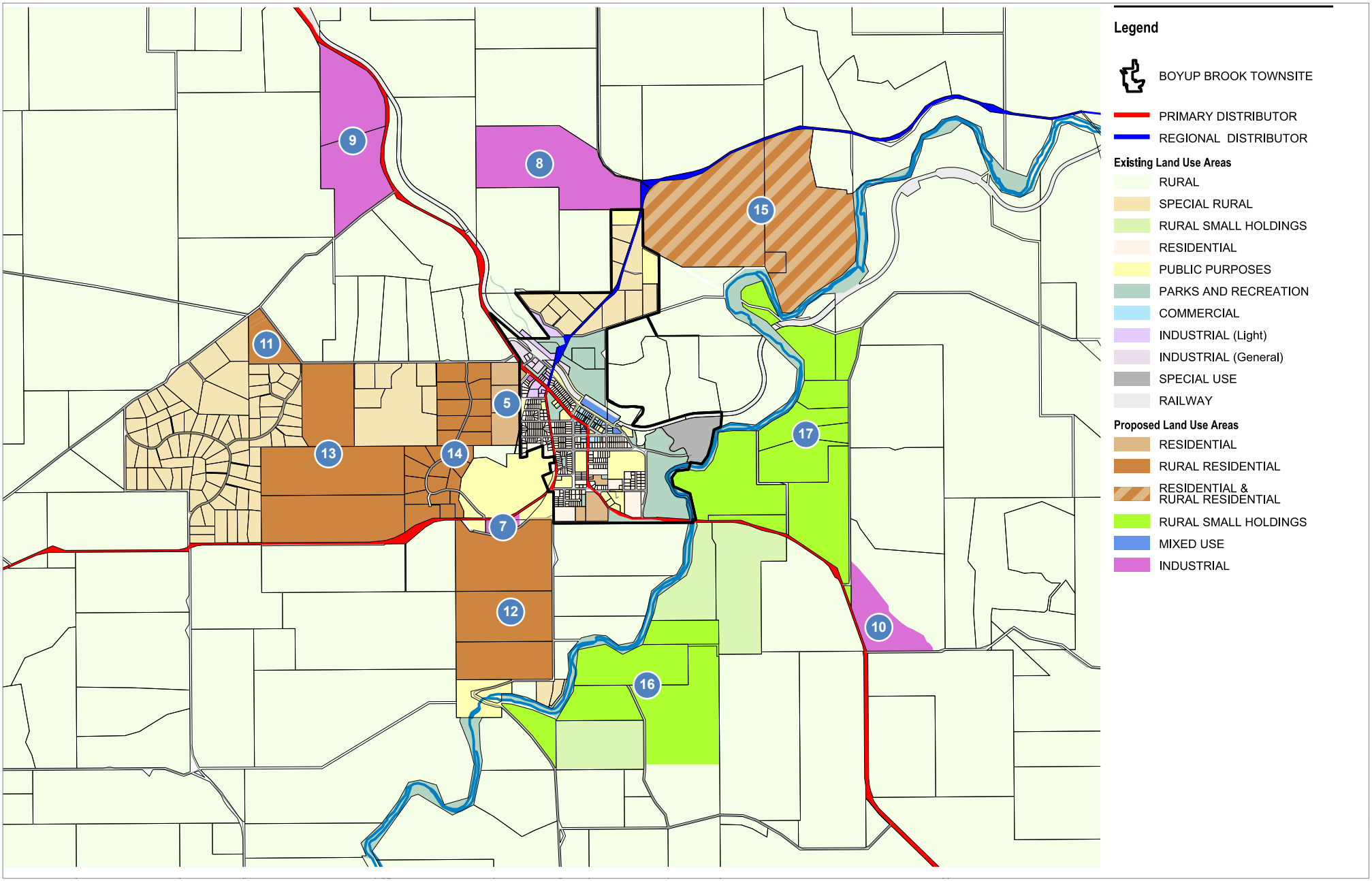


Figure 7: Planning Areas for further investigation.

15. BOYUP BROOK NORTH RESIDENTIAL EXPANSION

Site Details:

Lot 51 (4) Boyup Brook-Arthur Road, Boyup Brook
Lot 1007 Boyup Brook-Arthur Road, Boyup Brook
Lot 1118 Boyup Brook-Arthur Road, Boyup Brook

Land Area:

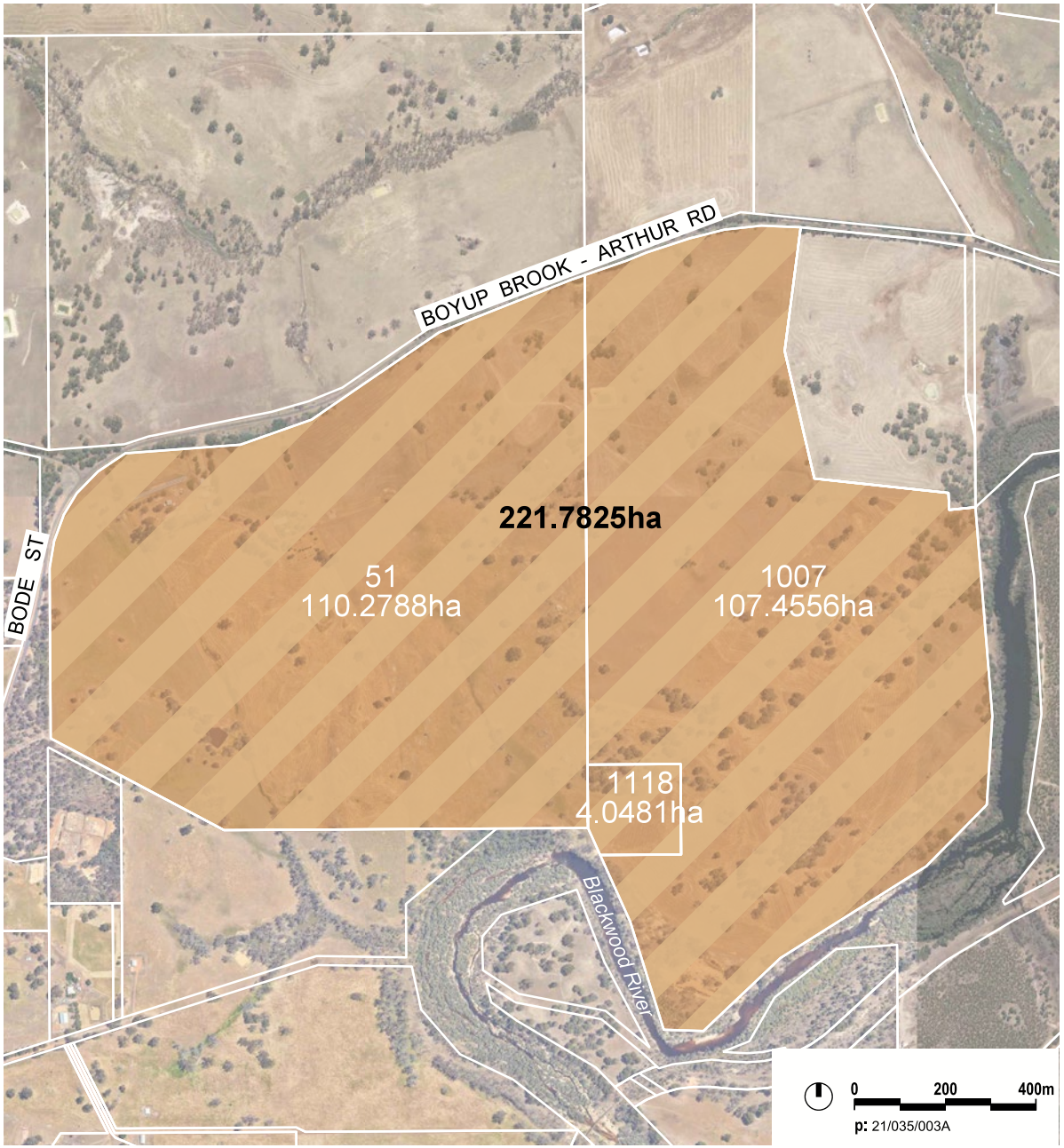
221.78ha (gross)
110.89ha (estimated Net Developable Area)

Planning Considerations:

Proposed Land Use: 'Rural Residential' or 'Residential'
Current Scheme Designation: 'Rural'
Proposed Scheme Designation: 'Rural Residential' or 'Residential'
Structure Planning Required: Yes (identify as 'Special Control Area - Structure Plan')
Lot Size/Density: min 2000m2 to 1ha (subject to licensed water supply for lots below 1ha)
Estimated Lot Yield: up to 360 lots (subject to detailed structure planning)

Issues/Opportunities:

1. Subdivision and development to be in accordance with WAPC SPP 3.7 – Planning in Bushfire Prone Areas and SPP 2.5 Rural Planning.
2. Compliance with the Government Sewerage Policy.
3. Vegetation and waterway protection.
4. Suitable setbacks to, and landscape management near, the Blackwood River.
5. Provision of licensed water supply.
6. Consideration of suitable development standards to occur through detailed structure planning.
7. Environmental Impact Assessment for any development in close proximity to the Blackwood River.



ATTACHMENT 10

ENGINEERING SERVICING REPORT

LEAFIELD DEVELOPMENT, BOYUP BROOK

July 2024

PREPARED FOR: Leafield Pty Ltd

Submitted by Peter Eastlake FIEAust CPeng (Ret)

Email pongo@bigpond.com

Mob 0427 906 540

ENGINEERING SERVICING REPORT
Leafield- Lots 51, 1007 and 1118
Boyup Brook – Arthur Road, Boyup Brook

Contents

1 Introduction 3
2 Site Description 3
3 Site Conditions 4
3.1 Geology 4
3.2 Topography 4
3.3 Vegetation 4
3.4 Acid Sulphate Soil (ASS) 4
3.5 Existing Building Infrastructure 5
3.6 Existing Servicing Infrastructure 5
3.7 Illegal Dumping and Contamination 5
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5.6 Communications 10
5.7 Gas 10

LEAFIELD- LOTS 51, 1007 and 1118

ENGINEERING SERVICING REPORT

1 Introduction

Peter Eastlake has been engaged by Leafield Pty Ltd to undertake a review into civil engineering related matters and infrastructure servicing opportunities and constraints for a potential residential and rural residential development of Lots 51, 1007 and 1118 Boyup Brook – Arthur Road, Boyup Brook. The name of the proposed development is Leafield, Boyup Brook.

This report summarises the existing servicing infrastructure, the expected servicing infrastructure and the likely Local Authority engineering conditions required to be undertaken to achieve an anticipated Western Australian Planning Commission (WAPC) and Shire of Boyup Brook Structure Plan and Rezoning approval for the Site.

The information contained herein has been provided to assist in the understanding of the potential engineering issues and constraints involved in the Leafield development in accordance with current residential and rural residential subdivision requirements. It is assumed the residential subdivision will be an R5 density with larger lots to address land capability. The overall lot yield on the Site is approximately 284 lots/dwellings.

It is noted that the advice contained herein is general in nature, as no detailed engineering, environmental, geotechnical or other design work has been undertaken as part of this report. No detailed discussions with the local authority or any of the servicing agencies (unless otherwise specifically noted within, where an issue was deemed to require additional clarification due to a significant effect on the potential for development).

A Local Water Management Strategy (LWMS) and a Site and Soil Evaluation (SSE) investigations were undertaken by Bio Diverse Solutions and associated reports prepared. An associated Groundwater Monitoring Bore Report was prepared by WML in January 2022. This Servicing Report should be read in conjunction with these documents.

2 Site Description

The Site is located 2 kilometres northeast of the Boyup Brook town site on the Boyup Brook – Arthur Road. The Site is bound by Boyup Brook – Arthur Road to the north and the Blackwood River to the south. The Site is surrounded by rural landholdings. The area subject to rezoning is approximately 222 hectares.

The Site is currently cropping and grazing land with a dwelling and sheds in the northwest of the Site. The Site consists of cleared pasture with sparse areas of mature trees and vegetation. Historical aerial images dating back to 1996 do not indicate any other land uses, the latest aerial image is presented in Figure 1 below.

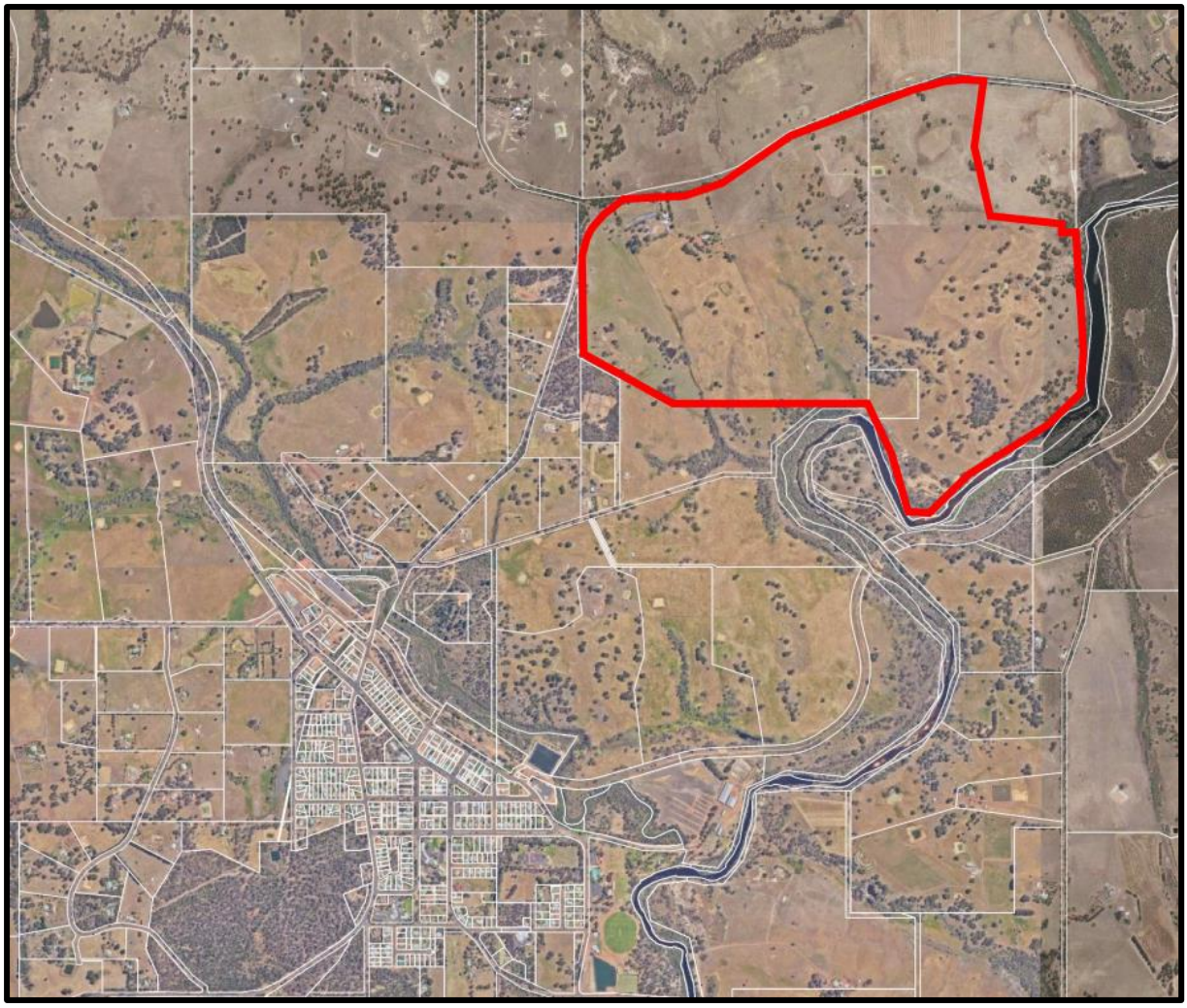


Figure 1: Aerial Photography (WA Now 2017)

3 Site Conditions

3.1 Geology

The Geology of the Site is predominantly silty sand over rock and/or sandy clay, which is suitable for residential development. Refer to the relevant Section of the LWMS which includes results of the soil investigation.

3.2 Topography

The Site generally grades from Boyup Brook-Arthur Road in the north to the Blackwood River to the south. The grade of the Site is generally moderate, with localised flat and steep areas. The road layout will need to consider the topography of the Site to ensure earthworks levels in the road reserve match as close as is reasonably practical to the natural levels. Refer to the relevant Section of the LWMS for further discussion of the Site topography.

3.3 Vegetation

Refer to the relevant Section of the LWMS.

3.4 Acid Sulphate Soil (ASS)

The Site does not fall within any known areas of ASS and ASS is not anticipated to be encountered, refer to the relevant Section of the LWMS.

3.5 Existing Building Infrastructure

The Site contains a single residential home and associated small farm infrastructure in the northeast corner of the property. It is noted that the existing building infrastructure is to be retained in future lots following subdivision, and the subdivision proposed will take into consideration separation of the existing buildings to proposed boundaries.

3.6 Existing Servicing Infrastructure

The existing dwelling is currently served with power from the existing overhead powerlines traversing the property. The NBN communications to the Site are wireless. There is presently no reticulated water, sewer, or gas supplies to the Site.

3.7 Illegal Dumping and Contamination

Visual inspection of the Site does not indicate any areas of potential illegal dumping or areas potentially contaminated with unwanted waste, materials etc. Research of the contaminated sites database, Figure 2 below, does not indicate any form of contamination on the Site nor that the Site has been remediated in the past.

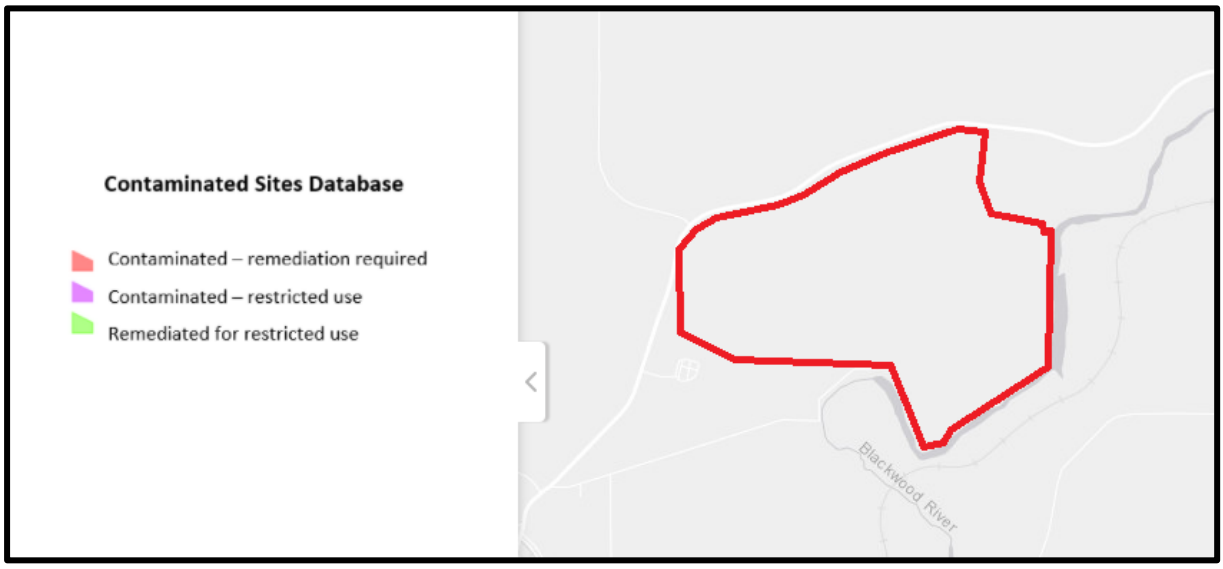


Figure 2: Contaminated Sites Database (Landgate (SLIP) March 2022)

3.8 Groundwater

Refer to the relevant Section of the LWMS.

4 Development Siteworks

The siteworks/earthworks within the Site will be undertaken as necessary to facilitate the construction of roads, drainage and servicing infrastructure associated with the creation of the lots. Noting the proposed generous lot sizes, little or no bulk earthworks will be undertaken on the individual lots however future lot purchasers may choose to undertake earthworks to create their homes and infrastructure upon creation of the lots. This will be subject to the Shire of Boyup Brook's Building approvals process.

5 Development Infrastructure

5.1 Roadworks

The Shire of Boyup Brook will be the ultimate approval authority for any proposed road network. Road infrastructure will be designed in accordance with the approved Structure Plan and will be based on hierarchy appropriate to the residential and rural residential zoning, with each lot having road frontage.

The internal road locations will need to be cognisant of the terrain to ensure that suitable road gradients and economic constructability are achieved, with due regard to the Aboriginal Heritage areas and avoiding trees with hollows suitable for black cockatoos.

It is anticipated that there will be three new road entrances on to the Shire controlled Boyup Brook – Arthur Road, as shown on the Subdivision Concept _Plan. The specific location of these intersections will be determined at the time of detailed design and will consider Site topography, appropriate sightlines, the existing tree line, drainage swales and the volumes of traffic generated by the new lots.

Another road connection to the existing Ritson Street reserve at the south west boundary of the site is proposed to facilitate a more direct connection towards Boyup Brook town site for the southern and eastern lots. Ritson Street reserve has currently an unsealed gravel road with the last section leading to the site having no road formation and being naturally vegetated. As this section is adjacent to the Blackwood River and is partially within an Aboriginal Heritage site, it is not expected that a road link will be constructed using this section of the road reserve. However it is an appropriate access for a path way link to the site. This road connection is not proposed to be included in the development planning and only a road reserve access to the lot development boundary will be included. There is also an opportunity to create a road connection to Ritson Street, from the south-west section of the Site, based on the Subdivision Concept Plan.

Donald Veal Consultants (DVC) undertook a Traffic Impact Assessment (TIA) in 2022 and prepared a TIA Report dated November 2022. This Servicing report should be read in conjunction with the TIA Report. It is noted that lot yield has since reduced since preparation of the TIA and accordingly traffic impacts are also lower.

5.2 Stormwater Management

Refer to the relevant Sections of the LWMS. To achieve the requirements of the LWMS piped drainage, roadside swales and storage basins will need to be constructed, sized to convey and store the 20% AEP storm event. In larger storm events stormwater will flow overland, unattenuated into the Blackwood River or existing Boyup Brook-Arthur Road drainage system.

5.3 Underground Power

It is proposed that all lots within this development will be serviced by underground power as required by the WAPC.

The Western Power Network Capacity Mapping Tool indicates the area has 10-15MVA forecast remaining capacity. Based on an R5 density with a power demand of 4.7kVa per dwelling the estimated total power requirement for residential development of the Site is approximately 4.7MVa, well within the available remaining capacity.

Western Power mapping of their existing underground and overhead electrical assets within the vicinity of the subject land is presented in Figure 3. Existing 3-phase overhead power lines traverse

the Site (solid blue in Figure 3), as part of subdivision these will need to be relocated and undergrounded within road reserves being created.

It is anticipated initial lots can be connected onto the existing network running through the Site. As development progresses it is expected offsite upgrades of the existing power networks will be required. The nearest transmission power line is approximately 2.4km west of the Site, the 132kV powerline shown in red in Figure 3.

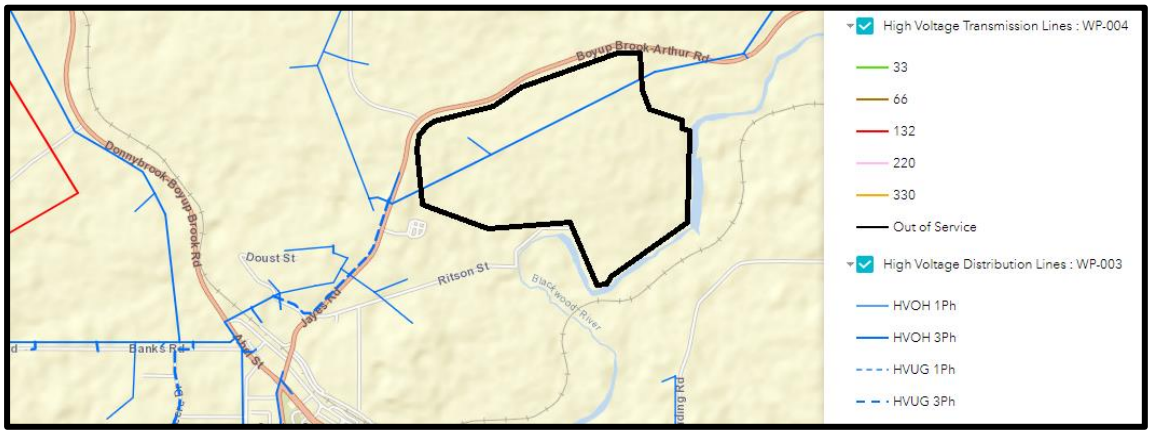


Figure 3: Existing Power Network (Western Power Network Capacity Mapping Tool, March 2022)

The WAPC may consider alternative power supply based upon the advice of the relevant licensed service provider.

While matters within this space are evolving quickly, the option outlined hereunder, while generally applying to larger lots, may be relevant.

An alternate option would the provision of a renewable energy source, under State Planning Policy 2.5 – Rural Planning Guidelines the WAPC permit a renewable energy source to power residential property:

"5.4 Renewable energy sources

The use of renewable energy sources to power residential properties has become increasingly attractive to homeowners in rural areas due to the expense and challenges of connecting to a reticulated supply. SPP 2.5 allows for the use of renewable energy sources where a network connection is not available or an infrastructure upgrade is not commensurate with the scale of a proposal.

An 'off-grid' system, also known as a 'stand-alone power' system, could be utilised to service rural lots. The main components of a stand-alone power system are:

- Renewable energy generation equipment, such as photovoltaic modules (solar panels), wind turbines, or 'hybrid' combinations of these;
- control and regulation equipment for battery charging and back-up power operation;
- energy storage such as batteries;
- inverters which convert electrical current so that common household appliances can be used; and
- a back-up electricity supply from either storage batteries and/or generators.

Any stand-alone power supply system must demonstrate that the energy generated through the renewable energy source/s is sufficient for the intended land use. The use of diesel generators to power residential properties is not considered a renewable energy source as defined in SPP 2.5." (SPP 2.5 Rural Planning Guidelines Version 3 December 2016 Western Australian Planning Commission)

5.4 Water Supply

The existing Water Corporation water reticulation network is presented in Figure 4 below. There is reticulated water within the Boyup Brook townsite itself only.

The Developer is supportive of providing reticulated water to the property including a pump station, a high level tank and a low level tank. This is subject to Water Corporation ensuring there is sufficient water to service Boyup Brook and that the Developer's upgrade costs are proportionate/reasonable.

Figure 6 show elevated points on the Site.

Water Corporation were contacted in October 2021 and in January 2022 to confirm the water supply available for the proposed subdivision and they initially advised that a water supply to the Site is not available

In April 2023, in correspondence to the Shire of Boyup Brook, the Water Corporation advised:

"16. Boyup Brook North Residential Expansion

Servicing of this site with scheme water has been previously investigated and is expected to cost approximately $7m. This is not in our Capital Investment Program and therefore must be funded by the proponent. We encourage the Shire to explore options to address the need for residential land."

In June 2023, Water Corporation confirmed there was sufficient water supply available for planned development in the Boyup Brook townsite plus proposed development of Leafield. Water Corporation advised:

> "To supply this site with water, the following would be required:
>
> - 2.2km DN100 Water main
> - 80kL Elevated tank on a 12m stand on ground at 255mAHD
> - 7L/s Transfer Pump located as shown below and connecting pipework to the scheme
>
> None of these assets are funded in our capital program and must be delivered at the developers cost."

Subject to the timing for Water Corporation to upgrade the water supply and storage to Boyup Brook, the Shire is supportive, in-principle, of a 'hybrid' servicing model where lots are initially provided with rainwater tanks and reticulated water services are laid for future connection. The tank size to accommodate allowance for fire protection and climate change. As discussed, this could see tank sizes of 120,000 litres for usual use and 15,000 litres reserved for firefighting. This proposal would increase the cost of development to the lot purchaser and such consequences must be fully considered.

Lots that are 1 hectare or above are not serviced with reticulated water.

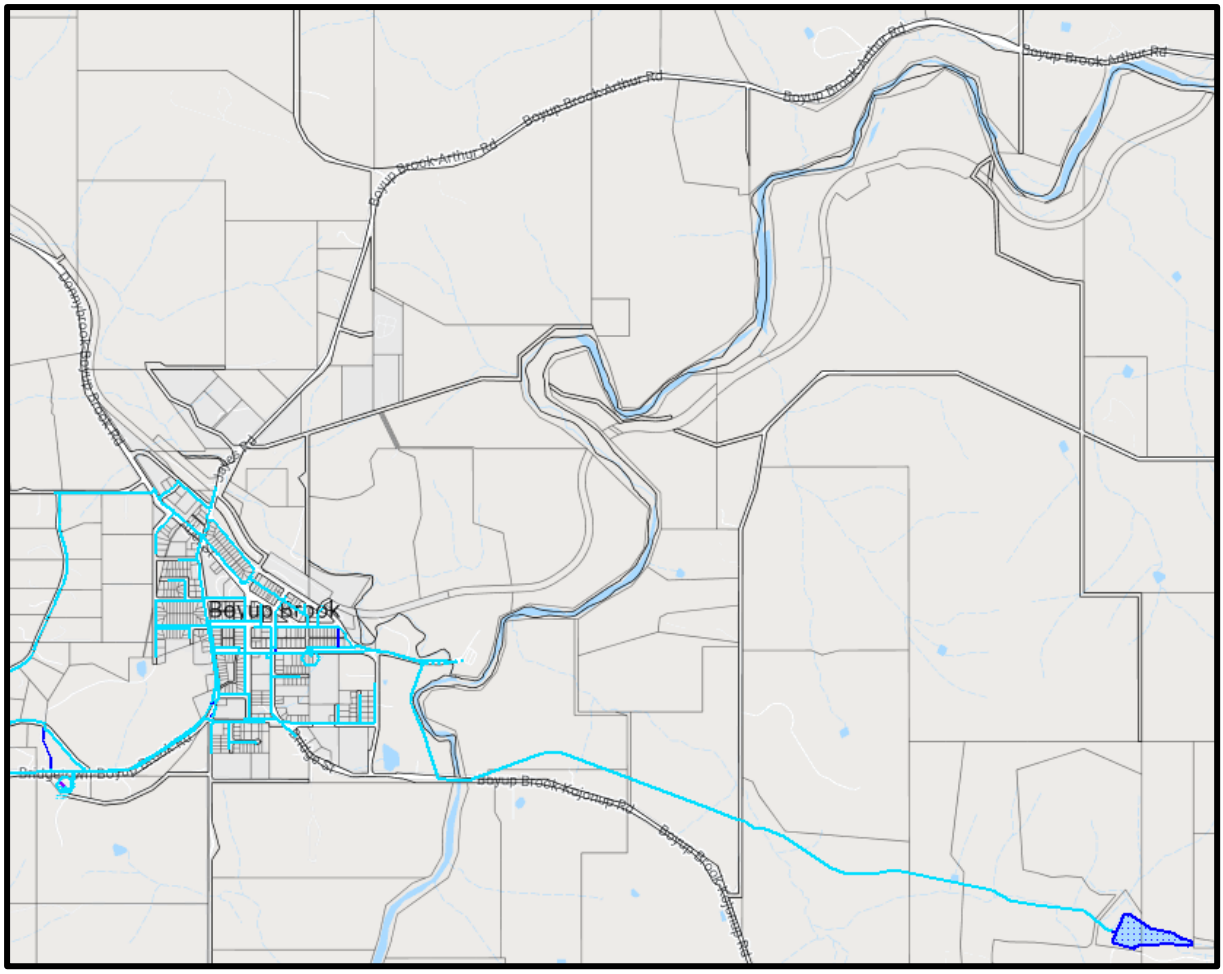


Figure 4: Existing Water Reticulation (Esinet March 2022)

5.5 Sewerage Effluent

The Site is not within a current or proposed wastewater catchment. It is proposed wastewater is managed at individual 'lot scale' level using either Leach Drains or Aerobic Treatment Units (depending on the geology of the lot), without reticulated sewer. On-site effluent disposal is discussed in more detail in the relevant Sections of the LWMS and the SSE.

5.6 Communications

The Boyup Brook townsite and nearby surrounds are served with Fixed Wireless NBN communications. Further afield Fixed Wireless is unavailable and NBN communications are provided by Satellite.

The NBN mapping is presented in Figure 5 below. Most of the Site falls within the NBN Fixed Wireless area, apart from the north-eastern corner of the Site (which falls within the Satellite area). Since the Site is served with wireless communications underground communications ducts (pit and pipe) are not required to be installed.

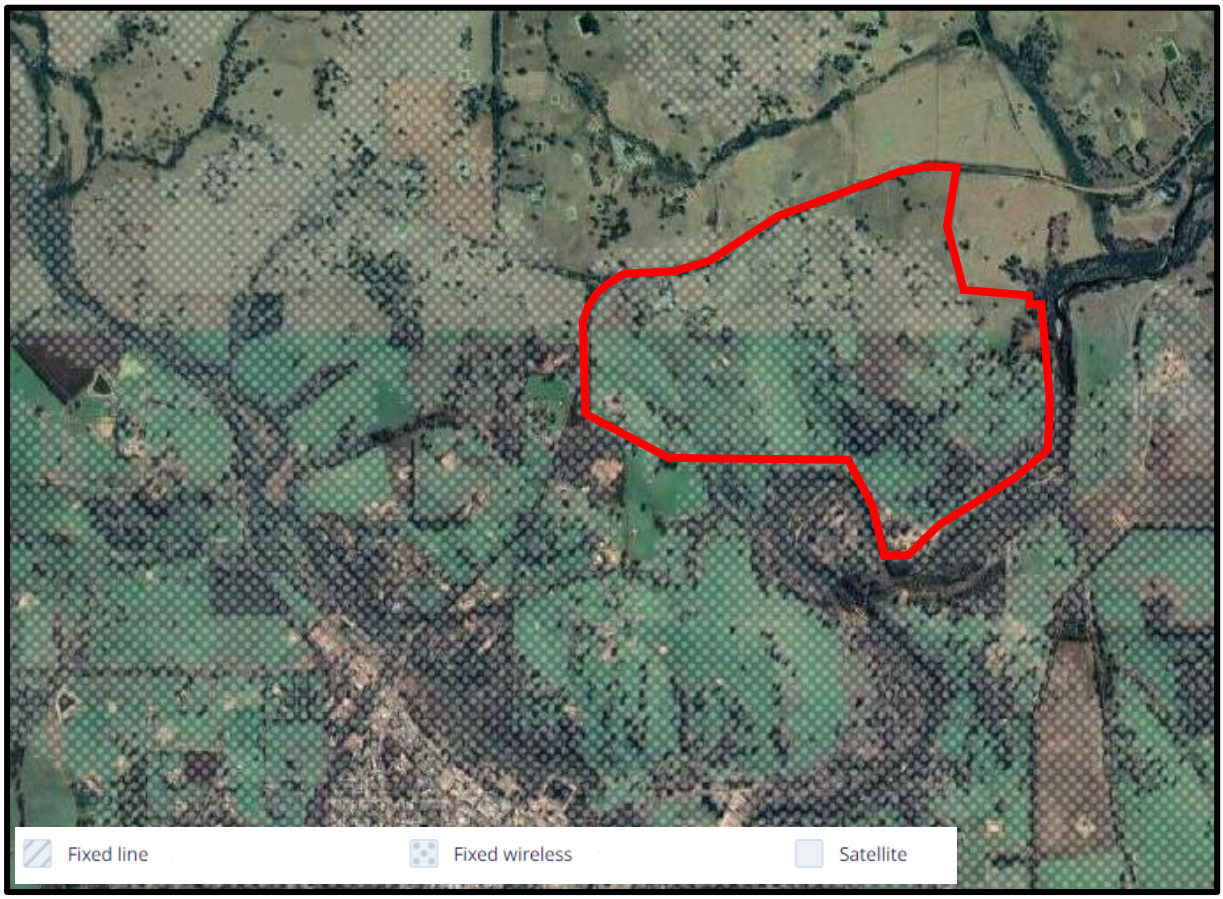
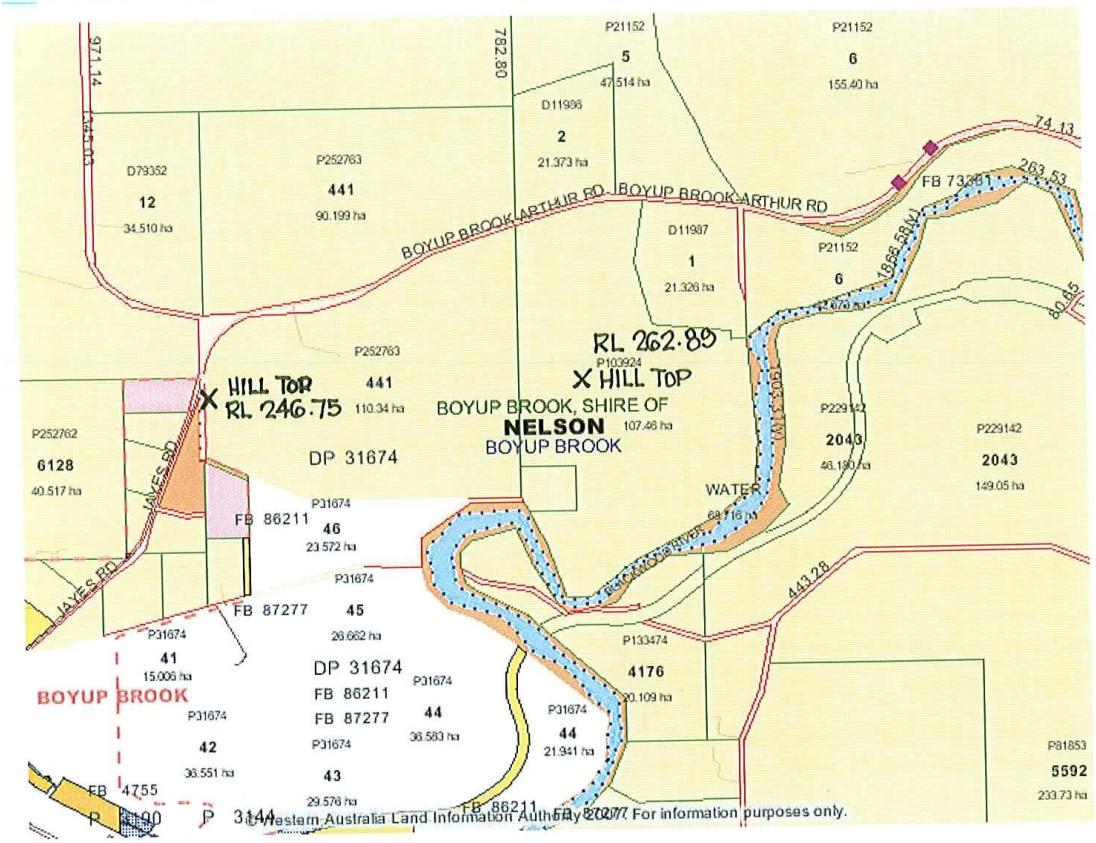


Figure 5: NBN Communications (NBN Co March 2022)

5.7 Gas

There is no existing underground gas supply in the Boyup Brook townsite or surrounds (including the subject Site), therefore it is not proposed to service the development with a reticulated gas supply. The provision of reticulated gas to the new development will not be a WAPC condition of subdivision.



http://www.landgate.com.au/mapviewer/erm_mapviewer.htm?user=ruGXL17&token=0f184bfa464cd... 30/01/2007

Figure 6: Elevated points

ATTACHMENT 11

TARGETED BLACK COCKATOO HABITAT SURVEY REPORT

Lots 51, 1007 & 1118 Boyup Brook -Arthur Road

Boyup Brook, WA 6244

Final v.2

04/10/2023



DOCUMENT CONTROL

Title: Targeted Black Cockatoo Habitat Survey Report – Lots 51, 1007and 1118 Boyup Brook-Arthur Road, Boyup Brook WA 6244.
Author (s): Charlize van der Mescht, Kahree Garnaut
Reviewer (s): Marisa Wearing, Dr Karlene Bain, Graham Penter
Job No.: EPP008-002
Client: Edge Planning & Property

REVISION RECORD

Revision	Summary	Prepared By	Reviewed By	Date
Draft v. 1	Internal QA review	C. van der Mescht, Kahree Garnaut	M. Wearing	13/07/2023
Draft v. 2	Technical Review	C. van der Mescht	K. Bain	24/07/2023
Final	Approval Review	C. van der Mescht	G. Penter	27/07/2023
Final	Delivered to client	C. van der Mescht		27/07/2023
Final v.2	Updates after client review	C. van der Mescht		04/10/2023

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1. Introduction, scope and background information

Edge Planning & Property ("the client") are in the process of preparing documentation that will assist with the subdivision planning and future development of Lots 51, 1007 and 1118 Boyup Brook-Arthur Road, located within the Shire of Boyup Brook (refer to Figure 1). Bio Diverse Solutions was commissioned as Environmental Consultants to undertake a targeted black cockatoo survey of the 221.69 ha survey area within Lots 51, 1008 and 1118 Boyup Brook-Arthur Road, Boyup Brook to ascertain the environmental constraints that may be present to assist with subdivision planning.

The scope of works included:

- Complete a desktop assessment of publicly available databases (including DBCA black cockatoo data) pertaining to the site;
- Undertake a targeted black cockatoo survey across the survey area, field GPS significant black cockatoo trees and individuals (if sighted);
- The targeted black cockatoo survey will include a list of the black cockatoo foraging species identified within the survey area. A foraging habitat quality score will be allocated;
- Prepare IBSA data package as per EPA guidelines, and provide to client at completion of survey (as required to be submitted via the IBSA website by the client); and
- Preparation of a targeted black cockatoo survey report, which will be aligned with the appropriate government agency legislation and guidelines.

The field survey was undertaken by Dr Karlene Bain (Wildlife Ecologist), Charlize van der Mescht (Ecologist), Mikayla Hollyock (Environmental Consultant) and Marisa Wearing (Technical Assistant) on the 6th to the 9th June, and 13th of June 2023.

1.1. Location and Existing Land Use

The "survey area" is defined as the approximately 221.69 ha area contained within Lots 51, 1007 and 1118 Boyup Brook-Arthur Road, located approximately 2 km from the locality of Boyup Brook. The survey area currently exists as parkland-cleared agricultural land, and forms the building envelopes of the proposed subdivision. The "study area" consists of the 40 km radius around the survey area, used for indications of likelihood of occurrence of black cockatoo breeding and roosting habitat. It provides a broader local context and assessment of the survey area.

1.2. Alignment to Legislation, Guidelines and Policies

This survey and subsequent report are aligned to the following legislation, guidelines and policies:

- *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). Administered by the Australian Government of Department of Agriculture, Water and Environment (DAWE);
- *Biodiversity Conservation Act 2016* (BC Act). Administered by the Western Australian Department of Biodiversity, Conservation and Attractions (DBCA);
- *Environmental Protection Act 1986* (EP Act). Administered by the Western Australian Department of Water and Environmental Regulations;
- EPA (2020) Technical Guidance – Terrestrial Vertebrate Fauna Surveys for Environmental Impact;
- DEWHA (2010) Survey Guidelines for Australia's Threatened Birds; and
- DAWE (2022) Referral guideline for 3 WA Threatened black cockatoo species.



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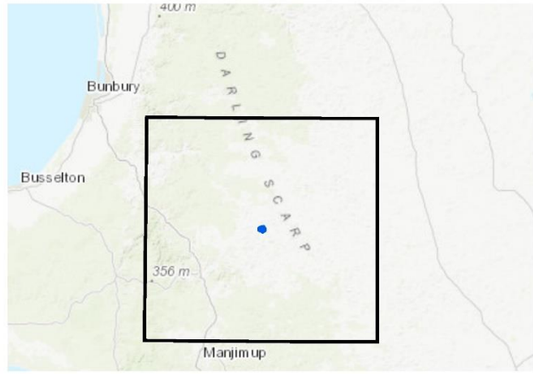

Overview Map Scale 1:3,000,000

Legend

- Survey Area
- 40 km Study Area

Scale
1:320,000@ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

CLIENT
Edge Planning & Property
Lots 51, 1007 & 1118 Boyup Brook - Arthur Road
Boyup Brook, WA, 6244

Figure 1: Survey Area Locality

	QA Check	*Drawn by*
	CvdM	**KMG**
STATUS	*FILE*	*DATE*
FINAL	**EPP008-002**	**12/06/2023**

1.3. Geology and soils

Database searches shows the survey area lies within the Boyup Brook Valleys System (253Bv). The Boyup Brook Valleys System is described as *"Valleys, in the south of the Eastern Darling Range (Blackwood Catchment). Gravel, sandy duplex loamy duplex. Jarrah-marri-wandoo forest and woodland."* (DPIRD, 2022a).

The Eastern Darling Range Zone is described as "*Moderately to strongly dissected lateritic plateau on granite with eastward-flowing streams in broad shallow valleys, some surficial Eocene sediments. Soils are formed in laterite colluvium or weathered in-situ granite."* (DPIRD, 2022b). The soil type within the application area is mapped as the Newlgalup moderate slopes Phase (253BvNW4), Dalmore subsystem (Boyup Brook; 253BvDM), Condinup subsystem (253BvCp) and Newlgalup granitic slopes Phase (253BvNWg). The Newlgalup moderate slopes Phase is described as "*Deeply incised valleys. Relief 60-100 m, slopes 15-35%. Soil parent material is gneiss and granite. Soils are deep loamy duplex soils, and yellow loamy earths with some shallow loamy duplex soils*", the Dalmore subsystem (Boyup Brook) is described as "*Undulating ridges and hill crests on laterite and granite. Relief 5-20 m, slopes 5-15%. Soils are gravels, loamy duplex and sandy duplex soils*", the Condinup subsystem is described as "*River channel, flood plain and raised alluvial terraces, soils are brown deep sands*", and the Newlgalup granitic slopes Phase is described as "*Relief 30-50 m, slopes 5-20%. Soil parent material is granite and gneiss. Soils are deep loamy duplex soils, deep sandy duplex soils, loamy and sandy gravels, with some loamy earths and shallow loamy duplex soils*" (DPIRD, 2022c).

1.4. Climate

The closest open Bureau of Meteorology (BoM) site with temperature records to 2023 is Manjimup (009573; BoM, 2023a), and the closest site with recent rainfall records is Newbicup (009587; BoM, 2023b). The average annual temperature in Newbicup ranges from 9.7 – 20.5°C. The average summer temperature ranges between 11.7-30.7°C, whilst average winter temperatures range between 3.9 – 17.9°C. The annual mean rainfall for Newbicup is 608.2 mm (BoM, 2023b). On average the months of May to August are the months with the highest rainfall (Figure 2). There was higher than average rainfall recorded in the months of August and November 2022, and March and April 2023 (Figure 2). The total rainfall in the year prior to the survey (June 2022 – May 2023) was 486.2 mm, which is 122 mm below average and equates to 20.1% decrease in average annual rainfall.

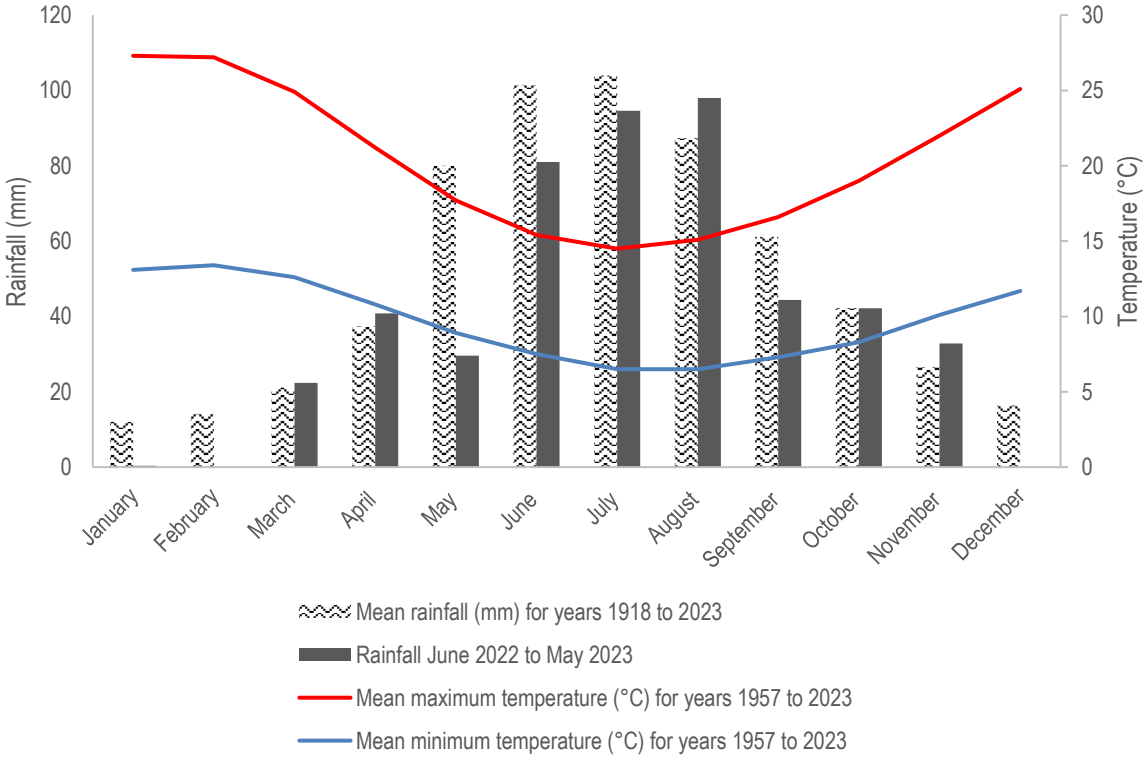

Figure 2: Temperature data for Manjimup (Station No. 009573) and rainfall data for Newbicup (Station No. 009587).

1.5. Habitat Connectivity

Habitat connectivity assessments rely on a bioregional and landscape-scale approach to evaluate habitat for fauna movement and ecological linkage across a region. Habitat connectivity is largely reliant on remnant vegetation, recognising it plays a very important role in developing corridors between protected areas to assist in achieving long-term biodiversity management outcomes (Wilkins et al. 2006). The survey area lies within a highly modified landscape consisting of agricultural properties, riparian vegetation corridors, and regional town centres. The Blackwood River riparian corridor meanders adjacent to the survey area, providing an almost continuous strand of habitat connection between Quelarup and Augusta. The Boyup Brook Dam reserve is situated approximately 3.2 km to the south-east. The Wilga State Forest is located approximately 9.8 km to the west of the survey area, and the Nollajup Nature Reserve is approximately 9.01 km to the south-west. The Greater Kingston National Park is approximately 21.2 km south of the survey area. There are other small to large areas of remnant bushland located to the north, south, east, and west of the survey area. The survey area is ultimately linked to these surrounding areas of vegetation through the existing road reserves, riparian vegetation corridors, and vegetation within private property.

1.6. Water and Wetlands

The survey area does not lie within any Public Drinking Water Source areas, with the closest being the Boyup Brook Dam area approximately 3.2 km to the south-east (DWER, 2022). The Blackwood River is located directly adjacent to the survey area, meandering close to the southern and eastern boundaries. The survey area lies within the Eastern Darling Range (HZ13-EDR) Hydrological Zone (DPIRD, 2022d). The Eastern Darling Range zone is described as "*Moderately to strongly dissected lateritic plateau on granite with eastward-flowing streams in broad shallow valleys, some surficial Eocene sediments. Soils are formed in laterite colluvium or weathered in-situ granite.*" (DPIRD, 2022d). The survey area lies within the Blackwood River Hydrographic Catchment (DWER, 2018a) and within the Hardy River Hydrographic Subcatchment (DWER, 2018b).

No RAMSAR wetlands, or significant wetlands are located within or near the survey area (DBCA, 2017).

There are multiple standing water bodies present within the survey area, namely eight dams. Additionally, there was an ephemeral creek/drainage channel present in the south-western portion of the survey area, draining into the Blackwood River.

1.7. Environmentally Sensitive Areas

The survey area does not contain any Environmentally Sensitive Areas (ESA), the nearest site lying approximately 3 km to the south-west within Shire Reserve 16199 (DWER, 2021).

1.8. Remnant Vegetation

The survey area lies within the Jarrah Forest Bioregion and Southern Jarrah Forest (JF2) subregion. Hearn *et al* (2002) describes the Southern Jarrah Forest subregion as "*duricrusted plateau of Yilgarn Craton characterised by Jarrah-Marri forest on laterite gravels and, in the eastern part, by Wandoo - Marri woodlands on clayey soils. Eluvial and alluvial deposits support Agonis shrublands. In areas of Mesozoic sediments, Jarrah forests occur in a mosaic with a variety of species-rich shrublands. The climate is Warm Mediterranean.*"

The vegetation has been mapped on a broad scale by J.S. Beard (Shepherd et al. 2002) in the 1970's, where a system was devised for state-wide mapping and vegetation classification based on geographic, geological, soil, climate structure, life form and vegetation characteristics (Sandiford and Barrett, 2010). Vegetation units were regarded as associations and were grouped into Vegetation Systems representing a particular pattern of association distribution within a given area. A GIS search of J.S. Beard's (Beard *et al.* 2013) vegetation classification places the survey area within two Vegetation Associations (DPIRD, 2019).

- **System Association Name**: Bridgetown.
- **Vegetation Association Number:** 3.
- **Structure Description:** Medium forest.
- **Floristic Description:** Forest with jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*).
- **Remnant Vegetation by Beard Association Rarity in LGA:** 58.48% remaining (GoWA, 2019).
- **Remnant Vegetation by Beard Association Rarity in IBRA Region:** 67.10% remaining (GoWA, 2019).

- **System Association Name**: Bridgetown.
- **Vegetation Association Number:** 992.
- **Structure Description:** Medium forest.
- **Floristic Description:** Forest with jarrah (*Eucalyptus marginata*) and wandoo (*Eucalyptus wandoo*).
- **Remnant Vegetation by Beard Association Rarity in LGA:** 22.42% remaining (GoWA, 2019).
- **Remnant Vegetation by Beard Association Rarity in IBRA Region:** 22.92% remaining (GoWA, 2019).

The Bridgetown 992 vegetation system association has less than 30% remaining within the Jarrah Forest IBRA bioregion and within the Shire of Boyup Brook, and therefore is considered to be 'extensively cleared'.

Mattiske and Havel (1998), as part of the biodiversity assessment for the comprehensive regional assessment for the south west forest region, mapped the area as containing three vegetation complexes present (data retrieved from DBCA_047).

- **Vegetation Complex:** Dalmore 1.
  Vegetation Description: Woodland of *Corymbia calophylla-Eucalyptus marginata* subsp. *marginata* with occasional *Eucalyptus wandoo* on uplands in the subhumid zone.
- **Vegetation Complex:** Newgalup 1 (NW1).
- **Vegetation Description:** Woodland of *Corymbia calophylla* and *Eucalyptus marginata* subsp. *marginata* with some *Eucalyptus wandoo* on upper slopes in the subhumid zone.
- **Vegetation Complex:** Newgalup 1 (NWg1).
- **Vegetation Description:** Woodland of *Corymbia calophylla-Eucalyptus marginata* subsp. *marginata* on slopes, open heath on shallow soils near granites, open forest of *Eucalyptus rudis-Eucalyptus wandoo* on the valley floors in the subhumid zone.
- **Vegetation Complex:** Condinup 1 (CP1).
- **Vegetation Description:** Low forest of *Eucalyptus rudis-Melaleuca rhaphiophylla* on valley floors and some *Corymbia calophylla* on valley slopes in the subhumid zone.

1.9. Heritage

The survey is located within the Kaniyang Nyungar nation (AIATSIS, 2023). One registered heritage site, the Blackwood River (Place ID 20434) is located within the site and is valued for its mythological and cultural heritage (DPLH, 2023). It is recognised that there has been a large scale of loss of cultural knowledge and information, and the survey area may contain additional heritage values that are not recognised through DPLH (2023). It is recommended that further due diligence be undertaken in accordance with the *Aboriginal Cultural Heritage Act 2021* (ACH Act) and guidelines.

2. Methodology – Desktop Assessment

A desktop inventory of known occurrence records, black cockatoo breeding sites, black cockatoo roosting sites, and black cockatoo foraging habitats known to occur within 40 km of the survey area was undertaken using the following data and databases:

- Black Cockatoo DBCA database records (DBCA, 2023);
- Distribution maps for Black Cockatoos within the Referral Guidelines for Three Threatened Black Cockatoo Species DAWE (2022);
- Carnaby's Cockatoo Confirmed (DBCA_050; DBCA, 2018a) and Unconfirmed Roost Sites (DBCA_051; DBCA, 2018b);
- Carnaby's Cockatoo Confirmed (DBCA_52; DBCA, 2018c) and Unconfirmed Roost Sites Buffered 6km (DBCA-053; DBCA, 2018d);
- Carnaby's Cockatoo Confirmed Breeding Areas within the Swan Coastal Plain and Jarrah Forest IBRA Regions (DBCA_054; DBCA, 2018e);
- Carnaby's Cockatoo Unconfirmed Breeding Areas within the Swan Coastal Plain and Jarrah Forest IBRA Regions (DBCA-055; DBCA, 2018f);
- Black Cockatoo Breeding Sites - Buffered DBCA_063 (DBCA, 2019a);
- Black Cockatoo Roosting Sites – Buffered DBCA_064 (DBCA, 2019b);
- Carnaby's Cockatoo Areas requiring investigation as feeding habitat in the Jarrah Forest IBRA Region DBCA_056 (DBCA, 2018g); and
- Carnaby's Cockatoo Areas requiring investigation as feeding habitat in the Swan Coastal Plain (SCP) IBRA Region DBCA_057 (DBCA, 2018h).

3. Methodology – Field Survey

Field survey work was carried out by Dr. Karlene Bain (Wildlife Ecologist), Charlize van der Mescht (Ecologist), Marisa Wearing (Technical Assistant) and Mikayla Hollyock (Environmental Consultant) from the 6th-13th June 2023.

The scope of this targeted black cockatoo survey was to assess whether the vegetation present in the survey area provides suitable foraging, roosting and/or breeding habitat for the conservation significant Carnaby's Cockatoo (*Calyptorhynchus latirostris,* Endangered), Baudin's Cockatoo (*Calyptorhynchus baudinii,* Endangered) and Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso.* Vulnerable).

Surveys were carried out on foot using traverses and targeted survey techniques consistent with the following documents developed by the EPA and Department of Agriculture, Water and the Environment (DAWE) formerly the Department of Sustainability, Water, Population, and Communities (DSEWPaC) and Department of the Environment, Water, Heritage and the Arts (DEWHA):

- EPA (2020) Technical Guidance – Terrestrial vertebrate fauna surveys for environmental impact assessment;
- DEWHA (2010) Survey guidelines for Australia's Threatened birds; and
- DAWE (2022) Referral guideline for 3 WA Threatened black cockatoo species.

The conclusions presented are based upon field data collected over a limited period of time and are indicative of the environmental condition of the site at the time, as well as persistent evidence such as foraging debris which can persist onsite for multiple years, and presence of hollows.

Surveys for cockatoos and their habitat were based on a targeted systematic assessment of hollow-bearing trees, foraging habitat, feeding activity, and roosting sites.

3.1. Surveys for Nesting Hollows

The aim of the black cockatoo habitat assessment was to identify all potential breeding trees (refer to Table 1) with a diameter, measured at 1.3 metres from the base of the tree (DBH), of 300 millimetres or greater. These trees are hereafter referred to as significant trees. Significant trees that contained one or more hollows of potential suitability for breeding by Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-Tailed Black Cockatoo are hereafter referred to as 'suitable nesting trees'.

Where present, significant trees were GPS located (~2.4 m accuracy), and their diameter was measured 1.3 m above ground using a diameter tape, photographed, and the presence or absence of potential nesting hollows determined. Where present, hollows were photographed, the entrance type (chimney, side or elbow) and dimensions of the hollow were recorded and hollows were assessed for signs of use by cockatoos, based on evidence such as chewing around the hollow entrance, and activity at the base of the tree, e.g., feathers, faecal material, and feeding debris.

Long term studies on Carnaby's Black Cockatoos have shown that they utilise tree hollows ranging from 100 mm–650 mm (average 260 mm) in diameter (Saunders *et al.* 2014a, 2014b), whilst Forest Red-tailed Black Cockatoos utilise hollows with diameters ranging from 100 mm x 120 mm to 440 mm x 1500 mm (mean 280 mm x 300 mm; Johnstone and Storr, 1998; Johnstone et al. 2013). There is little published about dimensions of hollows utilised by Baudin's Black Cockatoo; however, it is expected they would be similar to those utilised by Carnaby's. In all instances, these species also require a hollow with significant depth. Based on the published information, hollows with an entrance diameter larger than 100 mm x 100 mm that occurred in branches or trunks with the capacity for deep hollows were recorded as potential cockatoo hollows. Smaller hollows with the potential to develop into suitable nesting hollows were also recorded.

3.2. Surveys for Foraging Habitat and Feeding Activity

The EPBC Guidelines for Black Cockatoos (DAWE, 2022) outline general criteria for identifying foraging habitat for black cockatoos (Table 1) and include criteria for assessing quality. This has been used to assess foraging habitat quality. Trees that were not known foraging species were not considered to be foraging habitat.

Assessment of foraging habitat was based on published foraging preferences for the three target species. Carnaby's Cockatoo is known to prefer Kwongkan heathland, shrublands and woodlands dominated by Proteaceous species as foraging habitat, but will feed on individual Eucalypts and small stands of Eucalypt woodland or forest (Table 1). Forest Red-tailed Black

Cockatoos feed mostly on seeds of marri and jarrah and other Eucalypts within their range (Table 1). Baudin's Cockatoo prefers to feed on marri seeds and seeds of native Proteaceae species including banksias and hakeas (Table 1). The presence of foraging habitat was mapped in the field, and individual locations where feeding activity was encountered, were GPS recorded.

3.3. Surveys for Roosting Habitat and Activity

In this survey, the presence of cockatoo feathers and faecal material were used as indicators of roosting activity, with tall trees of any species within close proximity to water being assessed as a potential roosting tree. The presence of roosting habitat, if present was mapped in the field, and individual locations where roosting activity was encountered, were GPS recorded.

Table 1: Habitats used by Threatened Black Cockatoos (DAWE, 2022).

Habitat	Baudin's	Carnaby's	Forest Red-tailed
Breeding	Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly karri *(Eucalyptus diversicolor)*, marri, jarrah, wandoo, bullich *(E. megacarpa)* and Tuart.	Generally in woodland or forest, but also breeds in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly salmon gum, wandoo, tuart, jarrah, flooded gum *(E. rudis)*, York gum, powderbark *(E. accedens)*, karri and marri.	Generally in woodland or forest, but may also breed in partially cleared woodland or forest, including isolated trees. Nest in hollows in live or dead trees (many eucalypt species may provide suitable hollows), particularly marri, karri, wandoo, bullich, blackbutt *(E. patens)*, tuart and jarrah.
Night Roosting	Generally in or near riparian environments or other permanent water sources. Any tall trees may provide roosting habitat, but particularly jarrah, flooded gum, blackbutt, tuart and introduced eucalypts (blue gum (*E. globulus*), lemon scented gum (*Corymbia citriodora*).	Generally in or near riparian environments or natural and artificial permanent water sources. Any tall trees may provide roosting habitat, but particularly flat-topped yate (*E. occidentalis*), salmon gum, wandoo, marri, karri, blackbutt, tuart, introduced eucalypts and introduced pines.	Any tall trees may provide roosting habitat, but particularly tall jarrah, marri, blackbutt, tuart and introduced eucalypt trees or large trees on the edges of forests.

Table 1 continued.

Habitat	Baudin's	Carnaby's	Forest Red-tailed
Foraging and common food items	Primarily seeds of marri, rarely jarrah, in woodlands and forest, and seeds of native proteaceous plant species (for example, *Banksia* spp. (includes *Dryandra* spp.) and *Hakea* spp.). During the breeding season feed primarily on native vegetation, particularly marri (seeds, flowers, nectar and grubs). Also insects and insect larvae; pith of kangaroo paw (*Anigozanthos flavidus*); tips of *Pinus* spp.; *Macadamia* spp., almonds and pecans; seeds of apples and pears; and persimmons.	Native shrubland, kwongan heathland and woodland on seeds, flowers and nectar of native proteaceous plant species (*Banksia* spp., *Hakea* spp. and *Grevillea* spp.), as well as *Callistemon* spp. and marri. Also seeds of introduced species including *Pinus* spp., *Erodium* spp., wild radish, canola, almonds, macadamia and pecan nuts; insects and insect larvae; occasionally apples and persimmons; and liquidambar.	Primarily seeds of Jarrah and Marri in woodlands and forest, and edges of Karri forests, including wandoo and blackbutt. Forages on *Allocasuarina* cones, fruits of Snottygobble (*Persoonia longifolia*) and mountain marri (*C. haematoxylon*). Other less important foods include blackbutt, bullich, *Allocasuarina fraseriana*, *Hakea* spp., tuart, redheart moit (*E. decipiens*) and bushy yate (*E. lehmanni*). Also some introduced eucalypts such as river red gum (*E. camaldulensis*) and rose gum (*E. grandis*). On the Swan Coastal Plain, often feeds on introduced cape lilac (*Melia azedarach*), *E. caesia, E. erythrocorys,* lemon-scented gum and kaffir plum (*Harpephyllum caffrum*).

3.4. Fauna Survey Limitations and Constraints

An assessment of potential survey limitations was undertaken as per the EPA (2020) document *Technical Guidance Fauna Surveys for Environmental Impact Assessment.* Refer to Table 2 below.

Table 2: Fauna survey limitations and constraints.

Limitation	Constraint	Comment
Scope	Nil	The scope was a targeted black cockatoo survey to identify breeding, roosting or foraging habitat for black cockatoos.
Disturbances that may affect results	Nil	No recent disturbances which may affect results of the survey were identified. Historical and ongoing disturbances from agricultural activities may impact the presence of cockatoos within the survey area. However, given these disturbances are long-term and continuous, they are unlikely to have resulted in a significant limitation on detection probability or species occurrence during the survey period.
Intensity of survey	Nil	The targeted components of the survey were deemed appropriate given the scope was to identify breeding, roosting or foraging habitat for black cockatoos.
Sources of information (recent or historic) and availability of contextual information	Nil	DBCA data were acquired (not publicly available) to provide a more detailed understanding of potential cockatoo habitat within the survey area.
Remoteness or access issues	Nil	No access restrictions were encountered.

Table 2 continued.

Limitation	Constraint	Comment
Species detection probability (e.g., as a result of seasonal activity and fauna movement patterns)	Minor	Cockatoo breeding periods affect the ability of surveys to detect breeding individuals, however assessment of activity around potentially suitable hollows and protection of all potentially suitable hollows negates this limitation. Cockatoos also use a range of areas for foraging and roosting. The use of activity indicators that persist in the environment such as feeding debris (nuts) and faecal material negate this limitation and enable determination of the regularity and consistency with which an area is visited.
Survey limitations	Minor	Identifying hollows from the ground has limitations, as the full characteristics of a hollow are not evident (e.g., internal dimensions such as depth). The entrance dimensions and size of the branch / trunk into which the hollow was forming were used as indicators of the potential internal dimensions. The relative visibility of the canopy can also be limiting in identifying potential hollows, particularly where hollows are upward facing or obscured by foliage.
Experience of personnel	Nil	Dr Karlene Bain has 26 years of fauna survey experience through roles in biodiversity survey, research and management working with State Government, State Natural Resource Management groups, Regional NRM groups, Research Institutions, and Private Industry. Charlize van der Mescht has 3 years of cockatoo survey experience through her role at Bio Diverse Solutions and has been mentored by Dr Karlene Bain (Wildlife Ecologist) during this time.

4. Results – Desktop Assessment

Carnaby's Cockatoo has a wide-spread distribution across Western Australia, which extends from Kalbarri and Geraldton in the northwest of the state, inland to Morawa, Dowerin and Merredin and to the east of Esperance (DSEWPaC, 2012; DAWE, 2022). Carnaby's Cockatoo breed within the inland woodland parts of its distribution, in areas with 300-750 mm annual average rainfall (DPaW, 2013). This breeding range has expanded in recent years to extend further south into Jarrah-Marri forests and the coastal tuart forests south of Perth (Johnstone and Storr 1998; Johnstone *et al.* 2011). The survey area lies within the known breeding range of the Carnaby's Cockatoo (DAWE, 2022).

Baudin's Cockatoo is most commonly found in forested areas but is also found in the open agricultural areas within the southwest (DEC, 2008). The known distribution area for Baudin's Cockatoo, extends from Bullsbrook/Gideganup south to Kojonup and Albany, and inland to the Stirling Ranges (DEC, 2008; DAWE, 2022). The survey area falls within the predicted breeding range for this species (DAWE, 2022). The breeding ecology for this species is not well known outside of the southwest forests where it is known to breed within the Jarrah, Marri and Karri Forest (Refer to Table 1) of the far southwest of WA.

Forest Red-tailed Black Cockatoo occur within the south-west humid and sub-humid zones of Western Australia, in the dense Jarrah, Karri and Marri forests that receive more than an average of 600 mm annual rainfall (DEC, 2008). Their distribution extends from Perth, east to Wundowie and south through to Narrogin, Kojonup, Cranbrook and Albany (DAWE, 2022). The survey area is located within the known distribution for this species, and the Forest Red-tailed Black Cockatoo is mapped as likely to occur (DAWE, 2022). Forest Red-tailed Black Cockatoo are known to breed in Marri, Jarrah, Blackbutt, Bullich and Wandoo within the south-west humid and subhumid zones of Western Australia (DEC, 2008; DAWE, 2022). Based on this information, breeding habitat is likely to be present within the survey area. (DAWE, 2022).

There are no confirmed Black Cockatoo breeding sites within a 10 km range of the survey area, with the closest being two records located approximately 32.1 km north of the survey area (DBCA, 2018e; 2019a). There are two Black Cockatoo roost sites within 5 km of the survey area, and an additional 18 known roost sites and two known breeding sites within the 40 km study area (DBCA, 2019a; b; 2023).



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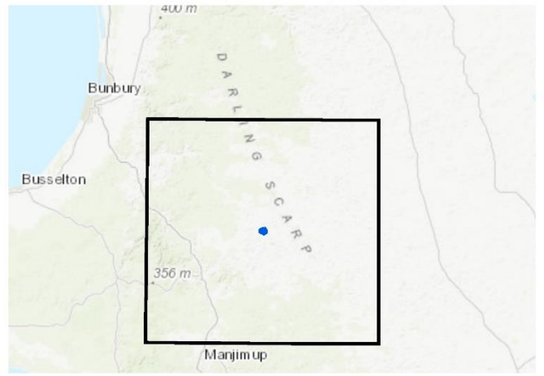

Overview Map Scale 1:3,000,000

Legend

- Survey Area
- 40 km Study Area
- Black Cockatoo Breeding Sites
- Black Cockatoo Roost Sites
- BlackCockatoo Breeding Sites (Buffered)
- Black Cockatoo Roosting Sites (Buffered)
- Carnabys Cockatoo Confirmed Breeding Sites (SouthWest)
- Carnabys Cockatoo Confirmed Roost Sites (Buffered 6km)
- Carnabys Cockatoo Confirmed Roost Sites

Scale
1:320,000@ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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Figure 3: Desktop Black Cockatoo Data

	QA Check	*Drawn by*
	CvdM	**KMG**
STATUS **FINAL**	*FILE* **EPP008-002**	*DATE* **12/06/2023**

5. Field Survey Results

5.1. Breeding Habitat

A total of 1354 significant trees were identified within the survey area, 154 of which contained hollows and 328 of which contained hollows forming (Refer to Table 6). None of the hollows identified during the survey period have any evidence of recent use by cockatoos. Seventy-eight of the hollow-bearing trees are not suitable for breeding/nesting by any of the three black cockatoo species as they are all currently too small (less than 100 mm x 100 mm opening and minimal internal depth), and do not have the capacity to develop the required dimensions. Seventy-nine of the hollow-bearing trees contain hollows with entrance dimensions greater than 100 mm x 100 mm and the potential to meet internal hollow dimensions. These trees are considered suitable nesting trees. Refer to Figures 5, 6 and 7 for tree locations and Tables 6 and 7 Appendix B for details of all trees and images of trees with hollows.

The survey area lies within the known predicted/modelled breeding range for Carnaby's Cockatoo, Baudin's Cockatoo and Forest Red-tailed Black Cockatoo (DAWE, 2022). The survey area contains breeding/nesting habitat for all three cockatoo species in the form of suitably sized nesting hollows and there is potential for the development of future nesting hollows within additional significant trees that do not currently contain hollows. The proximity of the site to the Blackwood River increases the value of the survey area from a feeding, roosting, and breeding perspective. Any loss of, or impact on known, suitable or potential nesting trees, and the habitat around these trees, may require a referral to the Minister. Ideally, measures should be identified to protect suitable and future potential nesting trees.

5.2. Foraging and Roosting Habitat

Two individuals of Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) were observed flying over the survey area, and landing within the riparian vegetation of the Blackwood River, to the west of the survey area.

Cockatoo feeding debris was observed under a large proportion of the marri trees present within the survey area. Evidence of foraging by Forest Red-tailed Cockatoo was most abundant and widespread, but Baudin's and Carnaby's Cockatoo feeding debris was also detected in smaller amounts (Figures 4 and 8). Evidence of both old and recent feeding debris from Forest Red-tailed Black Cockatoo suggests sustained use of the area for foraging by this species. Cockatoo feeding activity was most abundant and consistent in areas proximate to the riparian system. There was however, evidence of foraging by Forest Red-tailed Black Cockatoo throughout the survey area, associated with the marri trees. The wandoo and jarrah trees are also important food resources for Forest Red-tail Black Cockatoo. The evidence of feeding on these species is less able to be identified as cockatoo, due to the smaller size of the nuts. An area of pines in the north western corner of the survey area is a potentially important food resource for Carnaby's and Baudin's Cockatoo

The DAWE (2022) Foraging quality scoring tool template is only applicable to sites that are equal to or larger than 1 ha in size. The available foraging habitat for all three black cockatoo species is greater than 1 ha and therefore can be applied. The available black cockatoo habitat under the DAWE (2022) scoring system results in an overall score of 8, which is considered to be "High Quality" as per the DAWE Guidelines (Table 5 in Appendix A).

Significant signs of foraging were observed in proximity to marri trees. Overall, the food sources available to the three black cockatoo species includes seed from mature marri, jarrah, wandoo and yate within the survey area, and the pine trees on the northern boundary of the survey area.

There was no evidence of black cockatoos roosting within the survey area, as assessed through the presence of accumulated feathers and faecal material. All trees present provide potentially suitable roosting habitat, particularly given the proximity of the site to permanent water, associated with the Blackwood River and multiple nearby dams. No detailed assessment of vegetation outside of the survey area was undertaken, however the immediate surrounding areas contain less disturbed habitat, with similar tree heights along the vegetated river and roadsides, where there is a mixture of marri, wandoo, jarrah, and yate present. The riparian areas are more likely to be used for roosting habitat. The potential roosting and foraging habitat for each black cockatoo species is broken down in Tables 3 and 4.

Occurrences of bridal creeper (*Asparagus asparagoides*) were opportunistically recorded across the survey area (Figure 11). Bridal creeper may negatively affect the long-term quality of the habitat resources for cockatoos, if not managed.

Table 3: Potential black cockatoo habitat present within the survey area.

Habitat	Foraging and Roosting Habitat			Roosting Habitat			Area(ha)	Percentage (%) of all mapped Cockatoo Habitat
	CC	BC	FRT	CC	BC	FRT		
Corymbia calophylla	✓	✓	✓	✓	✓	✓	5.96	30.08
Eucalyptus marginata			✓	✓	✓	✓	0.65	3.28
Eucalyptus occidentalis				✓	✓	✓	0.79	3.99
Eucalyptus rudis				✓	✓	✓	6.03	30.44
Eucalyptus wandoo			✓	✓	✓	✓	1.17	5.91
Marri, flooded gum	✓	✓	✓	✓	✓	✓	0.83	4.19
Marri, jarrah	✓	✓	✓	✓	✓	✓	1.10	5.55
Marri, jarrah, flooded gum	✓	✓	✓	✓	✓	✓	0.24	1.21
Marri, jarrah, wandoo	✓	✓	✓	✓	✓	✓	1.35	6.81
Wandoo, jarrah			✓	✓	✓	✓	0.55	2.78
Wandoo, marri	✓	✓	✓	✓	✓	✓	0.96	4.85
Wandoo, yate, jarrah			✓	✓	✓	✓	0.10	0.50
Pinus sp.	✓	✓		✓	✓		0.08	0.41
						Total	19.81	100

Note: CC: Carnaby's Cockatoo; BC: Baudin's Cockatoo; FRT: Forest Red-Tailed

Table 4: Area of foraging and roosting habitat available for the three species of black cockatoo.

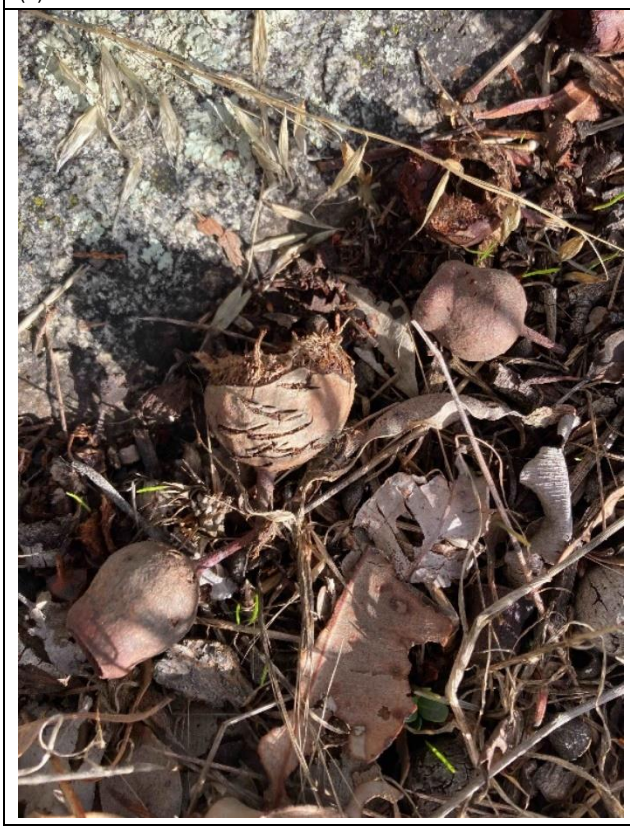
Habitat	Carnaby's Cockatoo	Baudin's Cockatoo	Forest Red-Tailed
Foraging and Roosting Habitat	10.51 ha	10.51 ha	12.91 ha
Roosting Habitat	19.81 ha	19.81 ha	19.81 ha



(a)



(b)



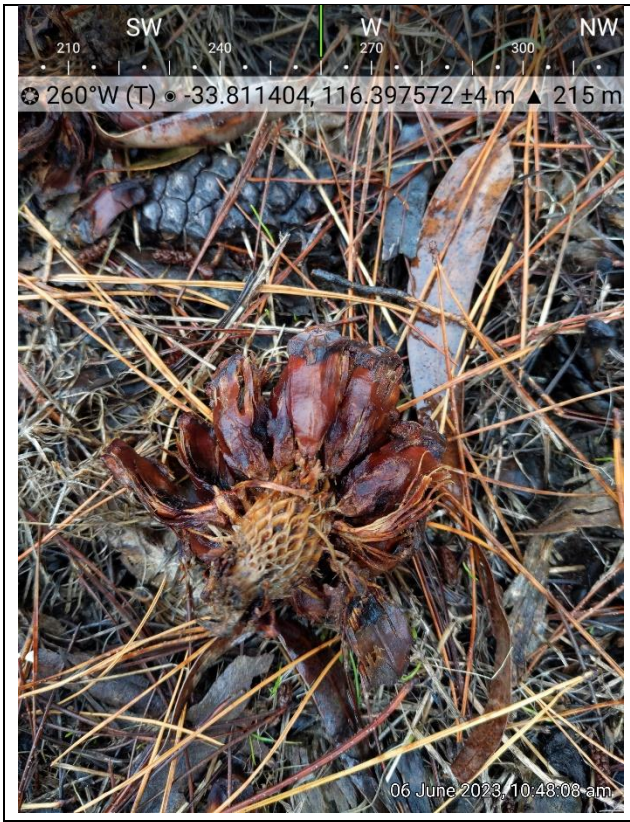
(c)



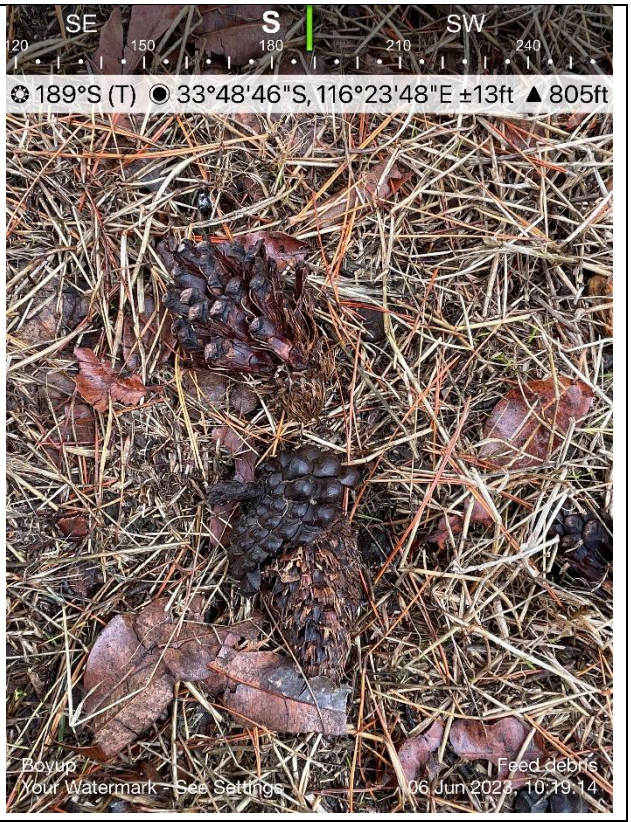
(d)

Figure 4: Evidence of cockatoo foraging.

(a) Baudin's Cockatoo feeding; (b) Carnaby's Cockatoo feeding; (c) Forest Red-tailed Cockatoo feeding; (d) significant feeding debris; (e) and (f) cockatoo feeding on pine cones from pine trees located outside of the survey area; (g) significant Forest Red-tailed Cockatoo feeding; (h) significant feeding debris.



(e)



(f)

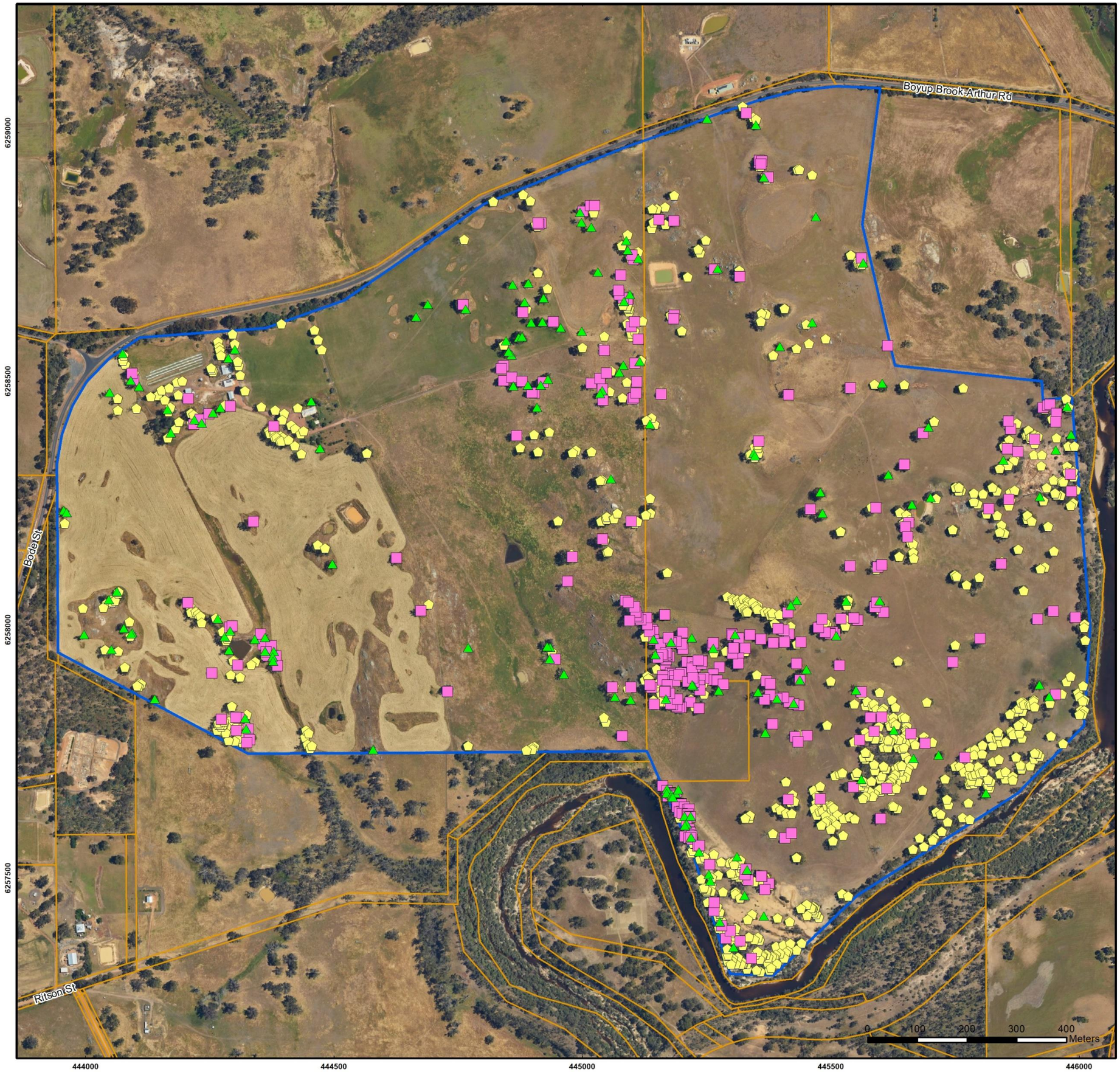


(g)



(h)

Figure 4 continued.



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Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre

Significant Trees (>300 mm DBH)

- Suitable
- Potential (hollows forming)
- Potential (no hollows)

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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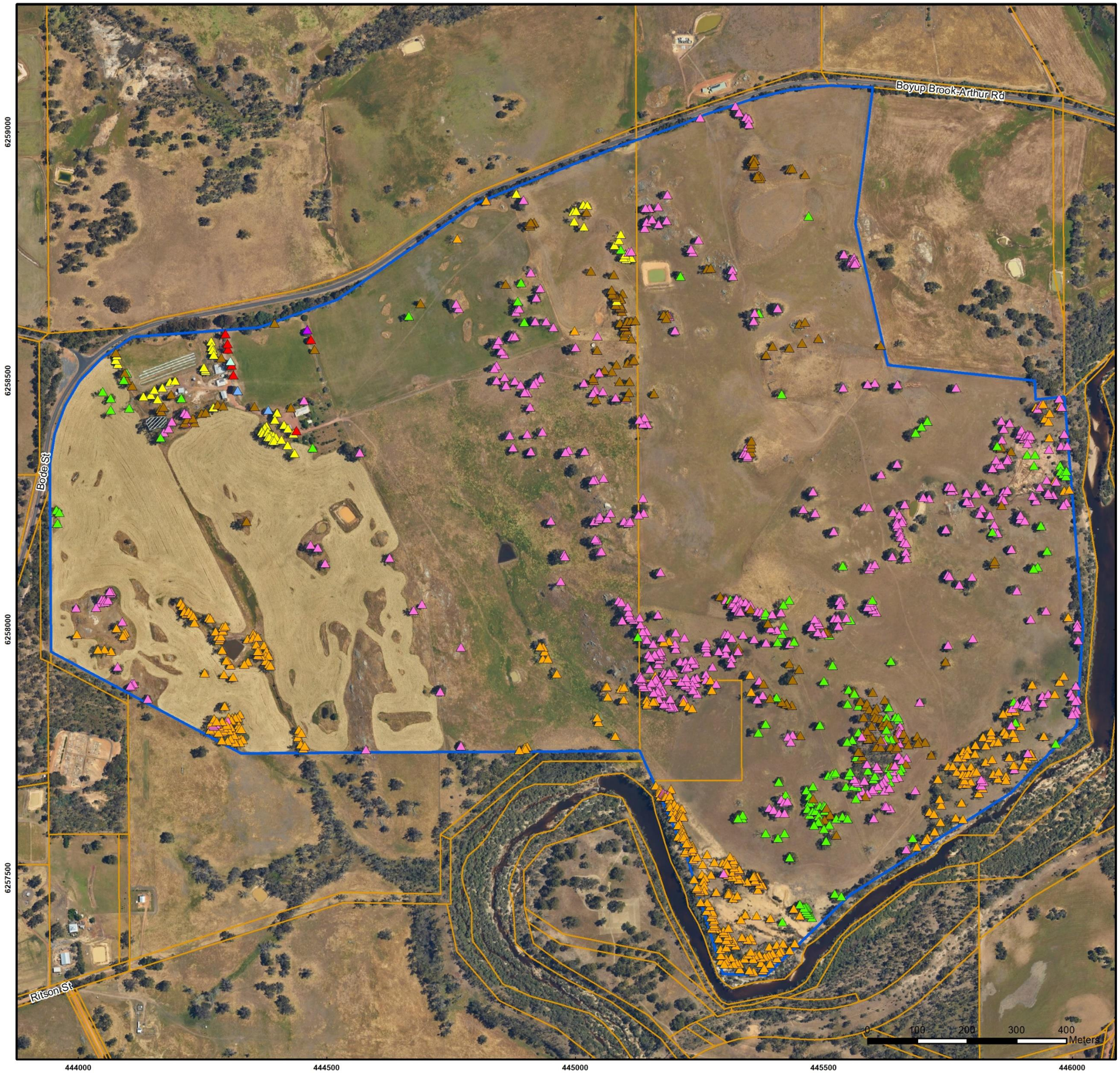
Figure 5: Significant Trees

	QA Check	*Drawn by*
	KK	**CvdM**
STATUS **FINAL**	*FILE* **EPP008**	*DATE* **03/07/2023**



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Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre

Tree Species

- *Corymbia calophylla* (marri)
- *Corymbia ficifolia* (red-flowering gum)
- *Eucalyptus botryoides* (southern mahogany)
- *Eucalyptus globulus* (blue gum)
- *Eucalyptus marginata* (jarrah)
- *Eucalyptus occidentalis* (flat-topped yate)
- *Eucalyptus rudis* (flooded gum)
- *Eucalyptus* sp.
- *Eucalyptus wandoo* (wandoo)
- *Pinus* sp. (pine)

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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Figure 6: Significant Tree Species

	QA Check **KK**	*Drawn by* **CvdM**
STATUS **FINAL**	*FILE* **EPP008**	*DATE* **25/07/2023**



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Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre

Cockatoo Hollows Suitable for Cockatoos

- *Corymbia calophylla*
- *Eucalyptus marginata*
- *Eucalyptus occidentalis*
- *Eucalyptus rudis*
- *Eucalyptus wandoo*

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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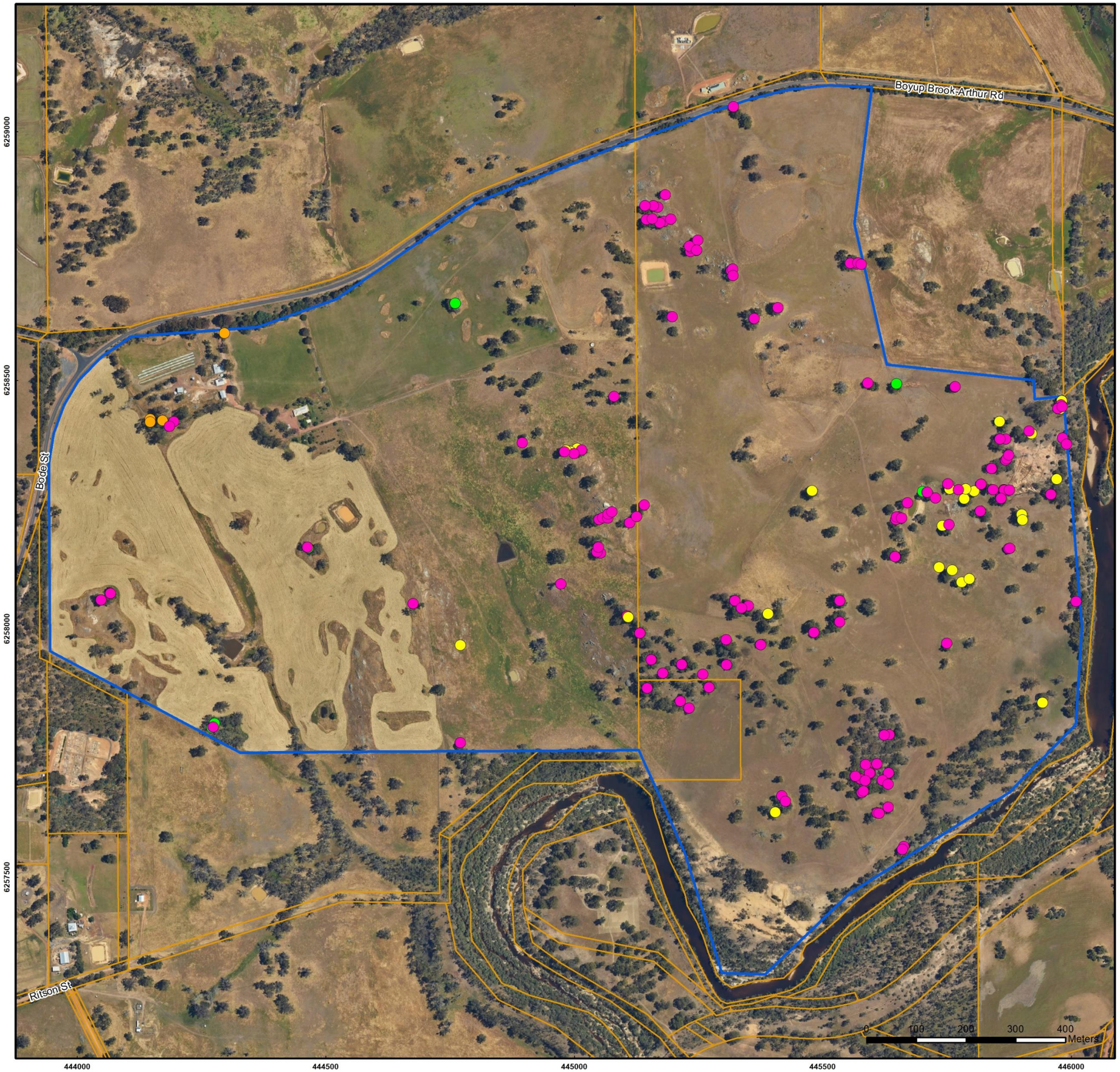
Figure 7: Hollows currently suitable for black cockatoos

	QA Check	*Drawn by*
	KK	**CvdM**
STATUS	*FILE*	*DATE*
FINAL	**EPP008**	**04/10/2023**



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Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre

Cockatoo Feed Evidence

- *Calyptorhynchus banksii naso*
- *Zanda baudinii*
- *Zanda latirostris*
- *Zanda* sp.

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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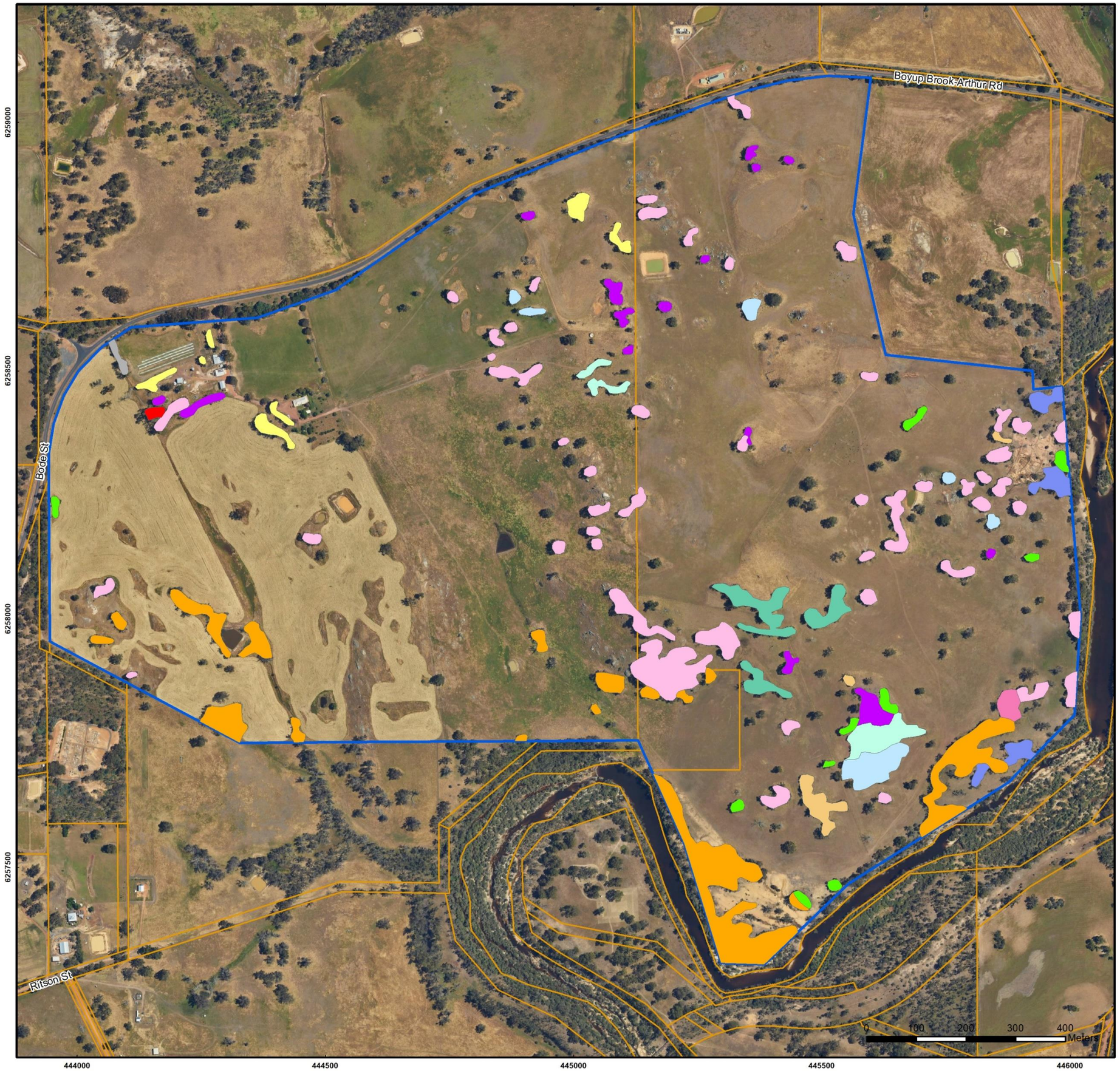
Figure 8: Cockatoo Feed Evidence

	QA Check	*Drawn by*
	KK	**CvdM**
STATUS **FINAL**	*FILE* **EPP008**	*DATE* **03/07/2023**



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BIO DIVERSE SOLUTIONS



Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre

Black Cockatoo Habitat

- *Corymbia calophylla*
- *Eucalyptus marginata*
- *Eucalyptus occidentalis*
- *Eucalyptus rudis*
- *Eucalyptus wandoo*
- Marri, flooded gum
- Marri, jarrah
- Marri, jarrah, flooded gum
- Marri, jarrah, wandoo
- Wandoo, jarrah
- Wandoo, marri
- Wandoo, yate, jarrah
- *Pinus* sp.

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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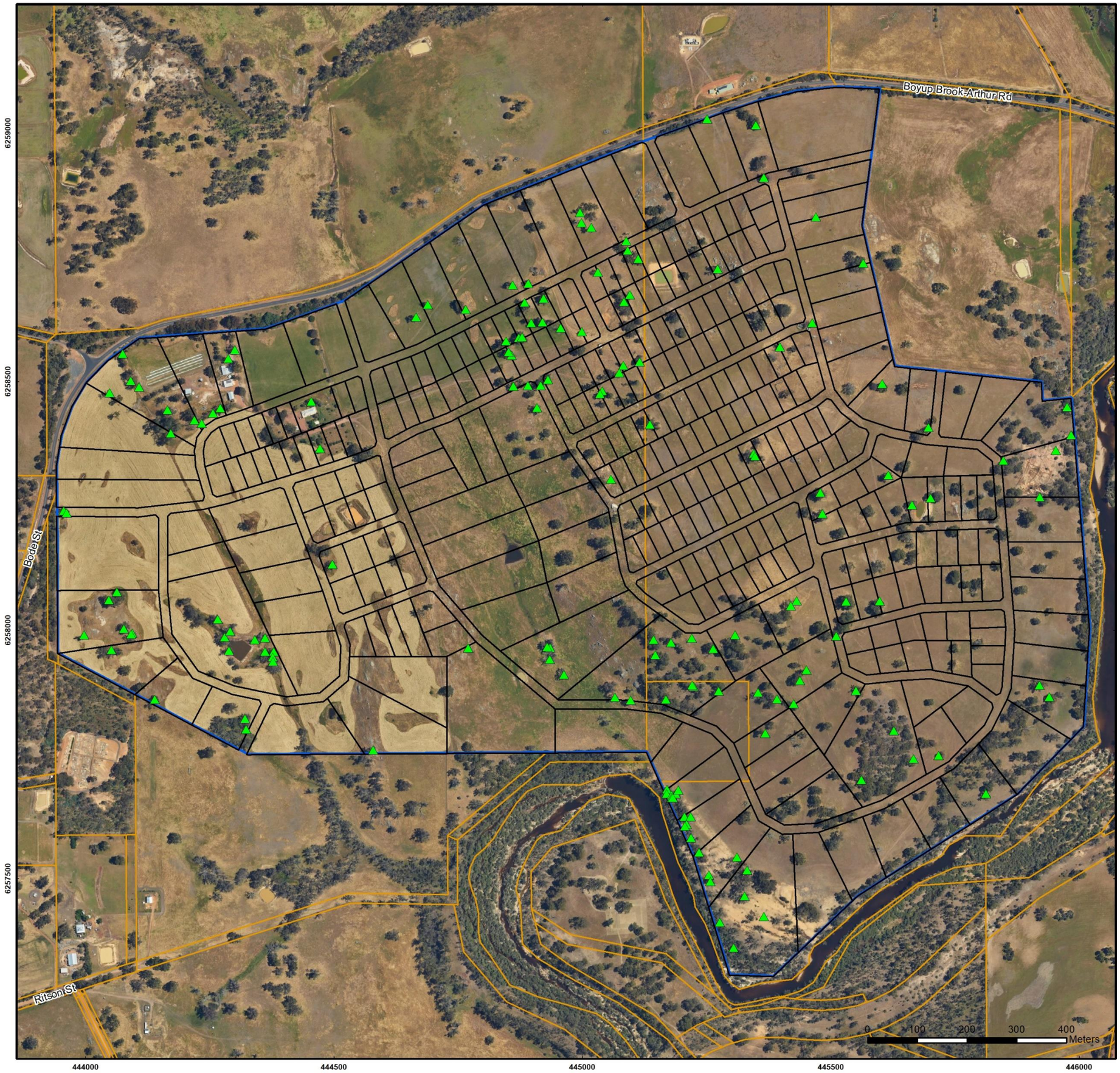
Figure 9: Black Cockatoo Habitat

	QA Check	*Drawn by*
	KK	**CvdM**
STATUS **FINAL**	*FILE* **EPP008-002**	*DATE* **25/07/2023**



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Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre

Leafield Proposed Rural Subdivision Local Structure Plan

Suitable Significant Trees (>300 mm DBH & contain hollows)

- Suitable

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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Figure 10: Suitable nesting trees and Subdivision Plan

	QA Check	*Drawn by*
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STATUS	*FILE*	*DATE*
FINAL	**EPP008**	**10/07/2023**



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Overview Map Scale 1:500,000

Legend

- Survey Area
- Cadastre
- Bridal creeper (*Asparagus asparagoides*)

Scale
1:7,500 @ A3
GDA MGA 2020 Zone 50

Data Sources
Aerial Imagery: WA Now, Landgate Subscription Imagery
Cadastre, Relief Contours and Roads: Landgate 2017
IRIS Road Network: Main Roads Western Australia 2017
Overview Map: World Topographic map service, ESRI 2012

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Figure 11: Opportunistic bridal creeper observations

	QA Check	*Drawn by*
	KK	**CvdM**
STATUS	*FILE*	*DATE*
FINAL	**EPP008**	**11/07/2023**

6. Summary

The scope for this survey was to provide the client with information on the presence of breeding, foraging and roosting habitat for black cockatoos within the survey area. A total of 1354 significant trees were identified within the survey area. Of these, 154 trees contained hollows, 79 of which were currently of suitable size for black cockatoos. These are spread across the survey area. No evidence of current or past (5-10 years) use of these hollows for nesting by black cockatoos was observed. Given the current understanding of known breeding distributions and preferred habitats, it is however likely that the breeding habitat present is suitable for all three species of black cockatoo.

A large amount of feeding evidence was detected for Forest Red-tailed Black Cockatoo throughout the survey area. A smaller amount of evidence of Baudin's and Carnaby's Cockatoo feeding was observed, mostly proximate to the riparian system and a small patch of pines in the northwest of the survey area. Given all three cockatoo species are known to feed on a wide range of eucalypt species, the presence of marri, jarrah, wandoo and yate were considered a potential food source. The DAWE (2022) foraging habitat tool was utilised to score the habitat. This resulted in a score of 8 for each of the three species which is considered the be "high quality" (DAWE, 2022).

Total foraging habitat available for Carnaby's Cockatoo and Baudin's Cockatoo is 10.51 ha and encompasses marri, jarrah, yate and wandoo trees within the survey area and pines trees on the northern boundary. Foraging habitat available for Forest Red-tailed Black Cockatoos is 12.91 ha and encompasses marri, jarrah, yate and wandoo trees within the survey area.

Baudin's Cockatoo, Carnaby's Cockatoo and Forest Red-tailed Black Cockatoo all have similar roosting habitat requirements, consisting of suitable tall trees close to permanent water sources, or riparian environments and in areas containing high quality foraging habitat. There was no evidence the survey area is being used as a roosting site by these species. There is however, potential roosting habitat present across the survey area within all habitat types. Total potential roosting habitat available within the survey area is 19.81 ha.

7. References

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DBCA, Department of Biodiversity, Conservation and Attractions (2018f). Carnaby's Cockatoo Unconfirmed Breeding Areas within the Swan Coastal Plain and Jarrah Forest IBRA Regions (DBCA-055) dataset.

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DBCA, Department of Biodiversity, Conservation and Attractions (2018h). Carnaby's Cockatoo Areas requiring investigation as feeding habitat in the Swan Coastal Plain (SCP) IBRA Region (DBCA-057) dataset.

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8. Appendices

Appendix A – Black Cockatoo Foraging Quality Scoring Tool

Appendix B – Significant Tree Data and Photos

Appendix C – Conservation Status Definitions

Appendix A

Black Cockatoo Foraging Quality Scoring Tool

Table 5: Foraging quality scoring tool (DAWE, 2022).

Starting score		**Baudin's Cockatoo**	**Carnaby's Cockatoo**	**Forest Red-tailed Black-Cockatoo**
10		**Start at a score of 10** if your site is native eucalypt woodlands and forest, and proteaceous woodland and heath, particularly Marri, within the range of the species, including along roadsides and parkland cleared areas. Can include planted vegetation. **This tool only applies to sites equal to or larger than 1 hectare in size.**	**Start at a score of 10** if your site is native shrubland, kwongan heathland or woodland, dominated by proteaceous plant species such as *Banksia* spp. (including *Dryandra* spp.), *Hakea* spp. and *Grevillea* spp., as well as native eucalypt woodland and forest that contains foraging species, within the range of the species, including along roadsides and parkland cleared areas. Also includes planted native vegetation. **This tool only applies to sites equal to or larger than 1 hectare in size.**	**Start at a score of 10** if your site is Jarrah or Marri woodland and/or forest, or if it is on the edge of Karri forest, or if Wandoo and Blackbutt occur on the site, within the range of the subspecies, including along roadsides and parkland cleared areas. **This tool only applies to sites equal to or larger than 1 hectare in size.**
Attribute	**Sub-tractions**	**Context adjustor (attributes reducing functionality of foraging habitat)**		
Foraging potential	**-2**	**Subtract 2** from your score if there is no evidence of feeding debris on your site.	**Subtract 2** from your score if there is no evidence of feeding debris on your site.	**Subtract 2** from your score if there is no evidence of feeding debris on your site.
Connectivity	**-2**	**Subtract 2** from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	**Subtract 2** from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.	**Subtract 2** from your score if you have evidence to conclude that there is no other foraging habitat within 12 km of your site.
Proximity to breeding	**-2**	**Subtract 2** if you have evidence to conclude that your site is more than 12 km from breeding habitat	**Subtract 2** if you have evidence to conclude that your site is more than 12 km from breeding habitat.	**Subtract 2** if you have evidence to conclude that your site is more than 12 km from breeding habitat.
Proximity to roosting	**-1**	**Subtract 1** if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	**Subtract 1** if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.	**Subtract 1** if you have evidence to conclude that your site is more than 20 km from a known night roosting habitat.
Impact from significant plant disease	**-1**	**Subtract 1** if your site has disease present (e.g. *Phytophthora* spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	**Subtract 1** if your site has disease present (e.g. *Phytophthora* spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.	**Subtract 1** if your site has disease present (e.g. *Phytophthora* spp. or Marri canker) and the disease is affecting more than 50% of the preferred food plants present.
Total score		*8*	*8*	*8*

Appendix B

Significant Tree Data and Photos

Table 6: **Significant trees (>300mm DBH).**
Note: Trees containing hollows are presented first. Trees are then sorted by Tree ID number. Due to the large quantity of trees measured, only photos of trees containing hollows have been included in this report. All photos can be provided upon request.

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
3	*Eucalyptus wandoo*	995	Yes	Branch	25 x 10	Elbow	10	Yes	Additional hollows present. Scratching not cockatoo	-33.8123198	116.3960993
7	*Eucalyptus marginata*	945	Yes	Branch	12 x 12	Chimney	12	No		-33.8122123	116.3959172
11	*Eucalyptus wandoo*	865	Yes	Branch	5 x 5	Side	12	Scratching	Branch too small for cockatoo habitat	-33.81171707	116.3957488
12	*Eucalyptus marginata*	1228	Yes	Branch	4 x 3	Side	10	No	Highly senescent crown, too small for cocky habitat	-33.81242235	116.3954593
16	*Corymbia calophylla*	1692	Yes	Branch	20 x 15	Elbow	12	No	Hollow upward facing. Possum tracks up tree. Additional hollows forming. Big tree significant hollow forming potential	-33.81316417	116.3967831
23	*Eucalyptus wandoo*	500	Yes	Trunk	15 x 12	Elbow	6	No	Possum track	-33.81298877	116.3974518
24	*Eucalyptus wandoo*	450	Yes	Branch	8 x 8	Chimney	7	Yes	Too small for cockatoo habitat	-33.81292865	116.3972991
27	*Eucalyptus wandoo*	1208	Yes	Branch	6 x 4	Side	7	No	Too small for cockatoo habitat	-33.81280627	116.3977007
28	*Eucalyptus occidentalis*	1479	Yes	Branch	18 x 15	Elbow	5	Scratching	Multiple. Potential cockatoo hollow	-33.81271729	116.3978634
50	*Eucalyptus marginata*	1156	Yes	Branch	7 x 6	Side	12	No	Hollow butt. Large tree, significant hollow forming potential. Hollow too small for cockatoo habitat	-33.81345955	116.4000209
54	*Corymbia calophylla*	2069	Yes	Branch	12 x 15	Side	11	Yes	Large tree significant hollow forming potential. Multiple hollows forming. Significant hollow at base	-33.81555779	116.4002766
58	*Corymbia calophylla*	2152	Yes	Branch	25 x 25	Chimney	12	No	Large tree multiple additional hollows forming	-33.8189348	116.4011414
69	*Eucalyptus rudis*	1210	Yes	Branch	20 x 20	Chimney	8	Yes		-33.81654914	116.397774
70	*Eucalyptus rudis*	1438	Yes	Branch	12 x 12	Side	5	Scratching	Additional hollows forming	-33.8168695	116.397927
75	*Eucalyptus rudis*	1477	Yes	Branch	20 x 18	Chimney	6	No	Additional hollows forming	-33.81676825	116.3980441
78	*Eucalyptus rudis*	762	Yes	Branch	20 x 18	Chimney	1	No	Significant hollow at base. Multiple hollows. Multiple hollows forming	-33.81691992	116.3985824
83	*Eucalyptus rudis*	1108	Yes	Trunk	22 x 15	Chimney	2	No		-33.81688659	116.3988008
85	*Eucalyptus rudis*	1249	Yes	Branch	12 x 12	Chimney	8	No	Multi-stemmed roots clearly interconnected	-33.81714159	116.3989891
86	*Eucalyptus rudis*	1517	Yes	Branch	8 x 8	Elbow	7	Yes	Additional small hollows. Hollow too small for cockatoo habitat	-33.81723659	116.3989691
88	*Eucalyptus rudis*	655	Yes	Trunk	10 x 8	Elbow	5	Scratching	Multiple hollows. Hollow too small for cockatoo habitat	-33.81731992	116.3989741
94	*Eucalyptus rudis*	731	Yes	Trunk	10 x 12	Elbow	10	Scratching	Dead	-33.81714159	116.3988008
100	*Eucalyptus rudis*	1279	Yes	Branch	8 x 10	Elbow	7	No	Large tree with three significant leaders. Hollow too small for cockatoo habitat	-33.81711659	116.3980224
110	*Eucalyptus rudis*	519	Yes	Branch	12 x 10	Side	12	No		-33.81835159	116.3983574
112	*Eucalyptus rudis*	662	Yes	Branch	18 x 18	Chimney	7	No		-33.81854492	116.3983824
156	*Corymbia calophylla*	1121	Yes	Trunk	30 x 40	Chimney	8	No	Potential to develop into cockatoo hollow.	-33.81709207	116.403218
166	*Eucalyptus rudis*	1130	Yes	Branch	18 x 10	Chimney	4	No	Four leaders. Potential to develop into cockatoo hollow.	-33.81758494	116.4052971
174	*Eucalyptus wandoo*	975	Yes	Trunk	15 x 12	Elbow	8	No	Potential cockatoo hollow.	-33.81024365	116.4086912
189	*Corymbia calophylla*	1105	Yes	Branch	18 x 20	Elbow	11	No	Just inside of fenceline. Dead. Hollow occupied by bees.	-33.80751721	116.4084823
194	*Corymbia calophylla*	864	Yes	Branch	3 x 4	Side	6	No	Possum scratching up trunk. Hollow too small for cockatoo habitat	-33.80763829	116.4095406
208	*Eucalyptus wandoo*	617	Yes	Trunk	30 x 40	Elbow	5	No	Dead. Potential cockatoo hollow.	-33.80858679	116.4097098
212	*Eucalyptus marginata*	898	Yes	Trunk	16 x 18	Elbow	3	No	Dead. Potential cockatoo hollow	-33.80930855	116.4108335
220	*Corymbia calophylla*	725	Yes	Trunk	10 x 8	Elbow	8	No	Old forest red-tailed cockatoo feeding debris. Feather from ringneck parrot beneath hollow. Multiple small additional hollows. Two have the capacity to form into cockatoo hollows.	-33.8101541	116.4118577
225	*Eucalyptus wandoo*	644	Yes	Trunk	3 x 4	Side	5	No	Other hollows forming. Three out of four leaders are dead. Small hollow entrance within large part of trunk. Has the potential to develop into a cockatoo hollow.	-33.81123116	116.4107416
229	*Eucalyptus wandoo*	535	Yes	Branch	8 x 8	Chimney	2	No	Three leaders	-33.81166231	116.410033
238	*Corymbia calophylla*	1494	Yes	Branch	10 x 10	Chimney	14	No	Multiple additional hollows forming. Possum scratching up trunk	-33.8130558	116.4072019
280	*Corymbia calophylla*	467	Yes	Trunk	5 x 3	Side	5	No	Hollow too small for cockatoo habitat	-33.81359813	116.4094503
282	*Corymbia calophylla*	320	Yes	Trunk	6 x 5	Side	4	No	Dead. Hollow too small for cockatoo habitat	-33.81364157	116.4094824
300	*Eucalyptus rudis*	619	Yes	Trunk	8 x 8	Chimney	5	No	Hollow too small for cockatoo habitat	-33.81278503	116.4162738

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
305	*Corymbia calophylla*	744	Yes	Branch	10 x 5	Side	8	No	Additional hollows forming. Hollow too small for cockatoo habitat	-33.81328918	116.4163586
306	*Corymbia calophylla*	711	Yes	Trunk	20 x 20	Elbow	9	No	Dead.	-33.81356545	116.4160229
338	*Corymbia calophylla*	1010	Yes	Trunk	12 x 12	Side	10	No	Possum scratching up trunk. Potential cockatoo hollow. No evidence of use.	-33.81375105	116.414879
374	*Corymbia calophylla*	522	Yes	Trunk	18 x 15	Side	2	No	Dead. Hollow occupied by bees.	-33.81441022	116.4156676
386	*Corymbia calophylla*	1108	Yes	Branch	16 x 12	Elbow	8	No	Potential cockatoo hollow. No evidence of use.	-33.81442243	116.4132929
388	*Corymbia calophylla*	1590	Yes	Trunk	15 x 15	Chimney	2	No	Possum scratching up trunk. Multiple additional hollows forming.	-33.8145477	116.412886
440	*Eucalyptus rudis*	971	Yes	Trunk	15 x 12	Chimney	3	No	Multiple leaders. Potential cockatoo hollow	-33.81979129	116.4144558
516	*Corymbia calophylla*	793	Yes	Branch	10 x 8	Chimney	3	No	Multiple leaders. Hollow too small for cockatoo habitat	-33.81803795	116.4158512
518	*Eucalyptus rudis*	1792	Yes	Trunk	30 x 30	Chimney	2	No	Large hollow. Potential cockatoo. No evidence of recent use.	-33.81783153	116.4156327
532	*Eucalyptus wandoo*	1139	Yes	Trunk	15 x 12	Elbow	7	No	Other hollows forming. Branches just below DBH but too tight to get tape measure through. DBH measurement is around all 3 leaders.	-33.81909498	116.4134336
534	*Eucalyptus marginata*	1202	Yes	Branch	15 x 12	Elbow	8	No	Multiple additional hollows. Potential cockatoo hollow. Hollow butted.	-33.81790554	116.4116462
557	*Eucalyptus marginata*	778	Yes	Trunk	6 x 6	Side	12	No	Dead. Other small hollows present. Potential to develop into a cockatoo hollow. Hollow too small for cockatoo habitat	-33.81863604	116.4124607
573	*Corymbia calophylla*	828	Yes	Branch	25 x 25	Chimney	6	No	Shallow hollow. Has potential to develop into a cockatoo hollow. Primary crown dead.	-33.81914817	116.4128917
614	*Corymbia calophylla*	516	Yes	Trunk	5 x 4	Side	5	No	Dead. Hollow too small for cockatoo habitat	-33.81952612	116.4117537
767	*Eucalyptus rudis*	1055	Yes	Trunk	12 x 10	Side	7	No	Potential cockatoo hollow. No evidence for use	-33.8211536	116.4092556
773	*Eucalyptus rudis*	1972	Yes	Trunk	8 x 2	Side	1	No	Dead. Multiple hollows. Hollow too small for cockatoo habitat	-33.82091514	116.4090394
780	*Eucalyptus rudis*	905	Yes	Branch	15 x 12	Side	12	No	Dead. Multiple stems	-33.82123725	116.4084281
783	*Eucalyptus rudis*	565	Yes	Trunk	10 x 10	Chimney	4	No	Dead	-33.82135485	116.4084591
791	*Eucalyptus rudis*	733	Yes	Branch	15 x 12	Chimney	1	No	Multiple leaders	-33.82162565	116.4091973
792	*Eucalyptus rudis*	743	Yes	Trunk	30 x 30	Chimney	6	No	Dead stag. Exposed roots. Upward facing hollow	-33.8219924	116.4096139
813	*Eucalyptus rudis*	994	Yes	Trunk	12 x 10	Chimney	5	No	Multiple stems	-33.82256137	116.4089507
833	*Eucalyptus rudis*	997	Yes	Branch	12 x 12	Elbow	8	No	Dead. Potential cockatoo hollow, no evidence of use	-33.82209357	116.4086593
852	*Eucalyptus rudis*	691	Yes	Trunk	8 x 6	Elbow	5	No	Hollow too small for cockatoo habitat	-33.8208234	116.4082118
862	*Eucalyptus rudis*	1097	Yes	Branch	8 x 6	Elbow	7	No	Potential cockatoo hollow. Additional hollows forming. Hollow too small for cockatoo habitat	-33.81730805	116.4049946
865	*Eucalyptus rudis*	662	Yes	Trunk	8 x 6	Chimney	1	No	Four leaders, one fallen off. Not cockatoo suitable. Hollow too small for cockatoo habitat	-33.81709955	116.4050039
866	*Eucalyptus rudis*	1692	Yes	Trunk	20 x 18	Elbow	1	No	Multiple leaders over large area 20 m x 10 m, 5 stems	-33.81708627	116.4049364
887	*Corymbia calophylla*	1133	Yes	Branch	4 x 3	Chimney	9	No	Two stems, main dead. Hollow too small for cockatoo habitat	-33.81404179	116.4063417
902	*Corymbia calophylla*	503	Yes	Trunk	20 x 20	Chimney	7	No	Tops dead	-33.81244447	116.4061653
903	*Corymbia calophylla*	1033	Yes	Branch	8 x 8	Elbow	11	No	Hollow too small for cockatoo habitat	-33.81249712	116.4061212
911	*Eucalyptus wandoo*	646	Yes	Trunk	7 x 5	Side	7	No	High level of scratching around entrance. Potential to become bigger. Hollow too small for cockatoo habitat	-33.8121125	116.4065383
921	*Eucalyptus wandoo*	678	Yes	Branch	5 x 10	Chimney	7	Scratching	Leader measured. Hollow too small for cockatoo habitat	-33.81274464	116.3967105
934	*Eucalyptus sp.*	971	Yes	Branch	5 x 5	Chimney	4	No	Planted. Hollow too small for cockatoo habitat	-33.81165992	116.3981863
941	*Eucalyptus wandoo*	855	Yes	Branch	10 x 10	Chimney	6	No	Upwards facing	-33.81181622	116.3980435
955	*Corymbia calophylla*	759	Yes	Branch	2 x 4	Side	10	Rubbing	New bark removed, rubbing on underside. Hollow too small for cockatoo habitat	-33.81260309	116.3998391
956	*Eucalyptus marginata*	1112	Yes	Branch	20 x 20	Chimney	16	No	Other hollows forming	-33.8145599	116.3944399
957	*Eucalyptus marginata*	921	Yes	Branch	30 x 30	Chimney	16	No	Other hollows forming	-33.81460322	116.3945026
959	*Eucalyptus rudis*	1660	Yes	Branch	15 x 10	Chimney	14	No	Upwards facing	-33.81681927	116.3948692
962	*Corymbia calophylla*	802	Yes	Branch	10 x 10	Chimney	20	No	Upwards facing	-33.81618515	116.39541
968	*Corymbia calophylla*	760	Yes	Branch	5 x 5	Chimney	8	No	Broken branch slight entry. Hollow too small for cockatoo habitat	-33.81604202	116.3955874
970	*Eucalyptus rudis*	1677	Yes	Branch	5 x 5	Chimney	10	No	Two large hollows. Upwards facing. Hollow too small for cockatoo habitat	-33.81670967	116.3957338
972	*Eucalyptus rudis*	910	Yes	Trunk	5 x 5	Side	2	No	Potentially other small hollows. Hollow too small for cockatoo habitat	-33.81678755	116.3959185

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
973	*Eucalyptus rudis*	1011	Yes	Branch	10 x 5	Side	10	No	Rubbing. Future hollow forming potential. Hollow too small for cockatoo habitat	-33.81680842	116.3958915
976	*Eucalyptus rudis*	1880	Yes	Branch	30 x 30	Chimney	3	No	Multiple hollows forming and in tree	-33.81709104	116.3954632
983	*Corymbia calophylla*	1137	Yes	Branch	15 x 15	Chimney	22	No	Upwards facing	-33.81799349	116.3964002
988	*Corymbia calophylla*	1305	Yes	Branch	10 x 10	Chimney	18	No	Upwards facing	-33.81235159	116.4042341
990	*Corymbia calophylla*	681	Yes	Branch	15 x 15	Chimney	12	No	Other hollows forming	-33.81233825	116.4045508
991	*Corymbia calophylla*	1135	Yes	Trunk	8 x 8	Side	16	Scratching	Multiple hollows present. Hollow too small for cockatoo habitat	-33.81223159	116.4049841
993	*Corymbia calophylla*	867	Yes	Branch	5 x 5	Elbow	4	No	Hollows forming. Hollow too small for cockatoo habitat	-33.81233659	116.4048308
996	*Corymbia calophylla*	1173	Yes	Branch	15 x 20	Chimney	10	No	Hollows forming	-33.81273992	116.4047491
998	*Eucalyptus wandoo*	491	Yes	Branch	8 x 8	Chimney	12	No	Upwards facing. Hollow too small for cockatoo habitat	-33.81192159	116.4069841
1000	*Eucalyptus wandoo*	674	Yes	Trunk	10 x 10	Chimney	4	No	Upwards facing. Hollows forming	-33.81198492	116.4066291
1020	*Eucalyptus wandoo*	669	Yes	Trunk	3 x 3	Side	6	No	Upwards facing. Hollows forming. Hollow too small for cockatoo habitat	-33.81069992	116.4067791
1024	*Eucalyptus occidentalis*	1074	Yes	Branch	25 x 25	Chimney	12	No	Dying. Multiple hollows forming. Upwards facing hollow	-33.81082825	116.4066508
1029	*Eucalyptus wandoo*	565	Yes	Branch	6 x 6	Side	0	No	Hollow too small for cockatoo habitat	-33.81028659	116.4060874
1031	*Eucalyptus occidentalis*	1040	Yes	Branch	15 x 15	Chimney	8	No	Upwards facing. Multiple hollows present. Hollows forming	-33.81004992	116.4069674
1037	*Eucalyptus marginata*	1391	Yes	Branch	5 x 5	Elbow	12	No	Upwards facing. Hollows forming. Hollow too small for cockatoo habitat	-33.80989659	116.4067391
1039	*Eucalyptus occidentalis*	1130	Yes	Branch	10 x 10	Chimney	0	No	Upwards facing. Dead	-33.80972325	116.4067041
1041	*Eucalyptus occidentalis*	1291	Yes	Trunk	15 x 15	Chimney	5	No	Upwards facing.	-33.80920492	116.4057074
1046	*Eucalyptus occidentalis*	1263	Yes	Trunk	30 x 30	Chimney	10	No	Upwards facing. Multiple hollows.	-33.80947659	116.4059474
1047	*Eucalyptus occidentalis*	1554	Yes	Branch	20 x 20	Chimney	7	No	Multiple hollows. Hollows forming. Bee hive at base of tree. Dying.	-33.80938659	116.4057341
1056	*Eucalyptus rudis*	1251	Yes	Trunk	10 x 10	Chimney	10	No	Hollow forming potential. Dying	-33.81136659	116.4057291
1059	*Eucalyptus marginata*	1608	Yes	Branch	8 x 8	Side	0	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81108085	116.402128
1060	*Eucalyptus wandoo*	1302	Yes	Branch	10 x 10	Chimney	16	No	Other hollows forming	-33.81085677	116.4023824
1061	*Corymbia calophylla*	1480	Yes	Branch	5 x 5	Elbow	14	Rubbing	Rubbing on entrance (possum?). Other hollows forming. Hollow too small for cockatoo habitat	-33.81094702	116.4032103
1063	*Corymbia calophylla*	1155	Yes	Branch	3 x 3	Elbow	16	No	Other hollows forming. Significant possum scratchings. Hollow too small for cockatoo habitat	-33.81178529	116.4041964
1064	*Corymbia calophylla*	723	Yes	Branch	8 x 8	Chimney	12	No	Hollows forming. Hollow too small for cockatoo habitat	-33.81172405	116.4041361
1066	*Corymbia calophylla*	1219	Yes	Branch	2 x 5	Side	13	No	Other hollows forming. Significant Possum scratchings. Hollow too small for cockatoo habitat	-33.81152762	116.40408
1067	*Corymbia calophylla*	1144	Yes	Branch	2 x 2	Side	14	No	Other hollows forming. Big nest at top of canopy. Hollow too small for cockatoo habitat	-33.81147085	116.4043606
1068	*Corymbia calophylla*	1661	Yes	Branch	15 x 15	Chimney	12	No	Hollow forming potential. Significant possum scratchings	-33.81145749	116.4044273
1069	*Corymbia calophylla*	1188	Yes	Trunk	5 x 5	Side	10	No	Other hollows forming. Dead. Hollow too small for cockatoo habitat	-33.81129682	116.4052711
1071	*Corymbia calophylla*	1217	Yes	Branch	3 x 3	Elbow	12	No	Future hollow forming potential. Hollow too small for cockatoo habitat	-33.81118905	116.4048765
1072	*Eucalyptus marginata*	1092	Yes	Trunk	30 x 30	Chimney	7	No	Multiple Hollows. Beehive in hollow. Significant Possum scratchings	-33.81120274	116.4046319
1075	*Eucalyptus marginata*	1079	Yes	Branch	5 x 5	Chimney	8	No	Hollow too small for cockatoo habitat	-33.81082735	116.4044918
1076	*Eucalyptus wandoo*	1115	Yes	Branch	15 x 15	Side	14	No	Other hollows forming	-33.81051139	116.4042358
1077	*Eucalyptus marginata*	1008	Yes	Branch	3 x 3	Side	8	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81048965	116.404572
1080	*Corymbia calophylla*	1002	Yes	Branch	3 x 3	Elbow	11	No	Hollows forming. Significant Possum scratchings. Hollow too small for cockatoo habitat	-33.81076215	116.4049025
1081	*Corymbia calophylla*	897	Yes	Branch	5 x 40	Side	6	No	Multiple stems. Other hollows forming. Significant Possum Scratchings. Hollow too small for cockatoo habitat	-33.81234159	116.4122541
1084	*Eucalyptus marginata*	1475	Yes	Trunk	10 x 2	Side	7	No	Hollows forming. Hollow too small for cockatoo habitat	-33.81314159	116.4132574
1087	*Corymbia calophylla*	1496	Yes	Branch	3 x 3	Chimney	12	No	Hollows forming. Hollow too small for cockatoo habitat	-33.81400325	116.4123741
1091	*Corymbia calophylla*	1978	Yes	Branch	5 x 5	Chimney	14	No	Future hollow forming potential. Hollow too small for cockatoo habitat	-33.81469325	116.4109374
1093	*Corymbia calophylla*	1676	Yes	Trunk	15 x 15	Chimney	7	No	Old tree, significant hollow forming potential. Evidence of feeding	-33.81430825	116.4108924
1104	*Eucalyptus marginata*	1720	Yes	Trunk	30 x 30	Chimney	8	No	Upwards facing. Multiple hollows present. Dying	-33.81628325	116.4121708

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1106	*Corymbia calophylla*	1049	Yes	Trunk	3 x 3	Side	11	No	Multiple Hollows present. Multiple stems. Significant Possum Scratchings. Hollow too small for cockatoo habitat	-33.81628992	116.4114441
1113	*Eucalyptus marginata*	369	Yes	Branch	5 x 5	Chimney	3	No	Multiple Stems. Dead. Hollow too small for cockatoo habitat	-33.81691325	116.4112274
1123	*Eucalyptus marginata*	851	Yes	Trunk	20 x 20	Side	3	No	Upwards facing. Dead	-33.81626992	116.4103658
1124	*Eucalyptus marginata*	1945	Yes	Branch	5 x 5	Chimney	0	No	Hollows forming. Dying. Hollow too small for cockatoo habitat	-33.81635992	116.4102374
1137	*Eucalyptus wandoo*	733	Yes	Trunk	8 x 8	Chimney	5	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81752659	116.4105691
1139	*Eucalyptus wandoo*	1126	Yes	Trunk	15 x 15	Chimney	8	No	Upwards facing. Hollows forming. Leader measured.	-33.81771659	116.4104274
1145	*Eucalyptus wandoo*	791	Yes	Branch	5 x 5	Chimney	10	No	Other hollows forming. Multiple stems. Hollow too small for cockatoo habitat	-33.81814159	116.4102891
1149	*Eucalyptus wandoo*	533	Yes	Branch	10 x 10	Chimney	12	No	Other hollows forming	-33.81805492	116.4099274
1153	*Eucalyptus rudis*	1822	Yes	Branch	5 x 5	Side	14	No	Multiple other Hollows Present. Hollow too small for cockatoo habitat	-33.81793159	116.4095174
1157	*Eucalyptus marginata*	1339	Yes	Trunk	2 x 50	Side	8	No	Other hollows forming. Beehive inside hollow. Hollow too small for cockatoo habitat	-33.81867159	116.4096708
1161	*Corymbia calophylla*	777	Yes	Branch	10 x 10	Chimney	22	No	Upwards facing. Some branches dead	-33.81688825	116.4090224
1173	*Corymbia calophylla*	860	Yes	Branch	5 x 5	Side	8	No	Dead. Multiple hollows present. Hollow too small for cockatoo habitat	-33.81713159	116.4085474
1181	*Corymbia calophylla*	837	Yes	Trunk	15 x 15	Chimney	12	No	Upwards facing. Multiple stems	-33.81695992	116.4072524
1197	*Corymbia calophylla*	1494	Yes	Branch	10 x 10	Chimney	24	No	Hollows forming. Big nest in tree	-33.81724159	116.4072891
1216	*Corymbia calophylla*	1182	Yes	Trunk	5 x 5	Side	10	No	Multiple Hollows forming. Dead. Hollow too small for cockatoo habitat	-33.81694325	116.4080824
1224	*Eucalyptus rudis*	1024	Yes	Branch	5 x 8	Side	10	No	Multiple hollows present. Hollow too small for cockatoo habitat	-33.81701937	116.4076279
1231	*Eucalyptus rudis*	958	Yes	Branch	5 x 5	Side	16	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81789825	116.4086641
1246	*Corymbia calophylla*	439	Yes	Trunk	10 x 10	Chimney	10	No	Dead	-33.81781492	116.4081141
1247	*Corymbia calophylla*	870	Yes	Trunk	3 x 3	Side	10	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81779159	116.4080874
1270	*Corymbia calophylla*	1065	Yes	Trunk	30 x 8	Side	5	No	Hollows forming	-33.81804659	116.4075124
1288	*Eucalyptus rudis*	1151	Yes	Trunk	4 x 4	Side	6	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81805659	116.4067458
1289	*Eucalyptus rudis*	1145	Yes	Trunk	1 x 10	Side	2	No	Leader measured. Beehive in hollow. Hollow too small for cockatoo habitat	-33.81800325	116.4064008
1307	*Eucalyptus rudis*	508	Yes	Branch	10 x 10	Chimney	8	No	Upwards facing. Other hollows forming.	-33.8196806	116.4075264
1309	*Eucalyptus rudis*	977	Yes	Branch	15 x 15	Chimney	20	No	Multiple hollows present. Dead branches	-33.81975984	116.4075182
1314	*Eucalyptus rudis*	542	Yes	Branch	5 x 5	Chimney	14	No	Multiple stems. Dying, infested with termites. Hollow too small for cockatoo habitat	-33.819786	116.4076269
1315	*Eucalyptus rudis*	458	Yes	Branch	3 x 3	Elbow	4	No	Other hollows forming. Multiple stems. Hollow too small for cockatoo habitat	-33.81976205	116.4077168
1316	*Eucalyptus rudis*	587	Yes	Branch	2 x 2	Side	14	No	Multiple stems. Dying. Hollow too small for cockatoo habitat	-33.81969195	116.4077688
1319	*Eucalyptus rudis*	685	Yes	Branch	25 x 25	Chimney	22	No	Upwards facing. Multiple hollows present	-33.81983442	116.4076275
1320	*Eucalyptus rudis*	488	Yes	Trunk	5 x 5	Side	16	No	Other hollows forming. Hollow too small for cockatoo habitat	-33.81982922	116.4076513
1334	*Eucalyptus rudis*	682	Yes	Branch	10 x 10	Chimney	8	No	Upwards facing	-33.82017857	116.407905
1340	*Eucalyptus rudis*	416	Yes	Branch	3 x 3	Chimney	6	No	Multiple hollows present. Hollow too small for cockatoo habitat	-33.82017497	116.4080336
1343	*Eucalyptus rudis*	477	Yes	Branch	10 x 10	Chimney	8	No		-33.82031705	116.4079498
1344	*Eucalyptus rudis*	621	Yes	Branch	15 x 15	Chimney	10	No	Multiple other hollows forming	-33.82034552	116.4079107
1352	*Eucalyptus rudis*	703	Yes	Branch	5 x 5	Side	22	No	Multiple hollows present. Dead. Hollow too small for cockatoo habitat	-33.8205641	116.4080427
1	*Eucalyptus occidentalis*	735	No							-33.81248742	116.3965034
2	*Eucalyptus occidentalis*	908	No							-33.81250734	116.3963473
4	*Eucalyptus wandoo*	720	No						Hollows forming	-33.81221032	116.3959831
5	*Eucalyptus marginata*	1176	No						Dead	-33.81208427	116.395985
6	*Eucalyptus wandoo*	1045	No						Hollows forming	-33.81208655	116.3959474
8	*Eucalyptus occidentalis*	883	No							-33.81192085	116.3957978
9	*Eucalyptus occidentalis*	469	No							-33.81184935	116.3957498
10	*Eucalyptus occidentalis*	637	No							-33.81175867	116.3957706

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
13	*Eucalyptus marginata*	1223	No							-33.81253824	116.3956303
14	*Eucalyptus marginata*	1056	No						Hollow butted.	-33.81275167	116.3956352
15	*Eucalyptus marginata*	1310	No						Dead	-33.81272144	116.3960362
17	*Eucalyptus marginata*	875	No							-33.81325935	116.3967162
18	*Corymbia calophylla*	868	No						Forest red-tailed black cockatoo feed debris	-33.81309449	116.3968894
19	*Corymbia calophylla*	409	No							-33.8129608	116.3969664
20	*Corymbia calophylla*	542	No							-33.81296834	116.3969604
21	*Corymbia calophylla*	1455	No						Advanced senescent crown. Hollow forming in trunk	-33.81301365	116.3972838
22	*Eucalyptus wandoo*	430	No							-33.81299599	116.3972405
25	*Eucalyptus wandoo*	513	No						Hollows forming	-33.81292184	116.3974223
26	*Eucalyptus wandoo*	1039	No						Hollows forming	-33.81282775	116.3976102
29	*Eucalyptus wandoo*	637	No							-33.81266965	116.3979609
30	*Eucalyptus wandoo*	1074	No						Hollows forming	-33.81269194	116.3980786
31	*Eucalyptus wandoo*	722	No						Hollows forming	-33.81306007	116.3990235
32	*Eucalyptus occidentalis*	520	No							-33.81305985	116.3990153
33	*Eucalyptus occidentalis*	418	No							-33.81309029	116.3989799
34	*Eucalyptus occidentalis*	542	No							-33.81314302	116.3989137
35	*Eucalyptus occidentalis*	530	No							-33.81315802	116.3989176
36	*Eucalyptus occidentalis*	632	No							-33.81319122	116.3989447
37	*Eucalyptus occidentalis*	677	No							-33.81318144	116.3990208
38	*Eucalyptus occidentalis*	459	No							-33.81317409	116.3990462
39	*Eucalyptus occidentalis*	363	No							-33.81322719	116.3990945
40	*Eucalyptus occidentalis*	600	No							-33.813233	116.3991271
41	*Eucalyptus occidentalis*	512	No							-33.81323832	116.3991695
42	*Eucalyptus occidentalis*	680	No							-33.81326542	116.3992196
43	*Eucalyptus occidentalis*	365	No						Dead	-33.81325595	116.3990466
44	*Eucalyptus occidentalis*	701	No							-33.81326434	116.3990823
45	*Eucalyptus occidentalis*	342	No							-33.81332277	116.3991517
46	*Eucalyptus occidentalis*	553	No							-33.81333037	116.3991843
47	*Eucalyptus occidentalis*	898	No							-33.81331115	116.3993423
48	*Eucalyptus occidentalis*	775	No						Dead	-33.81341422	116.3994769
49	*Eucalyptus occidentalis*	1310	No							-33.8135604	116.3996213
51	*Eucalyptus wandoo*	1270	No						Hollows forming	-33.81478832	116.3985697
52	*Corymbia calophylla*	1750	No						Possum track. Fresh Carnaby and old forest red-tailed black cockatoo feeding evidence under tree. Large tree significant hollow forming potential.	-33.81521577	116.3999619
53	*Corymbia calophylla*	1325	No						Large tree significant hollow forming potential	-33.81527317	116.4001217
55	*Corymbia calophylla*	1334	No						Hollows forming	-33.81546497	116.4016756
56	*Corymbia calophylla*	1100	No						Hollows forming	-33.81641994	116.4021961
57	*Corymbia calophylla*	771	No							-33.81630747	116.4023728
59	*Eucalyptus rudis*	1877	No						Multiple hollows forming	-33.81625572	116.3971282
60	*Eucalyptus rudis*	868	No						Multi-stemmed	-33.81631652	116.3971758
61	*Eucalyptus rudis*	1024	No							-33.81640222	116.3972152
62	*Eucalyptus rudis*	970	No							-33.81645104	116.3972453

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
63	*Eucalyptus rudis*	402	No						Resprouted from log	-33.81642289	116.3972012
64	*Eucalyptus rudis*	785	No							-33.81641662	116.3973015
65	*Eucalyptus rudis*	592	No							-33.81645864	116.3973563
66	*Eucalyptus rudis*	550	No						Resprouted from log	-33.81650147	116.3974061
67	*Eucalyptus rudis*	1348	No							-33.8166175	116.3974285
68	*Eucalyptus rudis*	1806	No							-33.81653057	116.3977362
71	*Eucalyptus rudis*	381	No							-33.81694159	116.3979574
72	*Eucalyptus rudis*	335	No							-33.81690492	116.3979791
73	*Eucalyptus rudis*	1008	No							-33.81677825	116.3978841
74	*Eucalyptus rudis*	519	No						Four leaders	-33.81687325	116.3980008
76	*Eucalyptus rudis*	692	No						Hollows forming	-33.81670159	116.3980391
77	*Eucalyptus rudis*	1031	No						Double leader. Hollow forming potential. Hollows forming	-33.81668159	116.3980941
79	*Eucalyptus rudis*	1110	No						Hollows forming	-33.81682659	116.3987074
80	*Eucalyptus rudis*	649	No							-33.81685325	116.3987308
81	*Eucalyptus rudis*	886	No						Multi-stemmed	-33.81690159	116.3986974
82	*Eucalyptus rudis*	1021	No						Hollows forming	-33.81701899	116.3987678
84	*Eucalyptus rudis*	1355	No						Burrow at base. Hollows forming	-33.81703825	116.3989358
87	*Eucalyptus rudis*	615	No						Hollows forming	-33.81722659	116.3990358
89	*Eucalyptus rudis*	730	No							-33.81737825	116.3990324
90	*Eucalyptus rudis*	1844	No						Hollows forming	-33.81740659	116.3990708
91	*Eucalyptus rudis*	631	No						Multiple leaders. Hollows forming	-33.81722659	116.3988658
92	*Eucalyptus rudis*	838	No							-33.81721325	116.3988008
93	*Eucalyptus rudis*	1088	No						Hollows forming	-33.81714992	116.3988274
95	*Eucalyptus rudis*	618	No						Two out of three leaders dead	-33.81732992	116.3985874
96	*Eucalyptus rudis*	619	No							-33.81737992	116.3985024
97	*Eucalyptus rudis*	1107	No						Hollows forming	-33.81738992	116.3982058
98	*Eucalyptus rudis*	726	No							-33.81730159	116.3981324
99	*Eucalyptus rudis*	622	No							-33.81730992	116.3981091
101	*Eucalyptus rudis*	1738	No						Hollows forming	-33.81752992	116.3976408
102	*Eucalyptus rudis*	1025	No							-33.81756325	116.3980591
103	*Eucalyptus rudis*	1532	No							-33.81760659	116.3982608
104	*Eucalyptus rudis*	898	No							-33.81870159	116.3996591
105	*Eucalyptus rudis*	865	No						Seven stems	-33.81883659	116.3997174
106	*Eucalyptus rudis*	944	No							-33.81890992	116.3997758
107	*Eucalyptus rudis*	1287	No							-33.81886159	116.3998108
108	*Eucalyptus rudis*	1242	No							-33.81857492	116.3996874
108	*Eucalyptus rudis*	1242	No							-33.81862992	116.3997408
109	*Eucalyptus rudis*	1744	No							-33.81828659	116.3984024
111	*Eucalyptus rudis*	1174	No							-33.81847992	116.3983774
113	*Eucalyptus rudis*	476	No						Hollows forming. Leader measured	-33.81855492	116.3984324
114	*Eucalyptus rudis*	818	No						Hollows forming	-33.81872325	116.3984241
115	*Eucalyptus rudis*	667	No							-33.81873992	116.3983791
116	*Eucalyptus rudis*	852	No						Hollows forming	-33.81874325	116.3984624

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
117	*Eucalyptus rudis*	1223	No						Hollows forming	-33.81879492	116.3983958
118	*Eucalyptus rudis*	416	No							-33.81876325	116.3982924
119	*Eucalyptus rudis*	704	No							-33.81879659	116.3982991
120	*Eucalyptus rudis*	631	No						Two stems	-33.81866325	116.3982774
121	*Eucalyptus rudis*	687	No							-33.81840825	116.3982541
122	*Eucalyptus rudis*	1116	No						Hollows forming	-33.81834992	116.3982358
123	*Eucalyptus rudis*	1396	No							-33.81834825	116.3983008
124	*Eucalyptus rudis*	653	No						Dead	-33.81839159	116.3982274
125	*Eucalyptus rudis*	786	No						Hollows forming	-33.81834159	116.3981608
126	*Eucalyptus rudis*	752	No							-33.81839159	116.3982091
127	*Corymbia calophylla*	454	No							-33.81843159	116.3981358
128	*Corymbia calophylla*	497	No							-33.81840659	116.3981374
129	*Eucalyptus rudis*	820	No							-33.81851992	116.3982041
130	*Eucalyptus rudis*	361	No							-33.81854992	116.3981391
131	*Eucalyptus rudis*	516	No						Leader measured. hollow forming	-33.81857825	116.3981641
132	*Eucalyptus rudis*	650	No							-33.81872992	116.3981924
132	*Eucalyptus rudis*	862	No							-33.81877159	116.3981324
133	*Eucalyptus rudis*	674	No							-33.81875492	116.3980024
134	*Eucalyptus rudis*	1236	No							-33.81860159	116.3980124
135	*Eucalyptus rudis*	707	No							-33.81858659	116.3980424
136	*Eucalyptus rudis*	342	No						Dead	-33.81852992	116.3980608
137	*Eucalyptus rudis*	487	No							-33.81847992	116.3981174
138	*Eucalyptus rudis*	1095	No						Dead	-33.81840992	116.3980124
139	*Eucalyptus rudis*	588	No							-33.81850325	116.3979508
140	*Eucalyptus rudis*	899	No						Dead	-33.81858159	116.3978474
141	*Eucalyptus rudis*	596	No							-33.81861825	116.3979358
142	*Eucalyptus rudis*	1378	No						Three leaders	-33.81856659	116.3977524
143	*Eucalyptus rudis*	679	No							-33.81846659	116.3977774
144	*Eucalyptus rudis*	468	No							-33.81849659	116.3978408
145	*Corymbia calophylla*	320	No						Old forest red-tailed cockatoo marri chewing	-33.81849992	116.3978424
146	*Corymbia calophylla*	638	No							-33.81845659	116.3978974
147	*Corymbia calophylla*	520	No							-33.81846659	116.3978774
148	*Corymbia calophylla*	993	No						Possum tracks	-33.81846825	116.3978191
149	*Eucalyptus rudis*	755	No							-33.81843325	116.3977858
150	*Eucalyptus rudis*	711	No						Hollows forming	-33.81836825	116.3978408
151	*Eucalyptus rudis*	668	No							-33.81836825	116.3978408
152	*Eucalyptus rudis*	775	No						Hollows forming	-33.81836825	116.3978408
153	*Eucalyptus rudis*	464	No							-33.81840992	116.3978991
154	*Eucalyptus rudis*	1714	No						Large tree with significant hollow forming potential	-33.81813492	116.3980724
155	*Corymbia calophylla*	1264	No						Raptor nest in canopy, possum scratching up trunk. Large tree with significant hollow forming potential.	-33.81355328	116.4010422
157	*Corymbia calophylla*	1634	No						Cockatoo feather and forest red-tailed cockatoo feeding debris beneath. Hollows forming	-33.81789118	116.4027618
158	*Corymbia calophylla*	1063	No						Old feed debris from forest red-tailed cockatoo, property boundary near riparian vegetation. Possum scratching up trunk	-33.81888207	116.4032055

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
159	*Eucalyptus rudis*	562	No						Advanced senescence	-33.81889975	116.4046468
160	*Eucalyptus rudis*	785	No						Advanced senescence	-33.81891688	116.404595
161	*Eucalyptus rudis*	666	No						Advanced senescence	-33.81894871	116.4046015
162	*Eucalyptus rudis*	838	No						Dead	-33.81896524	116.4044727
163	*Eucalyptus rudis*	1210	No						Significant hollow forming in branch near trunk.	-33.81871721	116.4065601
164	*Eucalyptus rudis*	823	No							-33.81846354	116.4061997
165	*Eucalyptus rudis*	1069	No							-33.81837775	116.406168
167	*Corymbia calophylla*	1160	No							-33.81136889	116.407908
168	*Corymbia calophylla*	1236	No						Large tree with significant hollow forming potential. Possum scratching up trunk. Corella feeding debris and old forest red-tailed cockatoo feeding debris beneath.	-33.81111472	116.4077859
169	*Eucalyptus wandoo*	445	No						Hollows forming	-33.81108259	116.4077458
170	*Eucalyptus wandoo*	361	No							-33.8110848	116.4076661
171	*Eucalyptus wandoo*	483	No						Hollows forming	-33.81115009	116.4077249
172	*Eucalyptus marginata*	1076	No							-33.81038863	116.4080369
173	*Eucalyptus wandoo*	785	No						Hollows forming	-33.81025815	116.4086189
175	*Corymbia calophylla*	881	No						Large quantity of fresh forest red-tailed cockatoo feeding debris, some corella	-33.81027736	116.4091644
176	*Corymbia calophylla*	1009	No						Large quantity of forest red-tailed cockatoo feeeding debris old and fresh. A few corella feeeding debris. Possum scratching up trunk. Hollows forming	-33.81038911	116.4091745
177	*Corymbia calophylla*	990	No						Large quantity of forest red-tailed cockatoo feeeding debris old and fresh. A few corella feeeding debris.	-33.8099539	116.4083096
178	*Corymbia calophylla*	822	No						Large quantity of forest red-tailed cockatoo feeeding debris old and fresh. A few corella feeeding debris.	-33.80989015	116.4082726
179	*Corymbia calophylla*	861	No						Large quantity of fresh forest red-tailed cockatoo feeeding debris and some Baudin's feeding debris	-33.80972458	116.4084378
180	*Corymbia calophylla*	1642	No						Large quantity of fresh forest red-tailed cockatoo feeeding debris. Hollows forming	-33.8093732	116.4077439
181	*Corymbia calophylla*	813	No						Large quantity of fresh forest red-tailed cockatoo feeeding debris	-33.80944081	116.4075652
182	*Corymbia calophylla*	959	No						Large quantity of fresh forest red-tailed cockatoo feeeding debris	-33.80950738	116.407266
183	*Corymbia calophylla*	1187	No						Some forest red-tailed cockatoo feeding debris beneath tree.	-33.80939823	116.4073051
184	*Corymbia calophylla*	990	No						Some forest red-tailed cockatoo feeding debris beneath tree. Hollows forming	-33.80935366	116.4074236
185	*Corymbia calophylla*	935	No						Some forest red-tailed cockatoo feeding debris beneath tree.	-33.80912308	116.4075586
186	*Corymbia calophylla*	956	No						Some forest red-tailed cockatoo feeding debris beneath tree.	-33.80914968	116.4073751
187	*Corymbia calophylla*	885	No						Some forest red-tailed cockatoo feeding debris beneath tree.	-33.80914931	116.407283
189	*Corymbia calophylla*	1201	No						Some forest red-tailed cockatoo feeding debris beneath tree.	-33.80890729	116.4077594
190	*Corymbia calophylla*	681	No						Just inside of fenceline. Forest red-tailed cockatoo feeding debris beneath tree.	-33.80730724	116.4092536
191	*Corymbia calophylla*	1002	No						Multiple small hollows forming where branches have been lost. Hollows forming	-33.80742412	116.409333
192	*Corymbia calophylla*	751	No							-33.80750393	116.4094823
193	*Corymbia calophylla*	1280	No						Four leaders. Possum scratching up trunk.	-33.80753873	116.4095477
195	*Eucalyptus wandoo*	454	No							-33.80839742	116.4096172
196	*Eucalyptus wandoo*	638	No						Raptor nest in canopy	-33.80838827	116.4096377
197	*Eucalyptus wandoo*	423	No						Two stems. Hollows forming	-33.80832535	116.4096073
198	*Eucalyptus wandoo*	770	No						Two leaders, one broken off.	-33.80830304	116.4095936
199	*Eucalyptus wandoo*	567	No						Hollows forming	-33.80828194	116.4096146
200	*Eucalyptus wandoo*	465	No							-33.808299	116.4096388
201	*Eucalyptus wandoo*	961	No						Primary crown broken off near base of tree.	-33.80826933	116.4096326
202	*Eucalyptus wandoo*	552	No						Hollows forming	-33.80829522	116.4096731

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
203	*Eucalyptus wandoo*	365	No						Hollows forming	-33.80835138	116.4096486
204	*Eucalyptus wandoo*	464	No						Two leaders	-33.80856592	116.4097514
205	*Eucalyptus wandoo*	593	No						Two leaders. Hollows forming	-33.80859006	116.4097877
206	*Eucalyptus wandoo*	573	No						Two leaders. Hollows forming	-33.80858883	116.4098023
207	*Eucalyptus wandoo*	608	No							-33.80862387	116.409773
209	*Eucalyptus wandoo*	607	No						Four leaders, two have broken off.	-33.80845121	116.4104411
210	*Eucalyptus wandoo*	618	No						Four leaders. Multiple hollows forming	-33.80845145	116.4104836
211	*Eucalyptus wandoo*	506	No							-33.80855562	116.4107603
213	*Corymbia calophylla*	1617	No						Old feed debris from forest red-tailed cockatoo	-33.81001009	116.4115912
214	*Corymbia calophylla*	1196	No							-33.81015609	116.411744
215	*Corymbia calophylla*	772	No							-33.81010403	116.4117627
216	*Corymbia calophylla*	871	No							-33.81013592	116.4117604
217	*Corymbia calophylla*	863	No						Hollows forming	-33.8100649	116.4118158
218	*Corymbia calophylla*	410	No							-33.81013819	116.4118085
219	*Corymbia calophylla*	507	No							-33.81013024	116.4118369
221	*Corymbia calophylla*	648	No							-33.81018859	116.4118128
222	*Corymbia calophylla*	850	No							-33.81018018	116.4118298
223	*Eucalyptus wandoo*	804	No						Hollows forming	-33.81166217	116.4123814
224	*Eucalyptus wandoo*	536	No							-33.8112644	116.410616
226	*Eucalyptus wandoo*	766	No						Dead.	-33.81152985	116.4110319
227	*Eucalyptus wandoo*	431	No						Dead.	-33.8116121	116.4106717
228	*Eucalyptus wandoo*	575	No							-33.81170162	116.4103972
230	*Eucalyptus wandoo*	920	No						Dead	-33.81183129	116.4098793
231	*Eucalyptus wandoo*	376	No							-33.81182157	116.4098882
232	*Corymbia calophylla*	2004	No						Large tree with significant hollow forming potential	-33.81097726	116.4101457
233	*Eucalyptus marginata*	1541	No							-33.81107059	116.4097337
234	*Corymbia calophylla*	1330	No						Large tree with significant hollow forming potential. Possum scratching up trunk	-33.81106078	116.4096431
235	*Corymbia calophylla*	1468	No						Large tree with significant hollow forming potential. Possum scratching up trunk	-33.81120503	116.4096235
236	*Eucalyptus wandoo*	783	No						Hollows forming	-33.8125142	116.407447
237	*Corymbia calophylla*	897	No							-33.81306601	116.4073008
239	*Corymbia calophylla*	501	No						Two leaders	-33.81294407	116.4072365
240	*Corymbia calophylla*	662	No						Three leaders	-33.81298784	116.4071275
241	*Corymbia calophylla*	1788	No						Large tree with significant hollow forming potential	-33.81440566	116.4071963
242	*Corymbia calophylla*	606	No							-33.81467884	116.4072048
243	*Corymbia calophylla*	1434	No							-33.81575272	116.4075608
244	*Eucalyptus wandoo*	537	No						Three leaders	-33.81619931	116.4088633
245	*Eucalyptus wandoo*	618	No						Two leaders	-33.81623958	116.4089807
246	*Corymbia calophylla*	401	No							-33.8162672	116.4089841
247	*Corymbia calophylla*	478	No							-33.81625915	116.409075
248	*Eucalyptus marginata*	362	No						Two leaders	-33.8162584	116.4090794
249	*Corymbia calophylla*	739	No							-33.81629637	116.4091756
250	*Eucalyptus wandoo*	440	No							-33.81631971	116.4090932
251	*Corymbia calophylla*	568	No							-33.8163467	116.4091156

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
252	*Corymbia calophylla*	400	No							-33.81632608	116.4091397
253	*Eucalyptus marginata*	858	No						On same base as 254	-33.81624109	116.4092145
254	*Corymbia calophylla*	501	No						On same base as 253	-33.81624109	116.4092145
255	*Corymbia calophylla*	440	No							-33.81628287	116.4092946
256	*Corymbia calophylla*	586	No							-33.81631367	116.4093152
257	*Corymbia calophylla*	424	No							-33.81637541	116.4092483
258	*Corymbia calophylla*	366	No							-33.81641069	116.4091931
259	*Corymbia calophylla*	420	No							-33.81643798	116.4092601
260	*Corymbia calophylla*	648	No							-33.81647402	116.4092536
261	*Corymbia calophylla*	645	No							-33.81648348	116.409281
262	*Corymbia calophylla*	809	No							-33.81647968	116.4093004
264	*Corymbia calophylla*	460	No						Four leaders	-33.81635555	116.4095154
265	*Corymbia calophylla*	625	No							-33.81630475	116.4094131
265	*Corymbia calophylla*	392	No							-33.81639399	116.4094793
266	*Corymbia calophylla*	539	No							-33.81639884	116.4094764
267	*Corymbia calophylla*	584	No							-33.81638154	116.4094814
268	*Eucalyptus wandoo*	438	No						Four leaders	-33.81643045	116.4095205
269	*Corymbia calophylla*	553	No							-33.81647675	116.4096749
270	*Corymbia calophylla*	640	No							-33.81648819	116.4097535
271	*Corymbia calophylla*	714	No							-33.81653572	116.4097989
272	*Eucalyptus marginata*	405	No							-33.81654531	116.4098397
273	*Eucalyptus marginata*	720	No							-33.81650031	116.4098431
274	*Corymbia calophylla*	1023	No						Large tree with significant hollow forming potential	-33.81652748	116.4099919
275	*Eucalyptus marginata*	626	No						On same base as 276	-33.81669246	116.4098909
276	*Eucalyptus wandoo*	492	No						On same base as 275, 2 stems	-33.81669246	116.4098909
277	*Corymbia calophylla*	1020	No							-33.8136733	116.409474
278	*Corymbia calophylla*	1271	No						Possum scratching up trunk	-33.81362627	116.4093744
279	*Corymbia calophylla*	396	No							-33.8136187	116.4093864
281	*Eucalyptus wandoo*	428	No							-33.8135937	116.4095515
283	*Corymbia calophylla*	507	No						Dead	-33.81348264	116.4094748
284	*Eucalyptus wandoo*	379	No							-33.81350729	116.40955
285	*Eucalyptus wandoo*	418	No							-33.81344238	116.4095439
286	*Eucalyptus wandoo*	565	No						Four leaders. Hollows forming	-33.81338079	116.4095636
287	*Eucalyptus marginata*	1582	No						Hollows forming	-33.81253977	116.4102209
288	*Corymbia calophylla*	1303	No						Two out of three leaders dead. Hollows forming	-33.81242427	116.411561
289	*Corymbia calophylla*	997	No						Large tree with significant hollow forming potential	-33.81236006	116.4120884
290	*Corymbia calophylla*	1278	No						Large tree with significant hollow forming potential. Forest red-tailed cockatoo feeeding debris beneath	-33.81243831	116.4140152
291	*Eucalyptus rudis*	2456	No						Large tree with significant hollow forming potential. Large burls at base. Hollows forming	-33.81280092	116.4157497
292	*Eucalyptus rudis*	417	No							-33.8128126	116.4157847
293	*Corymbia calophylla*	518	No						Two leaders	-33.81282744	116.4157893
294	*Corymbia calophylla*	931	No						Two leaders. Hollows forming	-33.81275911	116.4158566
295	*Eucalyptus rudis*	1450	No						Burls. Hollows forming	-33.81274197	116.4159041

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
296	*Eucalyptus rudis*	981	No							-33.81300764	116.4159442
297	*Eucalyptus rudis*	1049	No						Hollows forming	-33.81290794	116.4160439
298	*Eucalyptus rudis*	1495	No						Large tree with multiple hollows forming. Burls on lower trunk	-33.81305824	116.4160246
299	*Corymbia calophylla*	740	No						Possum scratching up trunk	-33.8126427	116.4162549
301	*Corymbia calophylla*	1048	No						Baudins and forest red tailed black cockatoo feeding debris beneath. Two leaders. Possum scratching up trunk.	-33.81279524	116.4163074
302	*Eucalyptus rudis*	859	No						Five leaders	-33.81335075	116.4160355
303	*Corymbia calophylla*	359	No						Three leaders	-33.81350522	116.4162888
304	*Corymbia calophylla*	366	No						Four leaders	-33.81350574	116.416424
307	*Eucalyptus marginata*	480	No						Burnt dead stag. Rotten	-33.81386428	116.4162691
308	*Eucalyptus marginata*	609	No						Two leaders	-33.81397021	116.4162755
309	*Eucalyptus marginata*	437	No						Dead stag	-33.81385824	116.4157005
310	*Eucalyptus marginata*	682	No						Dead stag	-33.81365888	116.4155488
311	*Eucalyptus marginata*	506	No						Burnt dead stag. Rotten	-33.81365894	116.4157218
312	*Corymbia calophylla*	782	No						Baudins black cockatoo feed debris beneath. Hollows forming	-33.81318958	116.4150437
313	*Corymbia calophylla*	1214	No						Hollows forming	-33.81304077	116.414994
314	*Corymbia calophylla*	800	No							-33.81308216	116.4151771
315	*Corymbia calophylla*	1378	No						Large quantity of fresh forest red-tailed cockatoo feeding debris beneath	-33.81338647	116.4150084
316	*Eucalyptus wandoo*	1020	No						Multiple significant hollows forming.	-33.8135417	116.4149721
317	*Eucalyptus wandoo*	497	No							-33.81352502	116.4149928
318	*Eucalyptus marginata*	871	No							-33.81349772	116.4149013
319	*Corymbia calophylla*	629	No							-33.81330349	116.4153816
320	*Corymbia calophylla*	353	No							-33.81329146	116.4154049
321	*Corymbia calophylla*	587	No						Four leaders	-33.81322976	116.4154344
322	*Corymbia calophylla*	506	No							-33.8132104	116.4154323
323	*Corymbia calophylla*	922	No						Branches just above DBH	-33.81336377	116.4154689
324	*Corymbia calophylla*	410	No							-33.8133301	116.4154805
325	*Corymbia calophylla*	602	No							-33.81332025	116.4155011
326	*Corymbia calophylla*	415	No						Dead	-33.81330921	116.4156001
327	*Corymbia calophylla*	346	No							-33.81328836	116.4155653
328	*Corymbia calophylla*	747	No						Two leaders	-33.81330332	116.4155612
329	*Corymbia calophylla*	643	No							-33.81337259	116.4155962
330	*Corymbia calophylla*	443	No						Two leaders. Hollow forming in lower branch	-33.81337483	116.4155647
331	*Corymbia calophylla*	659	No						Baudins black cockatoo feed debris beneath.	-33.81331991	116.4156342
332	*Corymbia calophylla*	490	No						Dead	-33.81345293	116.4155621
333	*Eucalyptus wandoo*	788	No						Large tree with significant hollows forming	-33.81359828	116.4151993
334	*Corymbia calophylla*	920	No						Significant quantity of forest red-tailed cockatoo feeding debris. Possum scratching up trunk	-33.81372748	116.4151292
335	*Corymbia calophylla*	931	No						Significant quantity of forest red-tailed cockatoo feeding debris. Possum scratching up trunk	-33.81375907	116.4151116
336	*Corymbia calophylla*	892	No						Possum scratching up trunk	-33.81382941	116.4149309
337	*Corymbia calophylla*	876	No						Possum scratching up trunk	-33.81384441	116.4149825
339	*Corymbia calophylla*	669	No							-33.81389835	116.4147999
340	*Corymbia calophylla*	619	No						Dead	-33.81411772	116.4159718
341	*Eucalyptus rudis*	508	No							-33.81413543	116.4161544

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
342	*Corymbia calophylla*	661	No							-33.81415048	116.416181
343	*Eucalyptus marginata*	548	No						Dead. Hollows forming	-33.81401335	116.4163352
344	*Eucalyptus marginata*	590	No							-33.8140566	116.4163965
345	*Eucalyptus marginata*	461	No							-33.81396016	116.4164013
346	*Eucalyptus rudis*	1757	No						Hollows forming	-33.81432067	116.4163539
347	*Eucalyptus rudis*	748	No							-33.81429879	116.4164614
348	*Eucalyptus wandoo*	698	No							-33.81453157	116.4163847
349	*Corymbia calophylla*	566	No						Dead	-33.81453167	116.4163989
350	*Corymbia calophylla*	497	No							-33.81458122	116.4163392
351	*Corymbia calophylla*	1043	No						Multiple leaders	-33.81439611	116.4161163
352	*Corymbia calophylla*	608	No							-33.81438692	116.4160299
353	*Corymbia calophylla*	596	No							-33.81435282	116.4160037
354	*Corymbia calophylla*	665	No						Branches just above DBH	-33.81425269	116.4158224
355	*Corymbia calophylla*	690	No						Fresh forest red-tailed cockatoo feeeding debris	-33.81433651	116.4150294
356	*Corymbia calophylla*	1064	No						Large tree with significant hollow forming potential	-33.81444574	116.4150004
357	*Corymbia calophylla*	691	No						Hollows forming	-33.81445877	116.4149912
358	*Corymbia calophylla*	834	No							-33.81448081	116.4150377
359	*Corymbia calophylla*	871	No							-33.81429753	116.4151193
360	*Eucalyptus wandoo*	392	No							-33.81457774	116.4149901
361	*Corymbia calophylla*	964	No						Forest red-tailed cockatoo feeeding debris beneath	-33.81431102	116.4147307
362	*Corymbia calophylla*	1072	No						Forest red-tailed cockatoo feeeding debris beneath	-33.81423895	116.4146406
363	*Corymbia calophylla*	743	No						Hollows forming	-33.81462986	116.4145586
364	*Corymbia calophylla*	744	No							-33.81472449	116.4145133
365	*Corymbia calophylla*	879	No							-33.81475062	116.4147371
366	*Corymbia calophylla*	975	No						Dead	-33.81503104	116.4148242
367	*Corymbia calophylla*	362	No						Dead	-33.81492786	116.4148316
368	*Corymbia calophylla*	1622	No						Large tree with significant hollow forming potential. Some corella feeding beneath.	-33.81507517	116.4148963
369	*Eucalyptus marginata*	562	No							-33.81505759	116.4147916
370	*Corymbia calophylla*	1290	No						Large tree with significant hollow forming potential. Baudins feeeding debris beneath. Possum scratching up trunk	-33.81482748	116.4153944
371	*Corymbia calophylla*	901	No							-33.81475562	116.4153986
372	*Corymbia calophylla*	520	No							-33.81485787	116.4154924
373	*Corymbia calophylla*	627	No							-33.81449258	116.4157462
375	*Eucalyptus marginata*	1227	No							-33.81495212	116.4158431
376	*Corymbia calophylla*	877	No						Beehive in shallow depression in fork at base of tree.	-33.81436324	116.4144368
377	*Corymbia calophylla*	1221	No						Divides just above DBH	-33.81453632	116.4143124
378	*Corymbia calophylla*	796	No							-33.81449898	116.4142314
379	*Corymbia calophylla*	450	No						Two leaders	-33.8143451	116.4142329
380	*Corymbia calophylla*	691	No							-33.81429603	116.413956
381	*Corymbia calophylla*	1006	No							-33.81430613	116.4139019
382	*Eucalyptus marginata*	554	No							-33.81424452	116.4138665
383	*Corymbia calophylla*	831	No							-33.81423627	116.4138392
384	*Corymbia calophylla*	526	No							-33.81424082	116.413909

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
385	*Corymbia calophylla*	1812	No						Large tree with significant hollow forming potential. Possum scratching up trunk.	-33.8144426	116.4134149
387	*Corymbia calophylla*	1496	No						Large tree with significant hollow forming potential. Possum scratching up trunk.	-33.81500707	116.413773
389	*Corymbia calophylla*	1252	No							-33.81469065	116.4126262
390	*Corymbia calophylla*	758	No							-33.81473625	116.4127646
391	*Corymbia calophylla*	1004	No							-33.81487112	116.4127101
392	*Corymbia calophylla*	652	No							-33.81482979	116.4128324
393	*Corymbia calophylla*	751	No						Hollows forming	-33.81487752	116.412816
394	*Corymbia calophylla*	658	No						Hollows forming	-33.8149564	116.4127427
395	*Corymbia calophylla*	581	No							-33.81491533	116.4127191
396	*Corymbia calophylla*	401	No							-33.8150465	116.4127632
397	*Corymbia calophylla*	760	No							-33.8150555	116.4127774
398	*Corymbia calophylla*	745	No						Three stems. Hollows forming	-33.81513463	116.412787
399	*Corymbia calophylla*	1030	No						Dead	-33.81514356	116.4128079
400	*Corymbia calophylla*	815	No						Dead	-33.81523388	116.4128566
401	*Corymbia calophylla*	819	No							-33.8152558	116.4129109
402	*Corymbia calophylla*	858	No							-33.81541359	116.4129034
403	*Corymbia calophylla*	885	No						Two stems	-33.81552335	116.4129211
404	*Corymbia calophylla*	1849	No							-33.81548945	116.4126064
405	*Corymbia calophylla*	935	No							-33.81583071	116.4138101
406	*Corymbia calophylla*	1217	No							-33.81586487	116.4138558
407	*Corymbia calophylla*	659	No							-33.81585118	116.4138505
408	*Corymbia calophylla*	810	No						Three leaders	-33.81601053	116.4140636
409	*Corymbia calophylla*	1315	No						Two stems	-33.81587099	116.4143432
410	*Eucalyptus wandoo*	1060	No						Large tree with multiple significant hollows forming.	-33.81563332	116.4148232
411	*Eucalyptus wandoo*	334	No						Dead	-33.81558859	116.4148337
412	*Corymbia calophylla*	1309	No							-33.8153686	116.4151947
413	*Eucalyptus marginata*	1292	No							-33.81540579	116.4159729
414	*Eucalyptus marginata*	651	No							-33.81569321	116.4157698
415	*Eucalyptus marginata*	1015	No							-33.81572632	116.4156768
416	*Corymbia calophylla*	1020	No							-33.8161211	116.4153107
417	*Eucalyptus rudis*	803	No						Six leaders. Forming hollow in lower branch has potential to develop into a cockatoo hollow.	-33.81660956	116.4164256
418	*Corymbia calophylla*	647	No						Corella feeding debris beneath.	-33.81673393	116.4166241
419	*Corymbia calophylla*	1156	No						Corella and forest red-tailed cockatoo feeeding debris	-33.81679405	116.4166212
420	*Corymbia calophylla*	710	No							-33.81702723	116.4166381
421	*Corymbia calophylla*	1229	No						Multiple significant hollows forming.	-33.81649192	116.4159428
422	*Corymbia calophylla*	880	No						Hollows forming	-33.8166393	116.4156084
423	*Corymbia calophylla*	1887	No						Hollows forming	-33.81698524	116.4143505
424	*Corymbia calophylla*	993	No						Forest red-tailed cockatoo feeeding debris	-33.81710145	116.4138101
425	*Eucalyptus wandoo*	710	No						Hollows forming	-33.81740685	116.4137553
426	*Eucalyptus rudis*	616	No							-33.82012773	116.4133822
427	*Eucalyptus rudis*	1134	No						Multiple leaders.	-33.82016836	116.4134777
428	*Eucalyptus rudis*	686	No							-33.82000059	116.4136412
429	*Eucalyptus rudis*	796	No						Multiple leaders.	-33.81989834	116.4136092

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
430	*Eucalyptus rudis*	818	No						Multiple leaders.	-33.82031199	116.4136229
431	*Eucalyptus rudis*	566	No						Multiple leaders.	-33.82048214	116.4134949
432	*Eucalyptus rudis*	623	No						Four stems	-33.82059725	116.41333
433	*Eucalyptus rudis*	572	No							-33.82063747	116.4132958
434	*Eucalyptus rudis*	1210	No							-33.82075578	116.413104
435	*Eucalyptus marginata*	731	No							-33.82059687	116.4130169
436	*Corymbia calophylla*	973	No							-33.82080399	116.4128704
437	*Eucalyptus rudis*	934	No							-33.82023421	116.4139503
438	*Eucalyptus rudis*	855	No							-33.82026395	116.4141082
439	*Eucalyptus rudis*	754	No						Multiple leaders. Hollow butted.	-33.8199656	116.4140821
441	*Eucalyptus rudis*	582	No							-33.81970203	116.4145396
442	*Corymbia calophylla*	594	No							-33.81963966	116.4144897
443	*Corymbia calophylla*	739	No							-33.81965741	116.4145182
444	*Corymbia calophylla*	792	No							-33.81958025	116.4145673
445	*Corymbia calophylla*	396	No							-33.81954259	116.4145105
446	*Eucalyptus rudis*	534	No						Multiple leaders	-33.81953407	116.41488
447	*Eucalyptus rudis*	662	No						Multiple leaders	-33.81944524	116.4147735
448	*Eucalyptus rudis*	923	No						Multiple leaders	-33.8194032	116.4148899
449	*Eucalyptus rudis*	671	No						Multiple leaders	-33.81948908	116.4150509
450	*Eucalyptus rudis*	552	No						Multiple leaders	-33.81955836	116.4150488
451	*Corymbia calophylla*	1026	No						Possum scratching up trunk.	-33.81936035	116.4152359
452	*Eucalyptus rudis*	477	No							-33.81928844	116.4152405
453	*Eucalyptus rudis*	803	No							-33.81928972	116.4152183
454	*Eucalyptus rudis*	618	No						Multiple leaders	-33.81930294	116.4154294
455	*Eucalyptus rudis*	923	No							-33.81914412	116.4151222
456	*Eucalyptus rudis*	834	No							-33.81917405	116.4155147
457	*Eucalyptus rudis*	497	No							-33.81912522	116.4156327
458	*Eucalyptus rudis*	975	No							-33.81907717	116.4155913
459	*Corymbia calophylla*	910	No							-33.81907216	116.4155287
460	*Eucalyptus rudis*	1347	No						Multiple leaders.	-33.81875992	116.4158834
461	*Eucalyptus marginata*	926	No						Multiple small hollows forming in dead branches.	-33.81890192	116.4161437
462	*Eucalyptus rudis*	1414	No							-33.81953187	116.4135713
463	*Eucalyptus rudis*	835	No							-33.81929944	116.4137943
464	*Eucalyptus rudis*	989	No							-33.81930233	116.4138951
465	*Eucalyptus rudis*	724	No							-33.81940478	116.4139866
466	*Eucalyptus rudis*	635	No						Hollow butted.	-33.81957178	116.4141051
467	*Eucalyptus rudis*	581	No							-33.81962964	116.4141029
468	*Eucalyptus rudis*	518	No							-33.81958311	116.4141209
469	*Eucalyptus rudis*	482	No							-33.81962055	116.4141958
470	*Eucalyptus rudis*	491	No							-33.81957983	116.414284
471	*Eucalyptus rudis*	487	No							-33.81956389	116.4141471
472	*Eucalyptus rudis*	690	No							-33.81944637	116.41411
473	*Eucalyptus rudis*	744	No							-33.81946696	116.4141734

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
474	*Eucalyptus rudis*	498	No							-33.81943863	116.4142438
475	*Eucalyptus rudis*	780	No						Multiple leader	-33.81931181	116.4142901
476	*Eucalyptus rudis*	493	No							-33.81942189	116.4143389
477	*Eucalyptus rudis*	599	No							-33.81940501	116.4144093
478	*Eucalyptus rudis*	1054	No						Multiple leader	-33.81931053	116.4141084
479	*Eucalyptus rudis*	552	No						Multiple leader	-33.81914739	116.4141021
480	*Eucalyptus rudis*	1181	No						Double leader. Hollows forming	-33.81914063	116.4140023
481	*Eucalyptus rudis*	425	No							-33.81903459	116.4141276
482	*Eucalyptus rudis*	1008	No						Multiple leader	-33.81900118	116.4142307
483	*Eucalyptus rudis*	436	No						Double leader	-33.81909969	116.414209
484	*Eucalyptus rudis*	862	No						Multiple leader	-33.81907729	116.4143814
485	*Eucalyptus rudis*	557	No						Multiple leader	-33.81922675	116.4146133
486	*Eucalyptus rudis*	659	No						Multiple leader	-33.81918157	116.4147508
487	*Eucalyptus rudis*	1029	No							-33.81892742	116.4146161
488	*Eucalyptus rudis*	509	No							-33.81892256	116.4143925
489	*Eucalyptus rudis*	599	No							-33.81877676	116.4145605
490	*Eucalyptus rudis*	702	No							-33.81879535	116.4147099
491	*Eucalyptus rudis*	501	No							-33.81887467	116.4147932
492	*Eucalyptus rudis*	633	No							-33.81886471	116.4148914
493	*Eucalyptus rudis*	819	No							-33.81874573	116.4147414
494	*Eucalyptus rudis*	1015	No							-33.81868069	116.4147312
495	*Eucalyptus rudis*	631	No							-33.81867261	116.415008
496	*Eucalyptus rudis*	997	No							-33.81867817	116.4150189
497	*Eucalyptus rudis*	806	No							-33.81872999	116.4150619
498	*Eucalyptus rudis*	801	No							-33.81879663	116.4152503
499	*Eucalyptus rudis*	471	No							-33.81870739	116.4152055
500	*Eucalyptus rudis*	790	No							-33.81857963	116.4153797
501	*Eucalyptus marginata*	880	No							-33.81851372	116.4152663
502	*Corymbia calophylla*	572	No							-33.81856922	116.4151739
503	*Eucalyptus rudis*	781	No							-33.81831179	116.4152605
504	*Eucalyptus rudis*	874	No							-33.8183233	116.4151011
505	*Eucalyptus rudis*	1395	No							-33.81835733	116.4149942
506	*Corymbia calophylla*	1268	No							-33.81825477	116.4151941
507	*Corymbia calophylla*	985	No							-33.81813927	116.4152714
508	*Eucalyptus marginata*	395	No							-33.81814148	116.4152356
509	*Corymbia calophylla*	983	No							-33.81818573	116.4153021
510	*Corymbia calophylla*	522	No							-33.81818729	116.4154227
511	*Corymbia calophylla*	671	No							-33.81819727	116.4154612
512	*Corymbia calophylla*	1036	No							-33.8181077	116.4155163
513	*Corymbia calophylla*	378	No							-33.81812976	116.4155095
514	*Corymbia calophylla*	529	No							-33.81822944	116.4155285
515	*Corymbia calophylla*	1095	No						Baudins black cockatoo feed debris.	-33.81816364	116.4158651
517	*Corymbia calophylla*	791	No						Hollows forming	-33.81800538	116.4159839

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
519	*Eucalyptus rudis*	750	No							-33.81800374	116.4161231
520	*Eucalyptus rudis*	746	No							-33.81777948	116.4162272
521	*Eucalyptus rudis*	630	No							-33.81767727	116.4163193
522	*Corymbia calophylla*	611	No							-33.81798153	116.4164737
523	*Corymbia calophylla*	1196	No							-33.81805356	116.4165083
524	*Corymbia calophylla*	603	No							-33.81785189	116.416586
525	*Corymbia calophylla*	878	No							-33.81810874	116.4166184
526	*Corymbia calophylla*	595	No							-33.81813174	116.4165731
527	*Corymbia calophylla*	783	No							-33.81829823	116.4165345
528	*Corymbia calophylla*	462	No							-33.8182996	116.4166072
529	*Corymbia calophylla*	519	No							-33.8183651	116.4165702
530	*Corymbia calophylla*	479	No							-33.81837333	116.4165038
531	*Corymbia calophylla*	1199	No						Hollow butted.	-33.81973258	116.4130824
533	*Corymbia calophylla*	882	No							-33.81813707	116.4131854
535	*Eucalyptus wandoo*	640	No						Hollows forming	-33.81794216	116.4117629
536	*Eucalyptus marginata*	634	No							-33.81797993	116.4117703
537	*Eucalyptus marginata*	1604	No						Multiple leaders.	-33.81815852	116.411614
538	*Eucalyptus marginata*	400	No						Dead. Three stems	-33.81819355	116.4118577
539	*Eucalyptus wandoo*	668	No							-33.81811655	116.4118919
540	*Eucalyptus wandoo*	760	No							-33.81820472	116.4120108
541	*Eucalyptus wandoo*	310	No							-33.8181589	116.4120362
542	*Eucalyptus wandoo*	479	No							-33.81826016	116.4120944
543	*Eucalyptus wandoo*	734	No							-33.81794991	116.412162
544	*Eucalyptus wandoo*	518	No							-33.81809085	116.4124259
545	*Eucalyptus marginata*	954	No							-33.81822463	116.4125093
546	*Eucalyptus wandoo*	343	No							-33.81823875	116.4122483
547	*Eucalyptus wandoo*	361	No							-33.81829515	116.4122136
548	*Eucalyptus wandoo*	451	No						Hollows forming	-33.81839879	116.4122026
549	*Eucalyptus wandoo*	454	No							-33.81842636	116.4122487
550	*Eucalyptus wandoo*	477	No							-33.81843499	116.4123394
551	*Eucalyptus wandoo*	450	No							-33.81856848	116.4121388
552	*Eucalyptus wandoo*	472	No							-33.81853095	116.412378
553	*Eucalyptus marginata*	567	No							-33.81840907	116.4124585
554	*Eucalyptus wandoo*	501	No							-33.81856896	116.4123906
555	*Eucalyptus wandoo*	476	No							-33.81850145	116.4124637
556	*Eucalyptus wandoo*	474	No							-33.81854024	116.4125152
558	*Eucalyptus marginata*	1373	No						Hollow butted. Dead.	-33.8184519	116.4127281
559	*Eucalyptus marginata*	628	No							-33.81840087	116.4126541
560	*Corymbia calophylla*	546	No							-33.81856854	116.4127515
561	*Eucalyptus marginata*	333	No							-33.81841416	116.4127124
562	*Eucalyptus wandoo*	512	No							-33.81864804	116.4127273
563	*Corymbia calophylla*	524	No							-33.81866913	116.4127415
564	*Corymbia calophylla*	689	No							-33.81871202	116.4127472

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
565	*Eucalyptus wandoo*	475	No						Hollows forming	-33.81870795	116.4128337
566	*Corymbia calophylla*	415	No							-33.8188769	116.4127354
567	*Eucalyptus wandoo*	475	No							-33.81880732	116.4128946
568	*Eucalyptus wandoo*	404	No							-33.81890763	116.4129324
569	*Eucalyptus wandoo*	444	No							-33.81875877	116.4131246
571	*Eucalyptus wandoo*	493	No							-33.81884732	116.4131733
571	*Eucalyptus wandoo*	396	No							-33.81886207	116.4133011
572	*Eucalyptus wandoo*	618	No						Hollows forming	-33.81888101	116.4131418
574	*Corymbia calophylla*	817	No							-33.81910472	116.4127167
575	*Corymbia calophylla*	648	No							-33.81918497	116.4127931
576	*Eucalyptus wandoo*	340	No							-33.81925644	116.4128759
577	*Eucalyptus marginata*	382	No							-33.81933217	116.4127795
578	*Corymbia calophylla*	572	No							-33.81937614	116.4126512
579	*Eucalyptus marginata*	468	No							-33.81938737	116.412752
580	*Corymbia calophylla*	721	No							-33.81949376	116.4127167
581	*Eucalyptus marginata*	408	No							-33.81941917	116.4125797
582	*Corymbia calophylla*	565	No							-33.81951083	116.4126297
583	*Corymbia calophylla*	407	No							-33.81938636	116.4125831
584	*Eucalyptus marginata*	360	No							-33.81932761	116.4125064
585	*Eucalyptus wandoo*	350	No							-33.81929694	116.4125666
586	*Corymbia calophylla*	337	No							-33.8192826	116.4126356
587	*Eucalyptus marginata*	392	No							-33.8195814	116.4125237
588	*Eucalyptus marginata*	540	No							-33.81944698	116.4124932
589	*Corymbia calophylla*	1146	No							-33.81959352	116.41242
590	*Corymbia calophylla*	302	No							-33.81950331	116.4124322
591	*Corymbia calophylla*	468	No							-33.8195763	116.412392
592	*Corymbia calophylla*	331	No							-33.81961637	116.412343
593	*Eucalyptus marginata*	791	No						Severely hollow butted. Hollows forming	-33.81969722	116.4123058
594	*Corymbia calophylla*	693	No							-33.81973465	116.4124019
595	*Corymbia calophylla*	678	No							-33.81969466	116.4125152
596	*Corymbia calophylla*	343	No							-33.82001402	116.4124211
597	*Corymbia calophylla*	969	No							-33.82005903	116.4125363
597	*Corymbia calophylla*	350	No							-33.82002347	116.4124463
599	*Corymbia calophylla*	1839	No						Large tree with significant hollow forming potential. Hollows forming	-33.82024114	116.4121708
600	*Corymbia calophylla*	601	No							-33.81974603	116.4121703
601	*Corymbia calophylla*	404	No							-33.81970811	116.4121751
602	*Corymbia calophylla*	473	No							-33.81965763	116.412267
603	*Corymbia calophylla*	371	No							-33.81971438	116.4121413
604	*Corymbia calophylla*	439	No							-33.8197873	116.4120344
605	*Corymbia calophylla*	821	No							-33.81974978	116.4119329
606	*Eucalyptus wandoo*	619	No							-33.81983836	116.4119971
607	*Corymbia calophylla*	430	No							-33.81983134	116.411835
608	*Eucalyptus marginata*	354	No							-33.81966651	116.4118188

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
609	*Eucalyptus marginata*	1474	No						Multiple leaders	-33.81988103	116.4117854
610	*Eucalyptus marginata*	1711	No						Hollows forming	-33.819663	116.4115761
611	*Eucalyptus marginata*	301	No							-33.81964981	116.4117368
612	*Corymbia calophylla*	437	No							-33.81959503	116.4118464
613	*Corymbia calophylla*	456	No							-33.81956987	116.4117974
615	*Eucalyptus marginata*	567	No							-33.81945337	116.4116298
616	*Eucalyptus marginata*	398	No							-33.81939903	116.4116604
617	*Eucalyptus marginata*	467	No							-33.8195252	116.4121687
618	*Corymbia calophylla*	346	No							-33.8195588	116.4119749
619	*Eucalyptus marginata*	915	No							-33.81946989	116.4121994
620	*Corymbia calophylla*	327	No							-33.81934215	116.4122837
621	*Corymbia calophylla*	342	No							-33.81929515	116.4122413
622	*Eucalyptus marginata*	399	No							-33.81936972	116.4120514
623	*Corymbia calophylla*	324	No							-33.81925543	116.4120324
624	*Eucalyptus wandoo*	451	No							-33.8191609	116.4118401
625	*Eucalyptus marginata*	402	No							-33.81912617	116.411802
626	*Eucalyptus wandoo*	319	No							-33.81911385	116.4119308
627	*Eucalyptus wandoo*	430	No							-33.81904331	116.4118687
628	*Eucalyptus wandoo*	832	No							-33.81903706	116.411844
629	*Eucalyptus wandoo*	399	No							-33.81894718	116.4122389
630	*Eucalyptus wandoo*	335	No							-33.8189537	116.4123335
631	*Eucalyptus wandoo*	482	No							-33.81894823	116.4125574
632	*Eucalyptus wandoo*	442	No							-33.81898023	116.4126392
633	*Eucalyptus wandoo*	513	No							-33.81895391	116.4126861
634	*Eucalyptus wandoo*	405	No							-33.81879518	116.4126452
635	*Eucalyptus marginata*	355	No							-33.81880952	116.4125635
636	*Eucalyptus marginata*	319	No							-33.81878915	116.4124514
637	*Corymbia calophylla*	398	No							-33.81883672	116.4123871
638	*Eucalyptus wandoo*	357	No							-33.81881803	116.4123331
639	*Eucalyptus wandoo*	448	No							-33.81878815	116.4121637
640	*Eucalyptus wandoo*	543	No							-33.81875508	116.4121321
641	*Eucalyptus wandoo*	357	No							-33.81880231	116.4120602
642	*Eucalyptus wandoo*	440	No							-33.81878559	116.4120734
643	*Eucalyptus wandoo*	491	No							-33.81879492	116.4120528
644	*Eucalyptus wandoo*	458	No							-33.81870576	116.4119359
645	*Eucalyptus wandoo*	449	No						Hollows forming	-33.8186552	116.4120363
646	*Eucalyptus wandoo*	807	No						Significant hollow forming in lower fork. Hollows forming	-33.81840563	116.4119602
647	*Eucalyptus marginata*	890	No							-33.81867616	116.4118536
648	*Corymbia calophylla*	402	No							-33.81875572	116.4119203
649	*Eucalyptus marginata*	1035	No						Significant hollow forming. Hollows forming	-33.81881412	116.4117163
650	*Eucalyptus marginata*	956	No							-33.81884632	116.4116008
651	*Eucalyptus marginata*	1182	No							-33.81738564	116.4125665
652	*Eucalyptus marginata*	968	No						Hollows forming	-33.81745753	116.4112937

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
653	*Eucalyptus marginata*	1256	No						Large tree with significant hollow forming potential	-33.81774181	116.4111016
654	*Eucalyptus marginata*	1643	No						Large tree with significant hollow forming potential	-33.8185394	116.411013
655	*Eucalyptus marginata*	770	No							-33.81946047	116.4111877
656	*Eucalyptus marginata*	625	No							-33.81942501	116.4112849
657	*Eucalyptus marginata*	630	No							-33.81940558	116.4113458
658	*Eucalyptus marginata*	1261	No							-33.81972128	116.4107139
659	*Eucalyptus marginata*	893	No							-33.81965238	116.4108567
660	*Eucalyptus marginata*	1329	No							-33.81982938	116.4107835
661	*Eucalyptus marginata*	540	No							-33.81992407	116.4108126
662	*Eucalyptus marginata*	653	No							-33.81995041	116.4107722
663	*Eucalyptus wandoo*	422	No						Hollows forming	-33.81987859	116.4108556
664	*Eucalyptus marginata*	390	No							-33.82006102	116.4107309
665	*Eucalyptus marginata*	578	No							-33.82016916	116.4107821
666	*Eucalyptus marginata*	776	No							-33.82010421	116.4108459
667	*Eucalyptus marginata*	417	No							-33.82009795	116.4109088
668	*Eucalyptus marginata*	456	No							-33.82000537	116.4110031
669	*Eucalyptus marginata*	478	No						Dead	-33.82000255	116.4110886
670	*Eucalyptus marginata*	576	No						Dead	-33.82001668	116.4111094
671	*Eucalyptus marginata*	515	No							-33.82009581	116.4111049
672	*Eucalyptus wandoo*	413	No							-33.82004597	116.4111476
673	*Eucalyptus marginata*	514	No							-33.82019288	116.410977
674	*Eucalyptus wandoo*	379	No							-33.82017581	116.4112234
675	*Eucalyptus wandoo*	509	No							-33.82025855	116.4111027
676	*Eucalyptus wandoo*	473	No							-33.82028306	116.4110025
677	*Eucalyptus marginata*	905	No							-33.82030021	116.410966
678	*Eucalyptus marginata*	893	No							-33.82035508	116.410876
679	*Eucalyptus marginata*	671	No							-33.82035154	116.4112084
680	*Eucalyptus wandoo*	646	No							-33.82054185	116.411353
681	*Eucalyptus marginata*	1365	No							-33.8206411	116.41113
682	*Eucalyptus marginata*	400	No							-33.8204268	116.4110845
683	*Eucalyptus marginata*	1251	No							-33.82023997	116.4113601
684	*Eucalyptus marginata*	745	No							-33.82020425	116.4114931
685	*Eucalyptus marginata*	856	No							-33.82024508	116.4116027
686	*Eucalyptus marginata*	898	No							-33.81956556	116.4101142
687	*Eucalyptus marginata*	510	No							-33.81980095	116.410256
688	*Corymbia calophylla*	943	No						Hollows forming	-33.81988358	116.4101621
689	*Corymbia calophylla*	1269	No							-33.82003685	116.4099005
690	*Corymbia calophylla*	881	No							-33.82007328	116.4099962
691	*Corymbia calophylla*	563	No							-33.82013479	116.4101188
692	*Corymbia calophylla*	371	No							-33.82013932	116.4102349
693	*Corymbia calophylla*	565	No							-33.81993548	116.4102154
694	*Corymbia calophylla*	534	No							-33.81991969	116.4102955
696	*Eucalyptus marginata*	990	No							-33.82022383	116.4093181

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
696	*Eucalyptus marginata*	489	No							-33.82016777	116.4093258
697	*Eucalyptus marginata*	847	No							-33.8202261	116.4092216
698	*Eucalyptus marginata*	769	No						Dead. Burls around base.	-33.82050129	116.4098199
699	*Eucalyptus marginata*	820	No						Hollows forming	-33.82058237	116.410085
700	*Eucalyptus marginata*	663	No						Hollows forming	-33.82050071	116.4102302
701	*Eucalyptus marginata*	1276	No							-33.82093951	116.4103384
702	*Eucalyptus marginata*	672	No							-33.82160366	116.4113201
703	*Eucalyptus marginata*	696	No							-33.82164664	116.4114574
704	*Eucalyptus marginata*	854	No						Roots exposed	-33.82202639	116.4108131
705	*Eucalyptus marginata*	453	No							-33.8219688	116.4107536
706	*Eucalyptus marginata*	385	No							-33.8219339	116.410709
707	*Eucalyptus marginata*	748	No							-33.82185854	116.4107312
708	*Eucalyptus marginata*	522	No							-33.82189718	116.4106775
709	*Eucalyptus marginata*	468	No							-33.82183512	116.4106899
710	*Eucalyptus marginata*	639	No							-33.82185476	116.4106643
711	*Eucalyptus marginata*	320	No							-33.82185501	116.4106421
712	*Eucalyptus marginata*	592	No							-33.82179254	116.410551
713	*Eucalyptus rudis*	1125	No							-33.82199339	116.4105569
714	*Eucalyptus rudis*	1209	No							-33.82186995	116.4104235
715	*Eucalyptus marginata*	763	No							-33.82210585	116.4101738
716	*Eucalyptus rudis*	1721	No							-33.82203714	116.4099131
717	*Eucalyptus rudis*	552	No							-33.82255073	116.4098812
718	*Eucalyptus rudis*	432	No							-33.82252456	116.41004
719	*Eucalyptus rudis*	742	No							-33.82250361	116.4101857
720	*Eucalyptus rudis*	808	No						Multiple leaders	-33.82249474	116.4104357
721	*Eucalyptus rudis*	561	No							-33.82262157	116.4103244
722	*Eucalyptus rudis*	405	No							-33.82263608	116.4101336
723	*Eucalyptus rudis*	568	No							-33.82266532	116.4100885
724	*Eucalyptus rudis*	398	No							-33.82276638	116.4100507
725	*Eucalyptus rudis*	489	No							-33.82267696	116.4099564
726	*Eucalyptus rudis*	461	No							-33.82270249	116.4098722
727	*Eucalyptus rudis*	445	No							-33.82274063	116.4098327
728	*Eucalyptus rudis*	589	No							-33.82273644	116.4097812
729	*Eucalyptus rudis*	482	No							-33.82286721	116.4098979
730	*Eucalyptus rudis*	660	No							-33.82285109	116.4096971
731	*Eucalyptus rudis*	341	No							-33.82274809	116.409706
732	*Eucalyptus rudis*	563	No							-33.82269479	116.4096589
733	*Eucalyptus rudis*	395	No							-33.82270914	116.4095833
734	*Eucalyptus rudis*	411	No							-33.82271995	116.4095688
735	*Eucalyptus rudis*	884	No							-33.8227787	116.4095263
736	*Eucalyptus rudis*	1310	No						Hollows forming	-33.82276624	116.4093409
737	*Eucalyptus rudis*	675	No							-33.82269573	116.4094262
738	*Eucalyptus rudis*	361	No							-33.82264121	116.4094785

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
739	*Eucalyptus rudis*	382	No							-33.82244076	116.4095135
740	*Eucalyptus rudis*	450	No							-33.82238729	116.4094822
741	*Eucalyptus rudis*	668	No							-33.82242573	116.409407
742	*Eucalyptus rudis*	676	No							-33.82237894	116.4092892
743	*Eucalyptus rudis*	1430	No						Three stems. Hollows forming	-33.82141005	116.4097332
744	*Eucalyptus rudis*	1103	No						Two stems	-33.82138287	116.4096955
745	*Eucalyptus rudis*	334	No							-33.82141002	116.4097228
746	*Eucalyptus rudis*	455	No							-33.82144252	116.4097494
746	*Eucalyptus rudis*	762	No						Two stems. Hollows forming	-33.82152315	116.409645
747	*Eucalyptus rudis*	715	No						Two stems	-33.8214228	116.4096759
748	*Eucalyptus rudis*	579	No							-33.82136854	116.4095954
749	*Eucalyptus rudis*	489	No							-33.82131024	116.4096007
750	*Eucalyptus rudis*	609	No							-33.82130345	116.4096582
751	*Eucalyptus rudis*	926	No							-33.82127687	116.409635
752	*Eucalyptus rudis*	707	No							-33.82129374	116.4095931
753	*Eucalyptus rudis*	393	No							-33.82134715	116.4095819
755	*Eucalyptus rudis*	686	No						Multiple hollows forming	-33.82127814	116.4095805
756	*Eucalyptus rudis*	673	No						Three leaders. Hollows forming	-33.82127324	116.4095643
757	*Eucalyptus rudis*	375	No							-33.82128034	116.4095448
758	*Eucalyptus rudis*	797	No						Dead	-33.82137197	116.4094105
759	*Eucalyptus rudis*	1475	No						Three leaders. Hollows forming	-33.8213434	116.4092765
760	*Eucalyptus rudis*	551	No							-33.82133562	116.4092198
760	*Eucalyptus rudis*	1059	No						Dead. Hollows forming	-33.82124544	116.4092107
761	*Eucalyptus rudis*	665	No						Multi-stemmed	-33.82128615	116.4090852
762	*Eucalyptus rudis*	483	No						Two stems	-33.8212506	116.4089901
763	*Eucalyptus rudis*	434	No						Three stems	-33.82120444	116.4089543
764	*Corymbia calophylla*	645	No						Three leaders	-33.82121782	116.4089067
765	*Eucalyptus rudis*	743	No						Three stems	-33.8211947	116.4091067
766	*Eucalyptus rudis*	419	No						Primary crown lost, copice from base	-33.82117692	116.4092463
768	*Eucalyptus rudis*	723	No						Multi-stemmed. Hollows forming	-33.82114949	116.4092368
769	*Eucalyptus rudis*	606	No							-33.8211187	116.4091287
769	*Eucalyptus rudis*	532	No							-33.82196709	116.4093652
770	*Eucalyptus rudis*	688	No						Double leader	-33.82106475	116.4090671
771	*Eucalyptus rudis*	569	No						Double stem	-33.82103142	116.409105
772	*Eucalyptus rudis*	562	No							-33.82098167	116.4091184
774	*Eucalyptus rudis*	825	No						Multiple leader. Four out of five stems dead	-33.8210259	116.4088799
775	*Eucalyptus rudis*	589	No						Dead	-33.82101752	116.4089578
776	*Eucalyptus rudis*	621	No						Two stems	-33.82106007	116.4089806
777	*Eucalyptus rudis*	781	No						Dead. Three leaders. Hollows forming	-33.82101487	116.4086972
778	*Eucalyptus rudis*	1054	No						Dead	-33.82087422	116.40854
779	*Eucalyptus rudis*	969	No						Dead. Hollows forming	-33.82105612	116.4084443
781	*Eucalyptus rudis*	432	No						Dead. Multiple stems	-33.82124899	116.4086277
782	*Eucalyptus rudis*	573	No						Multi-stemmed	-33.82129679	116.4084907

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
784	*Eucalyptus rudis*	543	No						Dead. Multiple stems	-33.82144402	116.4084778
785	*Eucalyptus rudis*	509	No						Multi-stemmed	-33.82153815	116.408474
786	*Eucalyptus rudis*	723	No						Five leaders	-33.82155587	116.4087344
787	*Eucalyptus rudis*	432	No						Three stems	-33.82156397	116.4090205
788	*Eucalyptus rudis*	901	No						Double leader	-33.82156212	116.4090026
789	*Eucalyptus rudis*	414	No						Three leaders	-33.82159672	116.4090025
790	*Eucalyptus rudis*	491	No						Double leader	-33.82167012	116.4091041
794	*Eucalyptus rudis*	479	No							-33.82206242	116.4092689
795	*Eucalyptus rudis*	731	No							-33.82300645	116.4095388
796	*Eucalyptus rudis*	378	No						Three stems	-33.82298384	116.4097382
797	*Eucalyptus rudis*	452	No						Two stems	-33.82294265	116.4097706
798	*Eucalyptus rudis*	440	No							-33.82298092	116.4094476
799	*Eucalyptus rudis*	312	No							-33.8229618	116.4092421
800	*Eucalyptus rudis*	460	No							-33.82286305	116.4092334
801	*Eucalyptus rudis*	513	No							-33.82286154	116.4091665
802	*Eucalyptus rudis*	380	No							-33.82283625	116.4091608
803	*Eucalyptus rudis*	323	No							-33.8228699	116.4091073
804	*Eucalyptus rudis*	391	No							-33.82274669	116.4090509
805	*Eucalyptus rudis*	379	No							-33.82286355	116.4089981
806	*Eucalyptus rudis*	543	No						Primary crown lost	-33.82276282	116.4089392
807	*Eucalyptus rudis*	529	No							-33.82280907	116.4089232
808	*Eucalyptus rudis*	375	No							-33.8228093	116.4088275
809	*Eucalyptus rudis*	334	No							-33.82286905	116.4088985
810	*Eucalyptus rudis*	384	No							-33.82271152	116.4088062
811	*Eucalyptus rudis*	304	No							-33.82270584	116.4088344
812	*Eucalyptus rudis*	381	No							-33.82259365	116.4088227
814	*Eucalyptus rudis*	1158	No						Dead. Hollows forming	-33.82240462	116.4087869
815	*Eucalyptus rudis*	713	No							-33.8225293	116.409156
816	*Eucalyptus rudis*	747	No						Hollows forming	-33.822446	116.4090989
817	*Eucalyptus rudis*	480	No							-33.82247197	116.4090541
818	*Eucalyptus rudis*	651	No							-33.8224302	116.4090413
819	*Eucalyptus rudis*	404	No							-33.82239652	116.4089902
820	*Eucalyptus rudis*	566	No							-33.82240227	116.408985
821	*Eucalyptus rudis*	511	No							-33.8224281	116.4089639
822	*Eucalyptus rudis*	516	No							-33.8224299	116.4089536
823	*Eucalyptus rudis*	805	No							-33.82236065	116.4089892
824	*Eucalyptus rudis*	419	No							-33.82230297	116.4089025
825	*Eucalyptus rudis*	904	No						Hollows forming	-33.82226225	116.4088884
826	*Eucalyptus rudis*	456	No						multiple leaders	-33.8222151	116.4090007
827	*Eucalyptus rudis*	709	No							-33.82220364	116.4087528
828	*Eucalyptus rudis*	390	No							-33.8222211	116.4087538
829	*Eucalyptus rudis*	530	No							-33.82223282	116.4087081
830	*Eucalyptus rudis*	632	No							-33.82221502	116.4086387

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
831	*Eucalyptus rudis*	792	No						Two stem. Hollows forming	-33.82216909	116.408699
832	*Eucalyptus rudis*	469	No						Dead	-33.82214374	116.4086849
834	*Eucalyptus rudis*	512	No						Two stems	-33.82206752	116.4086922
835	*Eucalyptus rudis*	844	No							-33.82201102	116.4086253
836	*Eucalyptus rudis*	511	No							-33.8219504	116.4086585
837	*Eucalyptus rudis*	598	No						Three leaders	-33.82191925	116.4086573
838	*Eucalyptus rudis*	1034	No						Hollows forming	-33.82189927	116.4085296
839	*Eucalyptus rudis*	738	No						Three leaders	-33.821817	116.4086027
840	*Eucalyptus rudis*	535	No						Two leaders. Hollows forming	-33.8217488	116.4085371
841	*Eucalyptus rudis*	641	No							-33.82174317	116.408397
842	*Eucalyptus rudis*	335	No							-33.82156272	116.4083722
843	*Eucalyptus rudis*	405	No							-33.82154555	116.4083666
844	*Eucalyptus rudis*	642	No							-33.82153255	116.4083867
845	*Eucalyptus rudis*	715	No						Two leaders	-33.82150912	116.408373
846	*Eucalyptus rudis*	441	No							-33.8214946	116.408305
847	*Eucalyptus rudis*	345	No							-33.82147567	116.408317
848	*Eucalyptus rudis*	914	No						Double leader	-33.82132354	116.408256
850	*Eucalyptus rudis*	582	No						Three stems	-33.82096082	116.4082374
851	*Eucalyptus rudis*	749	No						Four leaders	-33.82092247	116.4083291
853	*Eucalyptus rudis*	718	No							-33.82084325	116.4080488
854	*Eucalyptus rudis*	462	No						Dead	-33.82080144	116.40808
855	*Eucalyptus rudis*	976	No						Hollows forming	-33.82071969	116.4081887
856	*Eucalyptus rudis*	473	No						Two out of three leaders dead. Hollows forming	-33.82071252	116.4082233
857	*Eucalyptus rudis*	779	No							-33.8207493	116.4082316
858	*Eucalyptus rudis*	495	No						Dead	-33.82077379	116.4082265
859	*Eucalyptus rudis*	812	No							-33.8206789	116.4081213
860	*Eucalyptus rudis*	404	No						Dead	-33.82066594	116.4081246
861	*Eucalyptus rudis*	879	No						Dead	-33.8206731	116.4080922
863	*Eucalyptus rudis*	1353	No							-33.81718132	116.4050404
864	*Eucalyptus rudis*	1279	No						Two significant hollows forming	-33.8173127	116.4051093
867	*Corymbia calophylla*	1883	No						Old forest red-tailed cockatoo feeding debris. Multiple significant hollows forming	-33.81590577	116.4053932
868	*Corymbia calophylla*	3008	No						possum tracks	-33.81541375	116.4054777
869	*Corymbia calophylla*	974	No						Hollows forming	-33.81545787	116.4054922
870	*Corymbia calophylla*	1239	No						possum tracks	-33.81480515	116.4051903
871	*Corymbia calophylla*	1263	No						Forest red-tailed black cockatoo feed debris	-33.81538104	116.4062536
872	*Corymbia calophylla*	898	No							-33.81536434	116.4062825
873	*Corymbia calophylla*	1268	No							-33.81516902	116.406199
874	*Corymbia calophylla*	1211	No						Hollows forming	-33.81514247	116.4061539
875	*Corymbia calophylla*	1179	No							-33.81481669	116.4061275
876	*Corymbia calophylla*	332	No							-33.81473695	116.4062357
877	*Corymbia calophylla*	329	No							-33.81477674	116.4062367
878	*Corymbia calophylla*	699	No						Forest red-tailed black cockatoo feed debris	-33.81478194	116.4062453
879	*Corymbia calophylla*	519	No							-33.8147361	116.4062568

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
880	*Corymbia calophylla*	403	No							-33.81476355	116.4064043
881	*Corymbia calophylla*	723	No						High forest red-tailed cockatoo activity	-33.81477114	116.4064131
882	*Corymbia calophylla*	418	No							-33.81467252	116.4064837
883	*Corymbia calophylla*	1162	No						Significant hollows forming	-33.81482037	116.4067795
884	*Corymbia calophylla*	598	No							-33.81485197	116.4068655
885	*Corymbia calophylla*	667	No							-33.81482507	116.4069154
886	*Corymbia calophylla*	795	No							-33.81471137	116.4070984
888	*Corymbia calophylla*	884	No							-33.81407062	116.4061561
889	*Corymbia calophylla*	1009	No							-33.81407749	116.406114
890	*Corymbia calophylla*	1430	No						Baudins black cockatoo feed debris.	-33.81355005	116.405931
891	*Corymbia calophylla*	941	No						Baudins and forest red tailed black cockatoo feeding debris	-33.8135246	116.4055881
892	*Corymbia calophylla*	1197	No						Two stems	-33.81356915	116.4055131
893	*Corymbia calophylla*	1218	No							-33.81319487	116.4050157
894	*Corymbia calophylla*	666	No							-33.81323335	116.4046821
895	*Corymbia calophylla*	1702	No						Hollows forming	-33.8132573	116.4043016
896	*Corymbia calophylla*	1289	No							-33.81347197	116.4043759
897	*Corymbia calophylla*	1308	No							-33.81354817	116.4047624
898	*Corymbia calophylla*	918	No						Hollows forming	-33.81231132	116.4059278
899	*Eucalyptus wandoo*	383	No							-33.81226845	116.4061365
900	*Eucalyptus wandoo*	861	No						Hollows forming	-33.81222844	116.406122
901	*Corymbia calophylla*	519	No						Hollows forming	-33.81241637	116.4061736
904	*Eucalyptus wandoo*	754	No						Hollows forming	-33.81261977	116.4061843
905	*Corymbia calophylla*	949	No							-33.81246777	116.4063336
906	*Corymbia calophylla*	926	No							-33.81258145	116.4066111
907	*Corymbia calophylla*	885	No						Beehive at base. Multiple significant hollows forming.	-33.81259975	116.4068238
908	*Eucalyptus wandoo*	524	No						Hollows forming	-33.81257812	116.4068534
909	*Eucalyptus wandoo*	996	No						Hollows forming	-33.81249222	116.4069049
910	*Eucalyptus wandoo*	654	No						Hollows forming	-33.81228754	116.4069157
912	*Eucalyptus wandoo*	556	No							-33.8120858	116.4063697
913	*Corymbia calophylla*	654	No						Hollows forming	-33.81212764	116.4062616
914	*Eucalyptus wandoo*	418	No							-33.81229165	116.4067036
915	*Eucalyptus occidentalis*	556	No							-33.81239347	116.3965846
916	*Eucalyptus occidentalis*	877	No							-33.81235134	116.3967547
917	*Eucalyptus occidentalis*	712	No							-33.81224649	116.3969251
918	*Eucalyptus occidentalis*	880	No							-33.81222799	116.3970363
919	*Eucalyptus wandoo*	1188	No						Hollow forming potential	-33.81248079	116.396951
920	*Eucalyptus occidentalis*	732	No							-33.81256722	116.3966564
922	*Eucalyptus wandoo*	754	No							-33.81278275	116.3967339
923	*Eucalyptus wandoo*	320	No							-33.81270254	116.3967768
924	*Eucalyptus marginata*	1340	No						Hollows forming	-33.81254739	116.3971655
925	*Corymbia calophylla*	1265	No						Future hollow forming potential	-33.8128091	116.3972266
926	*Corymbia calophylla*	1497	No						Future hollow forming potential	-33.8128415	116.3972837
927	*Eucalyptus occidentalis*	575	No							-33.81205717	116.3977055

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
928	*Eucalyptus occidentalis*	630	No							-33.81202904	116.3976928
929	*Eucalyptus occidentalis*	6770	No							-33.81199032	116.3976643
930	*Eucalyptus botryoides*	1056	No						Future hollow forming potential	-33.81241497	116.3983978
931	*Eucalyptus sp.*	981	No						Future hollow forming potential	-33.81213002	116.3983032
932	*Eucalyptus sp.*	1151	No							-33.81195415	116.3982661
933	*Eucalyptus globulus*	996	No							-33.81187947	116.3982428
935	*Eucalyptus sp.*	826	No							-33.81155945	116.3981838
936	*Eucalyptus sp.*	998	No						Future hollow forming potential	-33.811384	116.398138
937	*Eucalyptus occidentalis*	500	No							-33.81151884	116.3978243
938	*Eucalyptus occidentalis*	604	No							-33.81161795	116.3978429
939	*Eucalyptus occidentalis*	457	No							-33.81167605	116.3978562
940	*Eucalyptus occidentalis*	697	No						Future hollow forming potential	-33.81176722	116.3978815
942	*Eucalyptus wandoo*	725	No						Future hollow forming potential	-33.81270635	116.3987563
943	*Eucalyptus botryoides*	833	No							-33.81276685	116.3990556
944	*Corymbia ficifolia*	1190	No							-33.81131825	116.3999188
945	*Eucalyptus sp.*	1096	No						Future hollow forming potential	-33.8114968	116.3999967
946	*Eucalyptus wandoo*	549	No						Future hollow forming potential	-33.81167687	116.4000748
947	*Eucalyptus wandoo*	550	No						Dead. Future hollow forming potential	-33.81119847	116.3992035
948	*Eucalyptus wandoo*	426	No							-33.81272785	116.3995483
949	*Eucalyptus occidentalis*	1365	No						Future hollow forming potential	-33.8128251	116.3992494
950	*Eucalyptus occidentalis*	657	No						Leader measured. Hollow forming potential	-33.81294475	116.3992026
951	*Eucalyptus occidentalis*	925	No						Future hollow forming potential	-33.81303894	116.3994001
952	*Eucalyptus occidentalis*	745	No						Future hollow forming potential	-33.81310607	116.3994842
953	*Eucalyptus occidentalis*	981	No						Future hollow forming potential	-33.81319761	116.3996036
954	*Eucalyptus sp.*	318	No						Planted	-33.81314752	116.3996665
958	*Eucalyptus marginata*	1190	No						Nest in top of tree	-33.81480215	116.3944637
960	*Corymbia calophylla*	890	No						Possum activity	-33.8163385	116.3948533
961	*Corymbia calophylla*	838	No						Possibly possum activity	-33.8162505	116.3953719
963	*Corymbia calophylla*	940	No						Cockatoo feeding	-33.8161954	116.3954654
964	*Corymbia calophylla*	1078	No						Future hollow forming potential	-33.81622969	116.3954876
965	*Corymbia calophylla*	903	No						Future hollow forming potential	-33.81620212	116.3955486
966	*Corymbia calophylla*	668	No							-33.8160724	116.3956167
967	*Corymbia calophylla*	738	No							-33.81604995	116.395628
969	*Corymbia calophylla*	545	No						Dead. Hollow forming potential	-33.81633064	116.3952907
971	*Corymbia calophylla*	507	No						Dead	-33.81659317	116.3958582
974	*Eucalyptus rudis*	1038	No						Future hollow forming potential	-33.81685477	116.3958756
975	*Eucalyptus rudis*	1140	No						Future hollow forming potential	-33.81712352	116.3956086
977	*Eucalyptus rudis*	1180	No						Leader measured. Hollow forming potential	-33.8170956	116.3953249
978	*Corymbia calophylla*	942	No						Feeding. Future hollow forming potential. Chewed Nuts	-33.8174131	116.3957496
979	*Corymbia calophylla*	688	No							-33.81771565	116.396064
980	*Corymbia calophylla*	873	No						Future hollow forming potential	-33.81771892	116.3961048
981	*Corymbia calophylla*	959	No							-33.81776912	116.3960518
982	*Corymbia calophylla*	518	No						Future hollow forming potential	-33.81775272	116.3960232

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
984	*Corymbia calophylla*	595	No						Hollows forming	-33.81198325	116.4040274
985	*Corymbia calophylla*	845	No						Hollows forming	-33.81203825	116.4039791
986	*Corymbia calophylla*	1262	No						Hollows forming	-33.81225659	116.4040258
987	*Corymbia calophylla*	669	No						Hollows forming	-33.81219825	116.4042008
989	*Corymbia calophylla*	773	No						Hollows forming	-33.81226825	116.4044258
992	*Corymbia calophylla*	836	No						Multiple stems. Hollows forming	-33.81228659	116.4048824
994	*Corymbia calophylla*	537	No						Hollows forming	-33.81248159	116.4046908
995	*Corymbia calophylla*	806	No						Hollows forming	-33.81247659	116.4046358
997	*Eucalyptus wandoo*	551	No						Hollows forming	-33.81195492	116.4068808
999	*Eucalyptus wandoo*	372	No						Multiple stems	-33.81189992	116.4070141
1001	*Eucalyptus wandoo*	525	No						Hollows forming	-33.81171659	116.4062158
1002	*Corymbia calophylla*	1283	No						Old tree with significant hollow forming potential	-33.81166159	116.4057441
1003	*Corymbia calophylla*	1283	No						Old tree with significant hollow forming potential	-33.81146159	116.4062208
1004	*Eucalyptus wandoo*	500	No						Hollows forming	-33.81151825	116.4069591
1005	*Eucalyptus wandoo*	723	No						Dead	-33.81146825	116.4068108
1006	*Eucalyptus wandoo*	665	No							-33.81140659	116.4068074
1007	*Eucalyptus wandoo*	408	No							-33.81137159	116.4068774
1008	*Eucalyptus wandoo*	390	No							-33.81129659	116.4068124
1009	*Eucalyptus wandoo*	752	No						Hollows forming	-33.81129159	116.4068108
1010	*Eucalyptus wandoo*	1085	No							-33.81122992	116.4067191
1011	*Eucalyptus wandoo*	6908	No							-33.81124325	116.4068358
1012	*Eucalyptus wandoo*	425	No							-33.81123659	116.4068508
1013	*Eucalyptus wandoo*	845	No						Hollows forming	-33.81120159	116.4068758
1014	*Eucalyptus wandoo*	877	No							-33.81119159	116.4069524
1015	*Eucalyptus wandoo*	547	No						Dead	-33.81118659	116.4070508
1016	*Eucalyptus wandoo*	548	No							-33.81101825	116.4067591
1017	*Eucalyptus wandoo*	319	No							-33.81096159	116.4067658
1018	*Eucalyptus wandoo*	526	No							-33.81094992	116.4067208
1019	*Eucalyptus wandoo*	480	No							-33.81091325	116.4067258
1021	*Eucalyptus wandoo*	441	No						Hollows forming	-33.81078159	116.4067391
1022	*Eucalyptus wandoo*	391	No						Dead. Hollows forming	-33.81079492	116.4067324
1023	*Eucalyptus wandoo*	626	No						Multiple stems	-33.81090159	116.4066274
1025	*Eucalyptus wandoo*	663	No						Hollows forming	-33.81076492	116.4066391
1026	*Eucalyptus wandoo*	319	No						Future hollow forming potential	-33.81072325	116.4065891
1027	*Eucalyptus wandoo*	456	No						Hollows forming	-33.81070492	116.4065491
1028	*Eucalyptus wandoo*	781	No						Hollows forming	-33.81062992	116.4065374
1030	*Eucalyptus wandoo*	785	No						Hollows forming	-33.81035325	116.4065874
1032	*Eucalyptus occidentalis*	629	No						Hollows forming	-33.81006825	116.4068624
1033	*Eucalyptus occidentalis*	695	No						Hollow forming potential	-33.81004492	116.4068008
1034	*Eucalyptus occidentalis*	845	No						Hollows forming	-33.80998825	116.4068341
1035	*Corymbia calophylla*	702	No						Future hollow forming potential	-33.80994325	116.4069158
1036	*Corymbia calophylla*	716	No						Dead	-33.80992992	116.4069708
1038	*Eucalyptus occidentalis*	1465	No						Future hollow forming potential	-33.80981825	116.4066108

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1040	*Eucalyptus occidentalis*	745	No						Dying. Future hollow forming potential	-33.80961825	116.4067408
1042	*Eucalyptus occidentalis*	1242	No						Hollows forming	-33.80919159	116.4057724
1043	*Eucalyptus occidentalis*	1225	No						Hollows forming	-33.80908325	116.4059341
1044	*Eucalyptus occidentalis*	1184	No						Hollows forming	-33.80908825	116.4060208
1045	*Eucalyptus wandoo*	786	No						Future hollow forming potential	-33.80921659	116.4060058
1048	*Eucalyptus occidentalis*	1117	No						Hollow forming potential. Beehive at base of tree.	-33.80887825	116.4044758
1049	*Corymbia calophylla*	1771	No						Old tree with significant hollow forming potential. Dying	-33.80899159	116.4046324
1050	*Eucalyptus wandoo*	498	No						Hollows forming. Leader measured	-33.80939659	116.4048591
1051	*Eucalyptus wandoo*	534	No						Hollows forming. Leader measured	-33.80942159	116.4048108
1052	*Eucalyptus wandoo*	360	No							-33.80945659	116.4047758
1053	*Eucalyptus wandoo*	533	No						Hollow forming Potential	-33.80942659	116.4047674
1054	*Eucalyptus wandoo*	648	No						Future hollow forming potential	-33.80942659	116.4047474
1055	*Eucalyptus wandoo*	718	No						Hollows forming	-33.80939825	116.4047908
1057	*Eucalyptus rudis*	1723	No						Future hollow forming potential	-33.80900125	116.4038229
1058	*Eucalyptus rudis*	2171	No						Dead	-33.80968555	116.4031887
1062	*Corymbia calophylla*	1317	No						Hollows forming. Significant feeding on Marri nuts	-33.81086717	116.4031547
1065	*Corymbia calophylla*	874	No						Future Hollow forming potential. Significant possum scratchings	-33.81160755	116.4040318
1070	*Corymbia calophylla*	683	No						Hollows forming	-33.81119324	116.4051106
1073	*Corymbia calophylla*	1067	No						Hollows forming. Significant Possum scratchings	-33.81101707	116.404454
1074	*Corymbia calophylla*	1318	No						Future hollow forming potential	-33.81095687	116.404528
1078	*Corymbia calophylla*	1406	No						Multiple broken limbs	-33.81030195	116.4047841
1079	*Corymbia calophylla*	931	No						Future hollow forming potential	-33.8105888	116.4049875
1082	*Corymbia calophylla*	1914	No						Very old tree. Hollow forming potential. Evidence of feeding	-33.81236825	116.4127391
1083	*Eucalyptus marginata*	1086	No						Future hollow forming potential	-33.81303992	116.4133841
1085	*Eucalyptus marginata*	1451	No						Hollows forming	-33.81324992	116.4131341
1086	*Corymbia calophylla*	1662	No						Hollows forming	-33.81381492	116.4127258
1088	*Corymbia calophylla*	629	No							-33.81458825	116.4120091
1089	*Corymbia calophylla*	1581	No						Hollows forming	-33.81459825	116.4121024
1090	*Corymbia calophylla*	1722	No						Old tree. Significant hollow forming potential	-33.81502825	116.4113358
1092	*Corymbia calophylla*	1644	No						Hollows forming	-33.81462159	116.4106774
1094	*Eucalyptus marginata*	1410	No						Hollows forming	-33.81565492	116.4115341
1095	*Corymbia calophylla*	818	No						Future hollow forming potential	-33.81571659	116.4121008
1096	*Corymbia calophylla*	1260	No						Hollows forming. Evidence of feeding	-33.81567492	116.4121324
1097	*Corymbia calophylla*	1707	No						Hollows forming	-33.81563492	116.4122241
1098	*Corymbia calophylla*	762	No						Hollows forming. Dying	-33.81649659	116.4122574
1099	*Corymbia calophylla*	636	No						Hollow forming potential. Multiple Stems	-33.81644992	116.4121774
1100	*Corymbia calophylla*	356	No						Dying	-33.81636325	116.4121724
1101	*Corymbia calophylla*	940	No						Future hollow forming potential	-33.81639325	116.4121308
1102	*Corymbia calophylla*	870	No						Hollows forming. Significant Possum Scratchings	-33.81640325	116.4120641
1103	*Corymbia calophylla*	753	No						Hollows forming	-33.81631992	116.4121108
1105	*Corymbia calophylla*	1729	No						Old tree. Hollow forming potential	-33.81627659	116.4114908
1107	*Corymbia calophylla*	944	No						Future hollow forming potential	-33.81636825	116.4114691
1108	*Eucalyptus marginata*	1026	No						Hollows forming. Dead	-33.81664325	116.4116924

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1109	*Corymbia calophylla*	1087	No						Hollows forming. Significant Possum Scratchings	-33.81660159	116.4116041
1110	*Corymbia calophylla*	1171	No						Hollows forming	-33.81660992	116.4113308
1111	*Corymbia calophylla*	1340	No						Future hollow forming potential	-33.81660659	116.4114158
1112	*Corymbia calophylla*	1263	No						Future hollow forming potential	-33.81674659	116.4114258
1114	*Eucalyptus wandoo*	510	No						Hollows forming. Multiple stems. one dead stem	-33.81687992	116.4111958
1115	*Eucalyptus wandoo*	330	No						Hollows forming. Multiple stems. Dead	-33.81684992	116.4111474
1116	*Eucalyptus marginata*	383	No						Hollows forming. Multiple stems. one stem dead.	-33.81687825	116.4110924
1117	*Corymbia calophylla*	775	No						Hollows forming. Leader measured	-33.81688492	116.4110924
1118	*Corymbia calophylla*	515	No						Hollows forming. Multiple stems. Two stems dead.	-33.81685492	116.4109791
1119	*Corymbia calophylla*	716	No						Future hollow forming potential	-33.81671659	116.4110174
1120	*Corymbia calophylla*	1570	No						Old tree with Significant hollow forming potential. Significant Possum Scratchings	-33.81667825	116.4109874
1121	*Corymbia calophylla*	560	No						Hollows forming. Multiple stems	-33.81676492	116.4108424
1122	*Corymbia calophylla*	544	No						Hollows forming	-33.81661659	116.4109174
1125	*Corymbia calophylla*	1086	No						Hollows forming	-33.81649325	116.4101791
1126	*Eucalyptus marginata*	678	No						Dead	-33.81674325	116.4102391
1127	*Eucalyptus marginata*	802	No						Hollows forming. Dead	-33.81688325	116.4101974
1128	*Corymbia calophylla*	620	No						Hollows forming	-33.81681325	116.4100891
1129	*Corymbia calophylla*	1335	No						Hollows forming	-33.81678659	116.4099574
1130	*Corymbia calophylla*	1211	No						Hollows forming	-33.81704325	116.4098541
1131	*Corymbia calophylla*	696	No						Leader measured. Hollows forming	-33.81697659	116.4095874
1132	*Corymbia calophylla*	999	No						Hollows forming. Termite mound taking over	-33.81689492	116.4093508
1133	*Eucalyptus marginata*	1022	No						Hollows forming. Some dead branches	-33.81702825	116.4101008
1134	*Corymbia calophylla*	1721	No						Future hollow forming potential	-33.81706492	116.4103691
1135	*Eucalyptus marginata*	1115	No						Hollows forming	-33.81702825	116.4104574
1136	*Eucalyptus wandoo*	775	No						Hollows forming	-33.81742159	116.4103591
1138	*Corymbia calophylla*	1516	No						Hollows forming. Significant Possum Scratchings	-33.81771659	116.4104274
1140	*Eucalyptus wandoo*	587	No						Hollows forming. Multiple stems	-33.81873159	116.4105824
1141	*Corymbia calophylla*	680	No						Future hollow forming potential	-33.81871492	116.4104191
1142	*Corymbia calophylla*	697	No						Hollows forming. Dying	-33.81874825	116.4103158
1143	*Corymbia calophylla*	404	No						Many hollows forming	-33.81884159	116.4103791
1144	*Eucalyptus wandoo*	338	No						Hollows forming	-33.81818325	116.4104041
1146	*Eucalyptus wandoo*	379	No						Hollows forming. Multiple stems. one stem dead infested by termites	-33.81815325	116.4102874
1147	*Eucalyptus wandoo*	587	No						Hollows forming. Multiple stems. Some branches dead	-33.81812159	116.4101841
1148	*Eucalyptus marginata*	599	No						Hollows forming. Leader measured, leader infested by termites. Multiple stems, two stems dead	-33.81803159	116.4100708
1150	*Eucalyptus wandoo*	694	No						Hollows forming	-33.81805492	116.4099274
1151	*Corymbia calophylla*	1150	No						Hollows forming	-33.81799325	116.4097758
1152	*Corymbia calophylla*	1215	No						Hollows forming	-33.81807325	116.4096574
1154	*Eucalyptus rudis*	1442	No						Future hollow forming potential	-33.81762159	116.4094958
1155	*Corymbia calophylla*	712	No						Hollows forming	-33.81773159	116.4096991
1156	*Eucalyptus wandoo*	576	No						Hollows forming. Multiple stems	-33.81778825	116.4097874
1158	*Eucalyptus marginata*	672	No						Hollows forming. Leader measured	-33.81851325	116.4098308
1159	*Corymbia calophylla*	703	No						Hollows forming	-33.81687325	116.4089574

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1160	*Corymbia calophylla*	862	No						Hollows forming	-33.81689492	116.4089674
1162	*Corymbia calophylla*	1532	No						Hollows forming	-33.81695159	116.4091058
1163	*Corymbia calophylla*	1490	No						Multiple hollows forming	-33.81695159	116.4091058
1164	*Eucalyptus wandoo*	477	No						Hollows forming. Leader measured	-33.81713492	116.4092458
1165	*Corymbia calophylla*	893	No						Future hollow forming potential	-33.81719492	116.4092441
1166	*Corymbia calophylla*	985	No						Hollows forming	-33.81731659	116.4091041
1167	*Corymbia calophylla*	937	No						Hollows forming	-33.81741325	116.4090908
1168	*Corymbia calophylla*	975	No						Hollows forming	-33.81723659	116.4089691
1169	*Corymbia calophylla*	406	No						Hollows forming	-33.81712992	116.4089908
1170	*Corymbia calophylla*	880	No						Hollows forming	-33.81712992	116.4089908
1171	*Corymbia calophylla*	599	No						Hollow forming potential. Multiple stems	-33.81718825	116.4088241
1172	*Corymbia calophylla*	786	No						Dead	-33.81721659	116.4085658
1174	*Corymbia calophylla*	1228	No						Hollows forming	-33.81708492	116.4085341
1175	*Corymbia calophylla*	569	No						Hollows forming	-33.81703325	116.4085508
1176	*Corymbia calophylla*	1466	No						Hollows forming	-33.81652992	116.4075008
1177	*Corymbia calophylla*	564	No						Hollows forming. Leader measured	-33.81679159	116.4072224
1178	*Corymbia calophylla*	975	No						Hollows forming	-33.81682492	116.4072524
1179	*Corymbia calophylla*	880	No						Future hollow forming potential	-33.81691325	116.4071858
1180	*Corymbia calophylla*	538	No						Future hollow forming potential	-33.81694325	116.4072358
1182	*Corymbia calophylla*	387	No						Hollows forming	-33.81697492	116.4072591
1183	*Corymbia calophylla*	1074	No						Hollows forming	-33.81705159	116.4073991
1184	*Corymbia calophylla*	642	No						Hollows forming	-33.81742325	116.4075091
1185	*Corymbia calophylla*	352	No						Hollows forming	-33.81733992	116.4075224
1186	*Corymbia calophylla*	345	No						Hollows forming	-33.81733159	116.4075274
1187	*Corymbia calophylla*	543	No						Hollows forming	-33.81733159	116.4075274
1188	*Corymbia calophylla*	350	No						Hollows forming	-33.81728325	116.4075491
1189	*Corymbia calophylla*	379	No						Hollows forming	-33.81728325	116.4075908
1190	*Corymbia calophylla*	350	No						Hollows forming	-33.81726825	116.4075391
1191	*Corymbia calophylla*	367	No						Hollows forming	-33.81723659	116.4075424
1192	*Corymbia calophylla*	330	No						Dead	-33.81718825	116.4075691
1193	*Corymbia calophylla*	458	No						Hollows forming	-33.81724825	116.4075208
1194	*Corymbia calophylla*	363	No						Hollows forming	-33.81720492	116.4075208
1195	*Corymbia calophylla*	663	No						Hollows forming	-33.81726492	116.4074508
1196	*Corymbia calophylla*	661	No						Hollows forming	-33.81723992	116.4074274
1198	*Corymbia calophylla*	745	No						Hollows forming. Leader measured	-33.81730159	116.4073424
1199	*Corymbia calophylla*	621	No						Hollows forming	-33.81757325	116.4076224
1200	*Corymbia calophylla*	650	No						Hollows forming	-33.81759492	116.4076558
1201	*Corymbia calophylla*	467	No						Hollows forming. Dying	-33.81764659	116.4076741
1202	*Corymbia calophylla*	646	No						Hollows forming	-33.81762325	116.4077058
1203	*Corymbia calophylla*	536	No						Hollows forming	-33.81772659	116.4077141
1204	*Corymbia calophylla*	465	No						Hollows forming	-33.81757825	116.4078458
1205	*Corymbia calophylla*	461	No						Hollows forming	-33.81761325	116.4078024
1206	*Corymbia calophylla*	395	No						Future hollow forming potential	-33.81757492	116.4077458

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1207	*Corymbia calophylla*	550	No						Hollows forming. Leader measured	-33.81737325	116.4079774
1208	*Corymbia calophylla*	747	No						Hollows forming	-33.81737992	116.4080991
1209	*Corymbia calophylla*	689	No						Hollows forming	-33.81746992	116.4081608
1210	*Corymbia calophylla*	403	No						Hollows forming	-33.81749492	116.4080891
1211	*Corymbia calophylla*	400	No							-33.81747992	116.4081541
1212	*Corymbia calophylla*	1135	No						Hollows forming	-33.81741992	116.4082908
1213	*Corymbia calophylla*	498	No						Hollows forming	-33.81737325	116.4082991
1214	*Corymbia calophylla*	381	No						Multiple stems	-33.81741825	116.4082941
1215	*Corymbia calophylla*	608	No						Hollows forming	-33.81734825	116.4082258
1217	*Corymbia calophylla*	975	No						Hollows forming	-33.81684492	116.4078858
1218	*Corymbia calophylla*	1570	No						Hollows forming	-33.81651992	116.4075008
1219	*Corymbia calophylla*	512	No						Hollows forming	-33.8171447	116.4078927
1220	*Corymbia calophylla*	541	No						Dying	-33.8171442	116.4078911
1221	*Corymbia calophylla*	671	No						Hollows forming	-33.81705087	116.4078703
1222	*Eucalyptus rudis*	342	No						Hollows forming	-33.81700404	116.407738
1223	*Eucalyptus rudis*	323	No						Hollows forming. Dead	-33.81703145	116.407638
1225	*Corymbia calophylla*	510	No						Hollows forming. Significant Possum scratchings	-33.81693945	116.4075794
1226	*Corymbia calophylla*	430	No						Hollows forming. Leader measured	-33.81747492	116.4086824
1227	*Corymbia calophylla*	521	No						Hollows forming. Leader measured	-33.81760325	116.4085424
1228	*Corymbia calophylla*	612	No						Hollows forming	-33.81771159	116.4085408
1229	*Eucalyptus rudis*	558	No						Hollows forming	-33.81771659	116.4086324
1230	*Corymbia calophylla*	1116	No						Hollows forming	-33.81778659	116.4087641
1232	*Corymbia calophylla*	647	No							-33.81796325	116.4083458
1233	*Corymbia calophylla*	529	No							-33.81805492	116.4080574
1234	*Eucalyptus rudis*	860	No						Hollows forming	-33.81810992	116.4080458
1235	*Eucalyptus rudis*	609	No							-33.81818992	116.4081408
1236	*Eucalyptus rudis*	936	No						Hollows forming	-33.81822325	116.4082324
1237	*Corymbia calophylla*	629	No						Hollows forming	-33.81788659	116.4082391
1238	*Corymbia calophylla*	975	No						Future hollow forming potential	-33.81783825	116.4081908
1239	*Corymbia calophylla*	436	No						Multiple stems	-33.81777825	116.4083058
1240	*Corymbia calophylla*	322	No							-33.81776992	116.4083274
1241	*Corymbia calophylla*	390	No						Hollows forming	-33.81767159	116.4083408
1242	*Corymbia calophylla*	592	No						Future hollow forming potential	-33.81767159	116.4083408
1243	*Corymbia calophylla*	420	No						Hollows forming. Multiple stems	-33.81769492	116.4082608
1244	*Corymbia calophylla*	990	No						Hollows forming	-33.81780325	116.4082441
1245	*Corymbia calophylla*	620	No						Hollows forming	-33.81789492	116.4082574
1248	*Corymbia calophylla*	354	No						Hollows forming. Dead. Leader measured	-33.81774492	116.4081208
1249	*Corymbia calophylla*	983	No						Hollows forming	-33.81773992	116.4079908
1250	*Corymbia calophylla*	375	No						Hollows forming	-33.81766492	116.4081041
1251	*Eucalyptus rudis*	929	No						Hollows forming. Multiple stems	-33.81819992	116.4078474
1252	*Corymbia calophylla*	542	No						Hollows forming	-33.81819992	116.4078474
1253	*Corymbia calophylla*	338	No						Hollows forming	-33.81820992	116.4078008
1254	*Corymbia calophylla*	958	No						Hollows forming	-33.81818659	116.4077524

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1255	*Corymbia calophylla*	848	No						Hollows forming	-33.81815325	116.4076574
1256	*Corymbia calophylla*	451	No						Hollows forming	-33.81814325	116.4076174
1257	*Corymbia calophylla*	494	No						Hollows forming	-33.81805325	116.4077641
1258	*Corymbia calophylla*	759	No						Future hollow forming potential	-33.81750659	116.4073224
1259	*Eucalyptus rudis*	500	No						Hollows forming. Leader measured	-33.81762992	116.4074441
1260	*Corymbia calophylla*	343	No						Leader measured	-33.81767992	116.4074724
1261	*Corymbia calophylla*	353	No						Hollow forming potential. Multiple stems	-33.81777159	116.4074258
1262	*Corymbia calophylla*	458	No						Multiple stems	-33.81770825	116.4074358
1263	*Corymbia calophylla*	460	No						Hollows forming	-33.81770659	116.4074424
1264	*Corymbia calophylla*	330	No						Hollows forming	-33.81779825	116.4075458
1265	*Corymbia calophylla*	353	No						Dead	-33.81779825	116.4075458
1266	*Corymbia calophylla*	359	No						Dead	-33.81788325	116.4076008
1267	*Corymbia calophylla*	794	No						Hollows forming	-33.81794825	116.4075891
1268	*Corymbia calophylla*	486	No						Hollows forming	-33.81790825	116.4075058
1269	*Corymbia calophylla*	1055	No						Hollows forming	-33.81791492	116.4074874
1271	*Corymbia calophylla*	1090	No						Future hollow forming potential	-33.81793825	116.4073991
1272	*Corymbia calophylla*	764	No						Future hollow forming potential	-33.81793825	116.4073991
1273	*Corymbia calophylla*	1195	No						Future hollow forming potential	-33.81783659	116.4072841
1274	*Corymbia calophylla*	1212	No						Hollows forming	-33.81783825	116.4072024
1275	*Corymbia calophylla*	778	No						Hollows forming	-33.81779325	116.4071691
1276	*Corymbia calophylla*	324	No							-33.81773159	116.4071424
1277	*Corymbia calophylla*	395	No							-33.81770159	116.4070574
1278	*Corymbia calophylla*	462	No							-33.81770159	116.4070574
1279	*Corymbia calophylla*	605	No							-33.81762825	116.4071124
1280	*Corymbia calophylla*	348	No							-33.81768159	116.4071624
1281	*Corymbia calophylla*	364	No							-33.81767325	116.4071341
1282	*Corymbia calophylla*	357	No							-33.81775659	116.4073524
1283	*Eucalyptus rudis*	375	No						Leader measured	-33.81806992	116.4072458
1284	*Eucalyptus rudis*	689	No						Future hollow forming potential	-33.81816159	116.4072608
1285	*Eucalyptus rudis*	545	No						Hollows forming. Multiple stems	-33.81814325	116.4072558
1286	*Eucalyptus rudis*	391	No							-33.81810159	116.4074258
1287	*Eucalyptus rudis*	675	No						Leader measured	-33.81809825	116.4073874
1290	*Eucalyptus rudis*	891	No						Hollows forming	-33.81783159	116.4063508
1291	*Eucalyptus rudis*	1221	No						Old tree, significant hollow forming potential. Multiple stems. Some branches dying	-33.81781825	116.4063874
1292	*Corymbia calophylla*	804	No						Hollows forming. Leader measured	-33.81682325	116.4071674
1293	*Eucalyptus rudis*	1491	No							-33.81785992	116.4066874
1294	*Eucalyptus rudis*	1129	No						Hollows forming	-33.81783325	116.4067558
1295	*Eucalyptus marginata*	649	No							-33.81692492	116.4070674
1296	*Corymbia calophylla*	438	No						Hollows forming	-33.81669992	116.4071208
1297	*Corymbia calophylla*	1108	No						Hollows forming	-33.81657159	116.4071058
1298	*Corymbia calophylla*	602	No						Hollows forming	-33.81661159	116.4069724
1299	*Corymbia calophylla*	678	No						Hollows forming	-33.81657159	116.4069141
1300	*Corymbia calophylla*	1309	No						Hollows forming	-33.81653992	116.4068874

Tree ID	Species	DBH (mm)	Hollows Present	Location	Size of Entrance (cm)	Type of Entrance	Height Above Ground (m)	Rubbing or Chewing Around Entrance	Comments	Latitude	Longitude
1301	*Corymbia calophylla*	871	No						Hollows forming	-33.81647325	116.4068691
1302	*Corymbia calophylla*	570	No						Hollows forming	-33.81637159	116.4068458
1303	*Corymbia calophylla*	831	No						Hollows forming	-33.81625825	116.4066474
1304	*Corymbia calophylla*	1276	No						Multiple hollows forming	-33.81629325	116.4067108
1305	*Corymbia calophylla*	575	No						Hollows forming	-33.81662492	116.4067291
1306	*Eucalyptus rudis*	719	No						Hollows forming	-33.81962385	116.4074344
1308	*Eucalyptus rudis*	520	No						Hollows forming. Dead	-33.8197142	116.4075275
1310	*Eucalyptus rudis*	463	No						Hollows forming. Multiple stems	-33.8198173	116.407537
1311	*Corymbia calophylla*	414	No						Hollows forming	-33.81975495	116.4076006
1312	*Corymbia calophylla*	740	No						Hollows forming	-33.81975625	116.4075951
1313	*Corymbia calophylla*	590	No						Hollows forming	-33.81976547	116.4076041
1317	*Corymbia calophylla*	368	No						Hollows forming	-33.81978547	116.4076472
1318	*Corymbia calophylla*	501	No						Hollows forming	-33.81980275	116.407699
1321	*Eucalyptus rudis*	1197	No						Hollows forming	-33.81986477	116.4077221
1322	*Eucalyptus rudis*	307	No							-33.81981224	116.4077449
1323	*Eucalyptus rudis*	831	No						Hollows forming. Multiple stems	-33.81995702	116.4077365
1324	*Eucalyptus rudis*	335	No						Hollow forming. Dead	-33.8199435	116.4077664
1325	*Eucalyptus rudis*	531	No						Hollows forming	-33.81995115	116.4078307
1326	*Eucalyptus rudis*	757	No						Hollows forming	-33.8199615	116.4078358
1327	*Eucalyptus rudis*	461	No						Hollows forming	-33.82001284	116.4077476
1328	*Eucalyptus rudis*	543	No						Hollows forming	-33.82008765	116.4078454
1329	*Eucalyptus rudis*	556	No						Hollows forming	-33.82010227	116.4077953
1330	*Eucalyptus rudis*	956	No						Hollows forming	-33.82001135	116.4079008
1331	*Eucalyptus rudis*	472	No						Hollows forming	-33.82005615	116.4079748
1332	*Eucalyptus rudis*	864	No						Hollows forming	-33.82004915	116.4080026
1333	*Eucalyptus rudis*	945	No						Hollows forming. Multiple stems	-33.82013332	116.4078565
1335	*Eucalyptus rudis*	502	No							-33.82019857	116.4078988
1336	*Eucalyptus rudis*	388	No							-33.82021214	116.4077992
1337	*Eucalyptus rudis*	668	No						Hollows forming	-33.8201577	116.4079551
1338	*Eucalyptus rudis*	803	No						Hollows forming	-33.8201385	116.4079788
1339	*Eucalyptus rudis*	860	No						Hollows forming	-33.82018665	116.4079798
1341	*Eucalyptus rudis*	406	No						Hollows forming. Multiple stems	-33.82019297	116.4080264
1342	*Eucalyptus rudis*	812	No						Hollows forming. Multiple stems	-33.82034927	116.4079444
1345	*Eucalyptus rudis*	920	No						Hollows forming	-33.82041525	116.4080042
1346	*Eucalyptus rudis*	669	No						Hollows forming. Multiple stems	-33.82045987	116.4080099
1347	*Eucalyptus rudis*	795	No						Hollows forming. Dead	-33.82047762	116.4080272
1348	*Eucalyptus rudis*	742	No						Hollows forming	-33.82051667	116.4080035
1349	*Eucalyptus rudis*	697	No						Hollows forming	-33.82055027	116.407909
1350	*Eucalyptus rudis*	842	No						Hollows forming	-33.8205749	116.4079949
1351	*Eucalyptus rudis*	656	No						Hollows forming	-33.82060222	116.4080675
1353	*Eucalyptus rudis*	450	No						Hollows forming	-33.82054037	116.4080596
1354	*Eucalyptus rudis*	398	No						Hollows forming. Dead	-33.82056902	116.4080364

Table 7: Photo evidence of significant trees (>300 mm DBH) that contained hollows.

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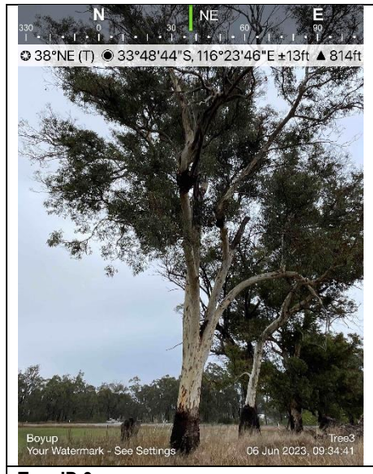
<td>
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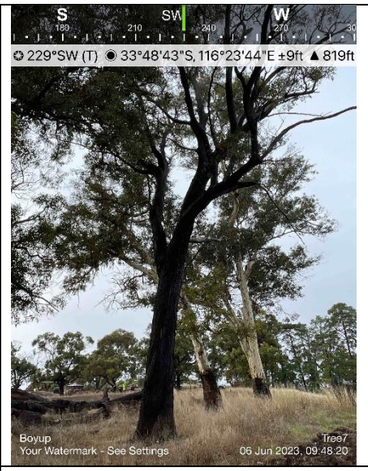
<td>
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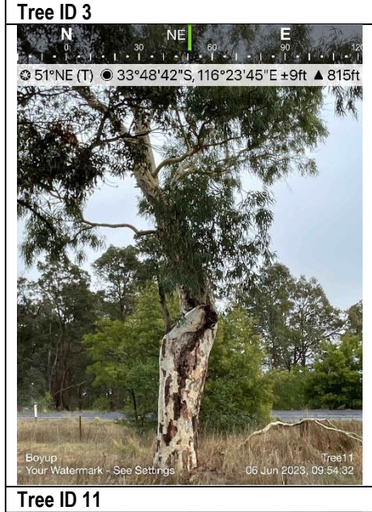
<td>
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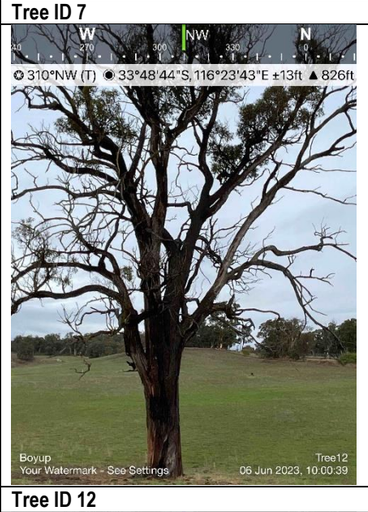
<td>
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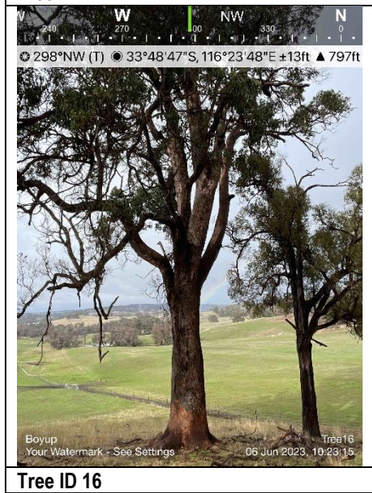
<td>
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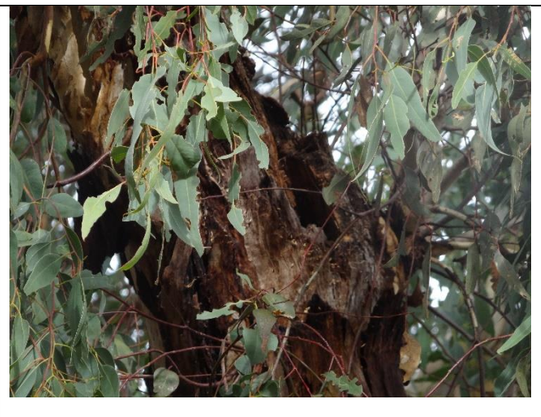
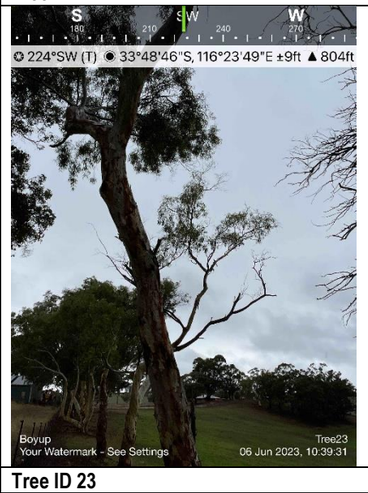
<td></td>
<td>
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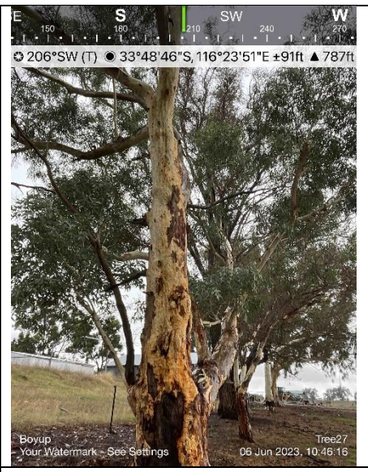



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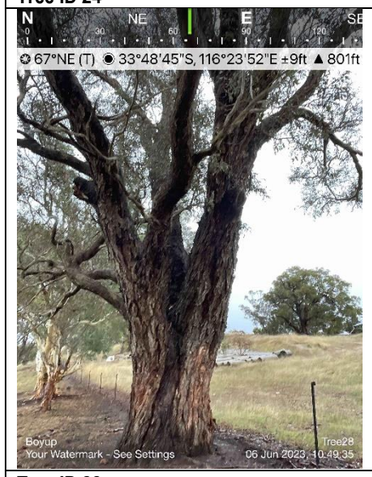



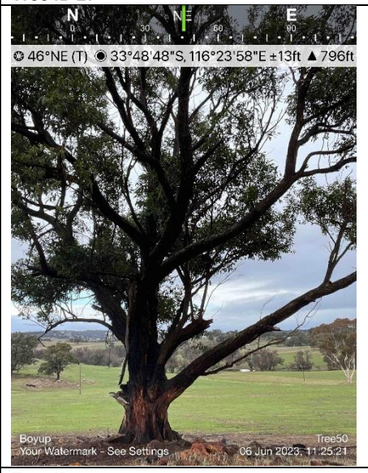



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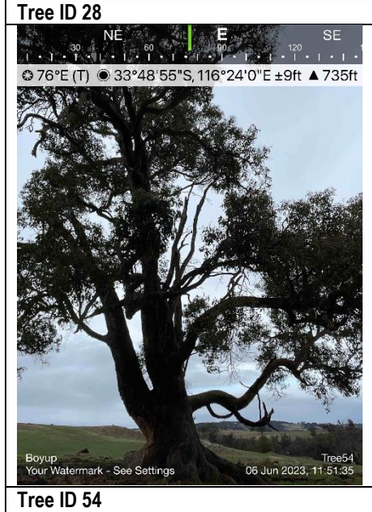



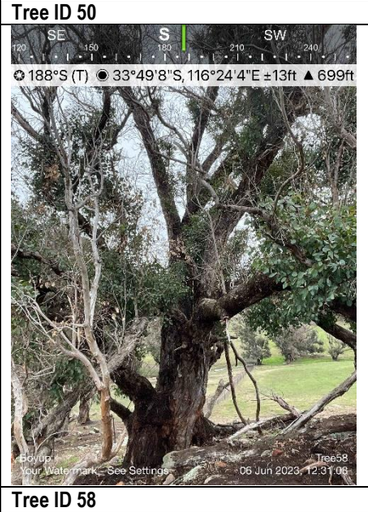



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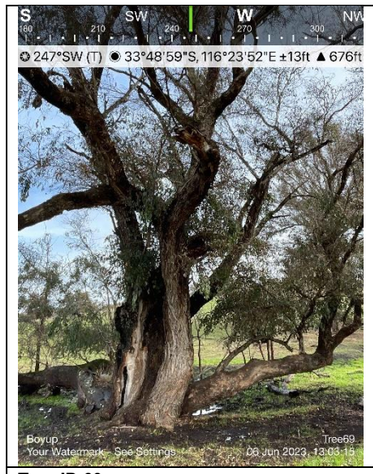
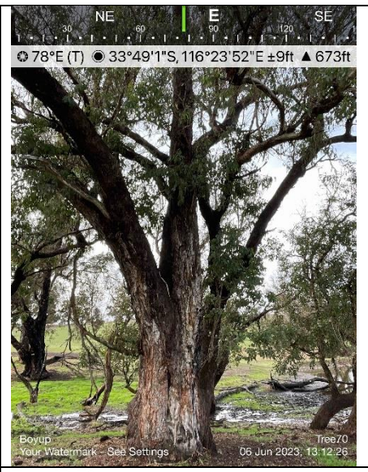






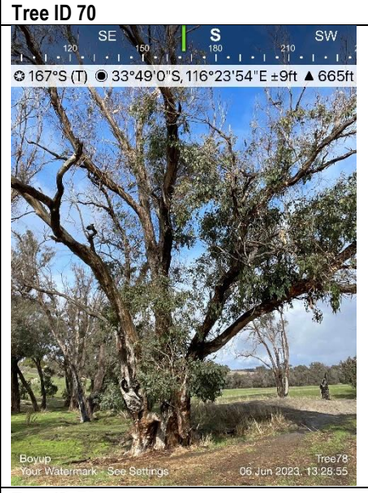


Tree ID 69

Tree ID 70









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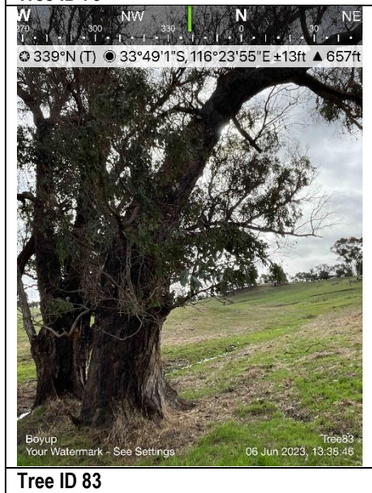



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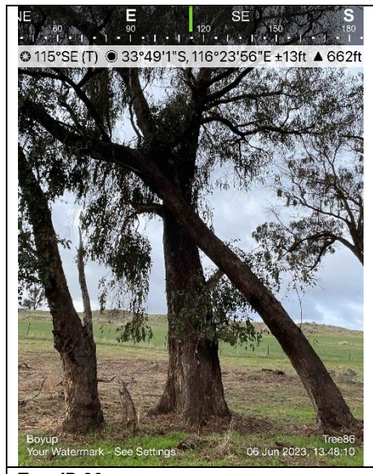







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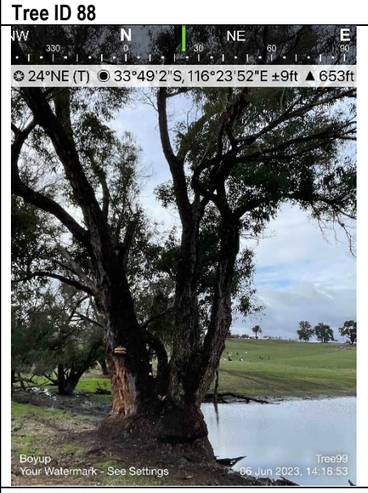



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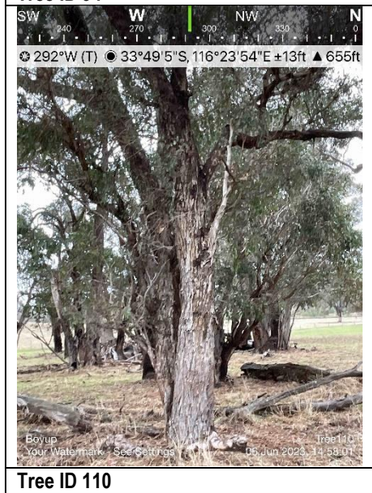







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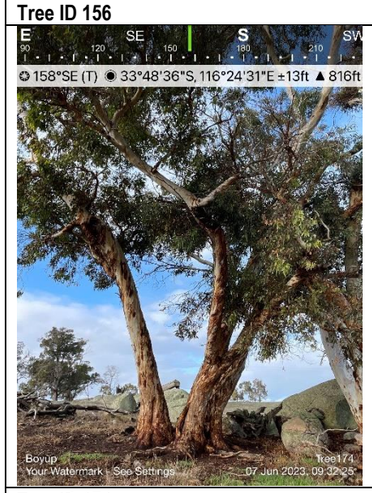
<td>
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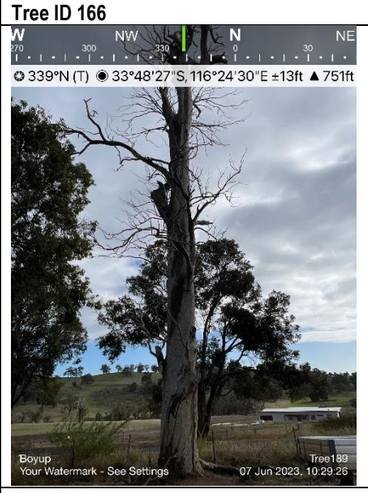
<td>
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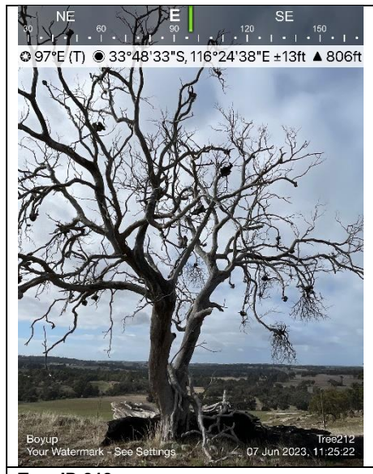



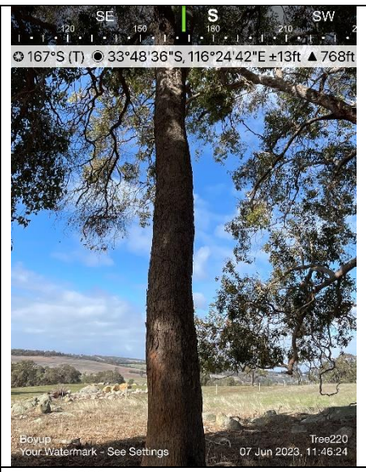



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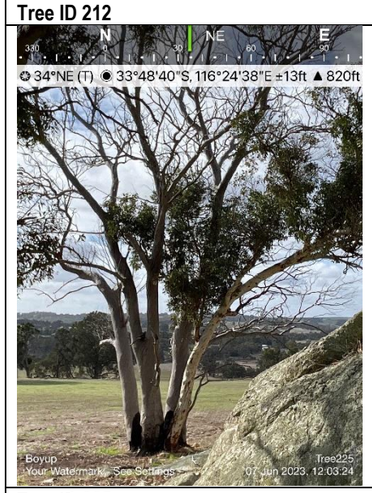



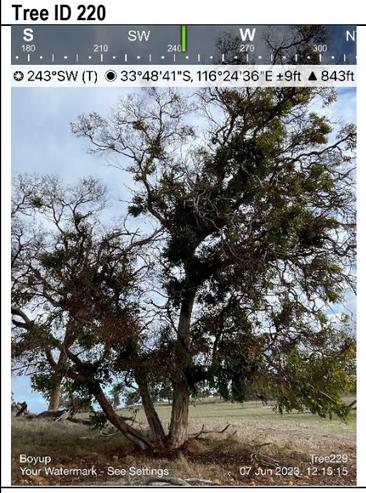



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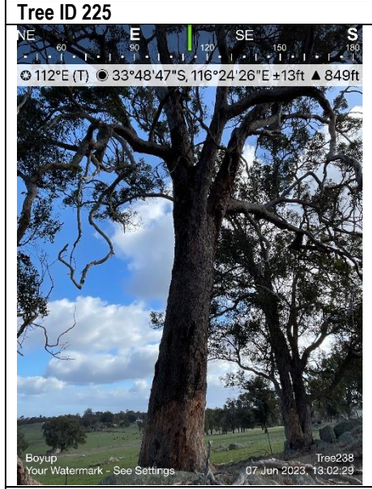







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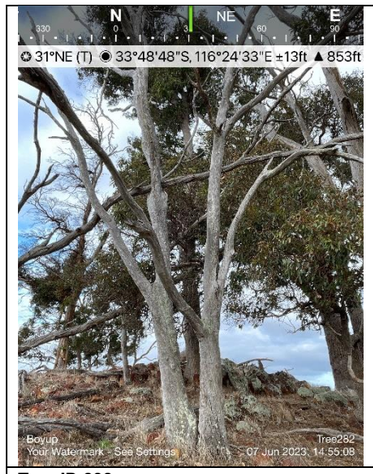



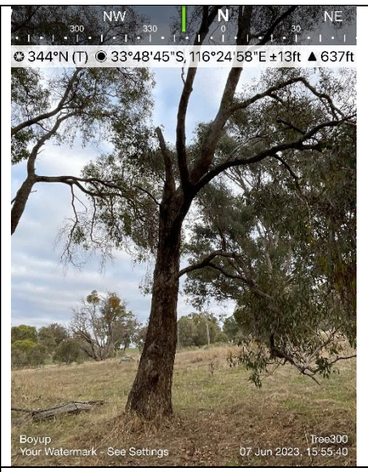



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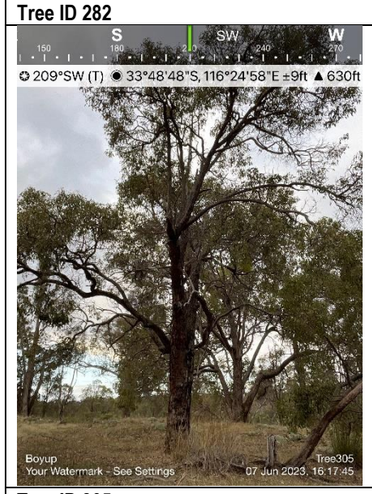







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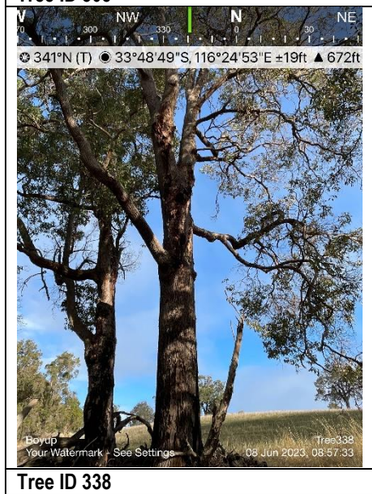

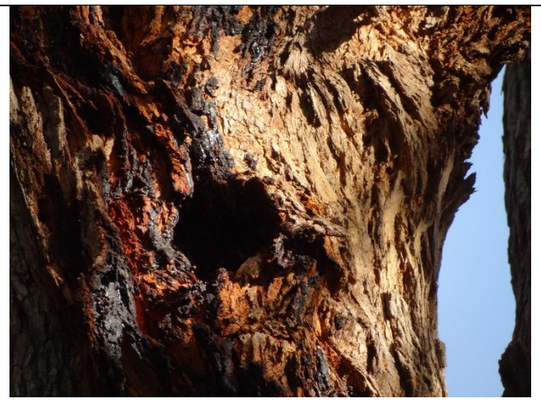

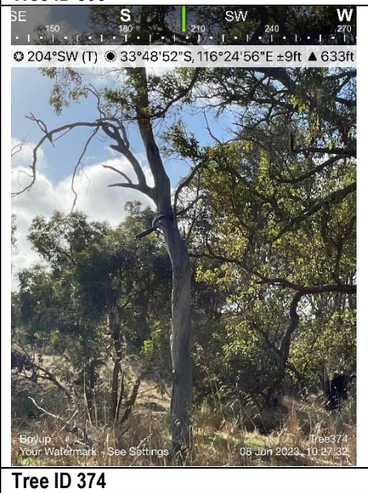



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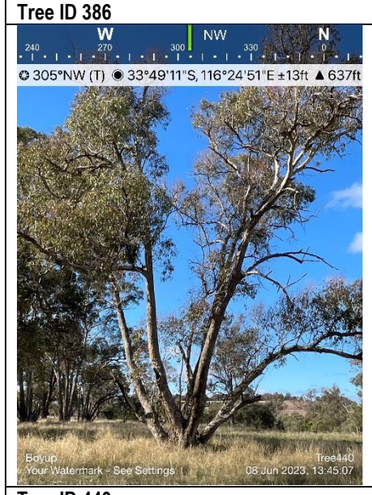			
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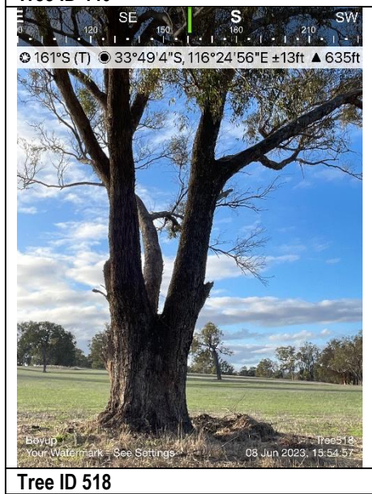	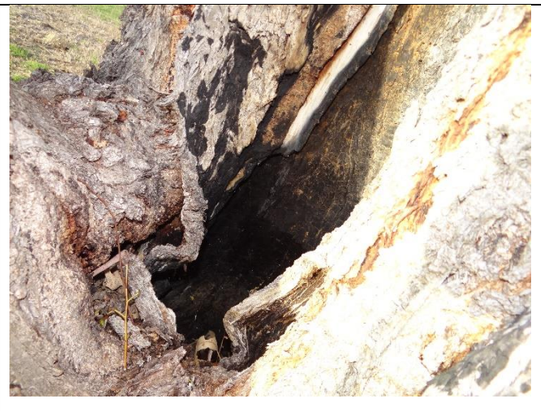		
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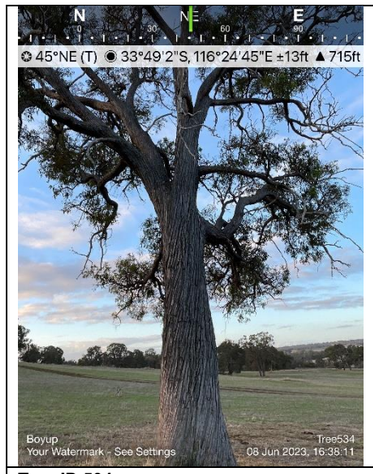







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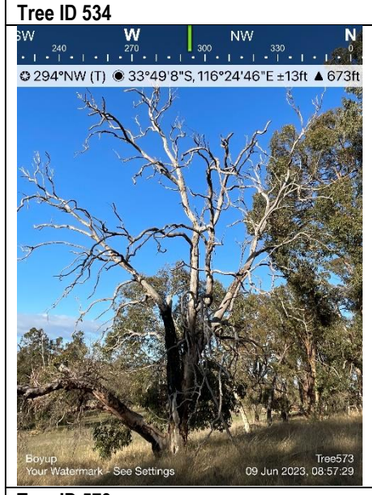

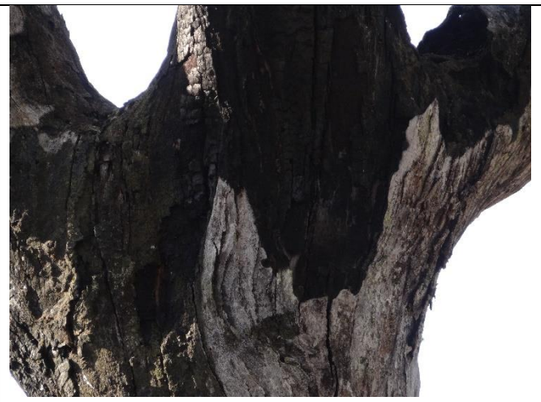





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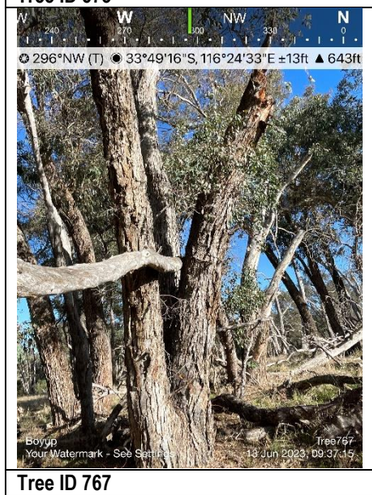

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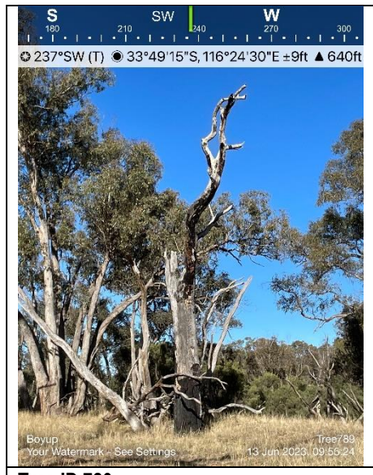
<td>
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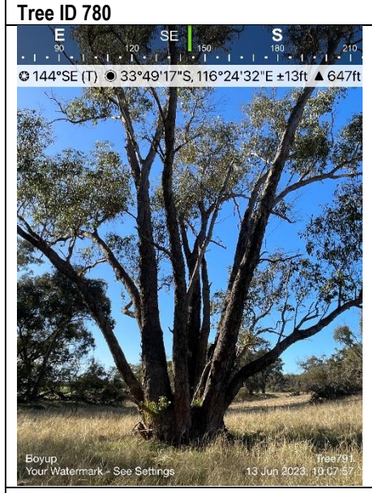
<td>
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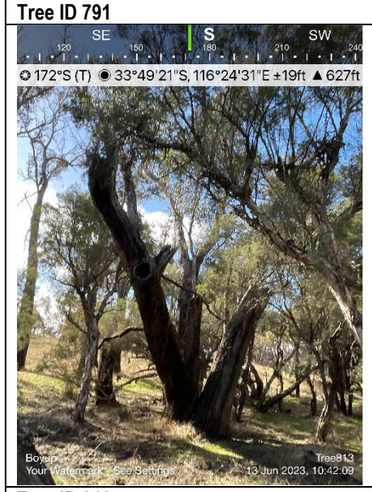
<td>
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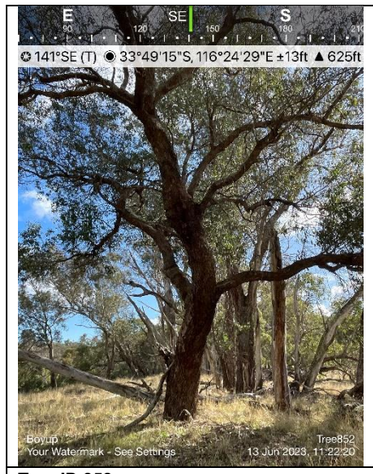

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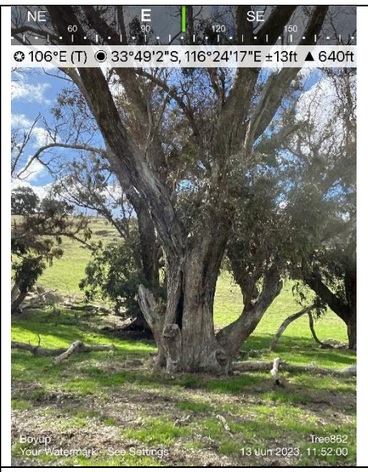

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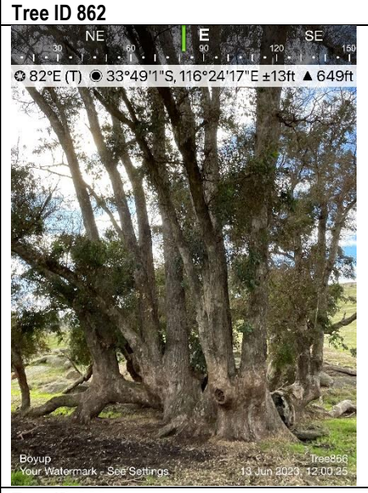

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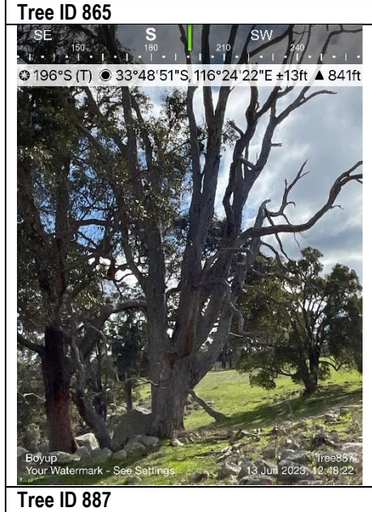

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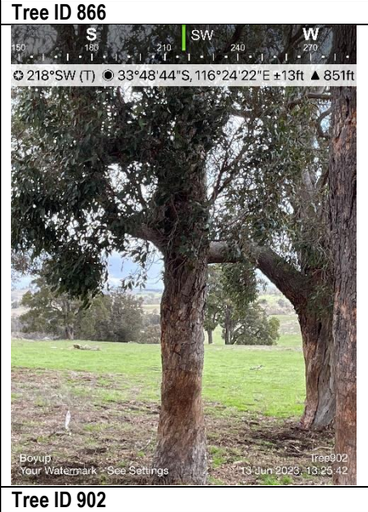

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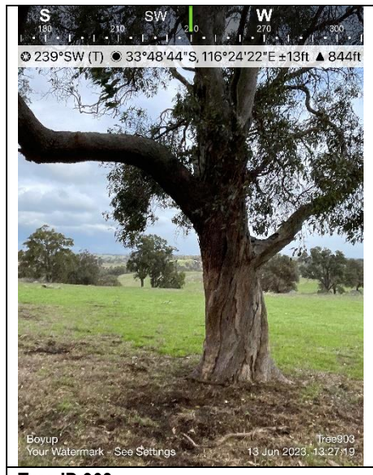
<td>
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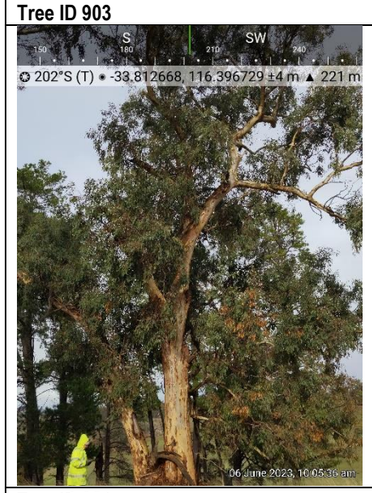
<td>
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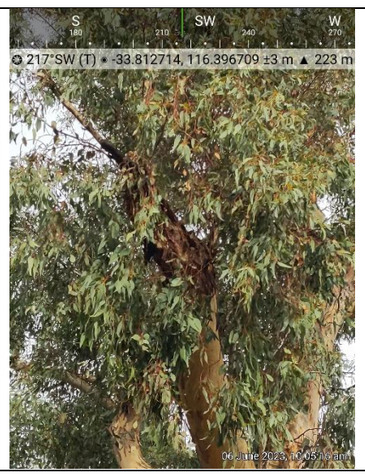
<td>
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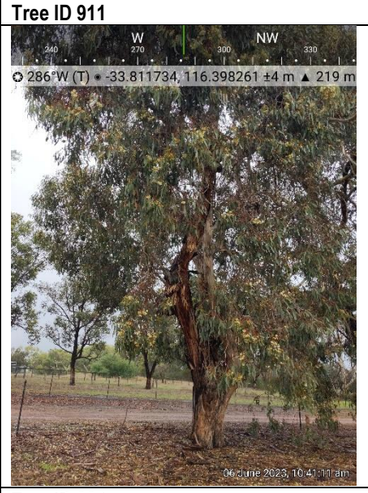
<td>
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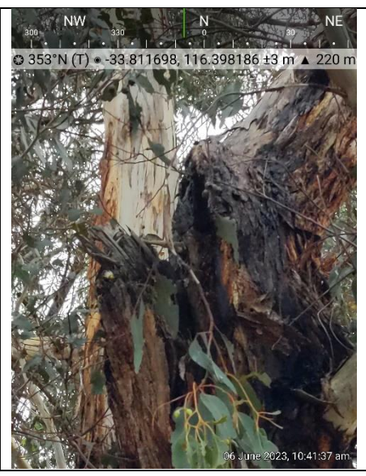
<td>
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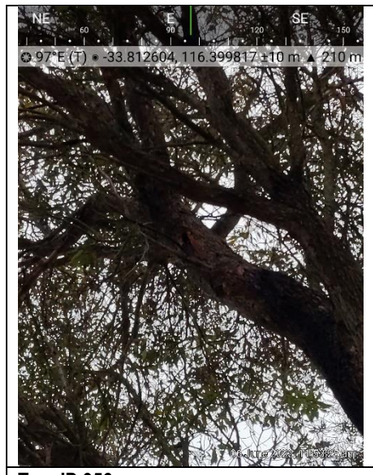
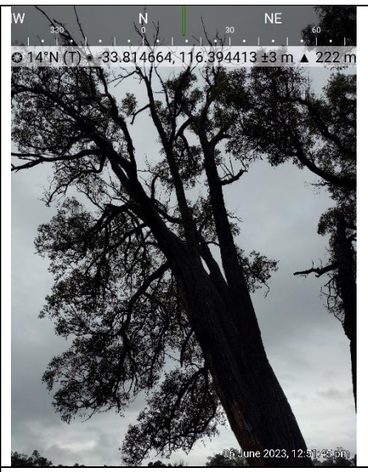
<tr><td></td><td>No photo available</td><td></td><td>No photo available</td></tr>
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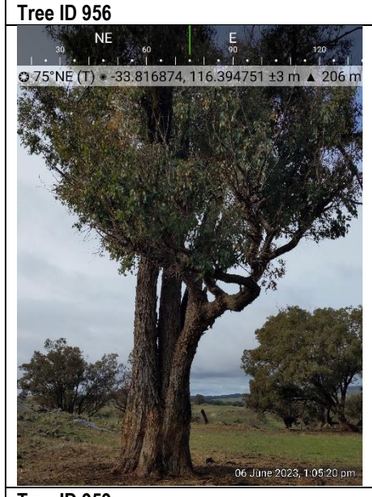
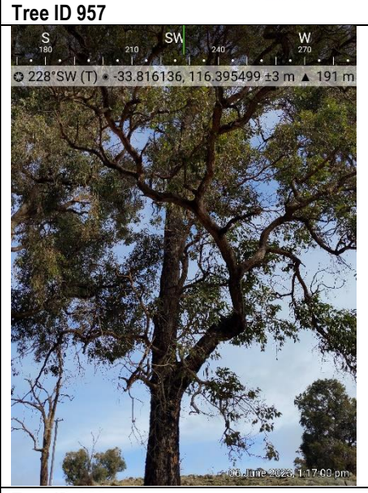
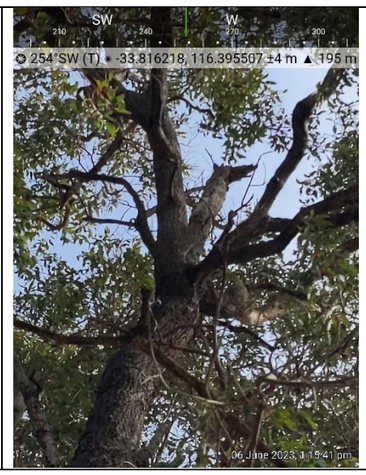
<tr><td></td><td>No photo available</td><td></td><td></td></tr>
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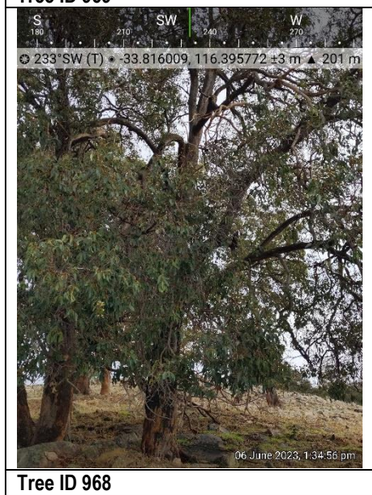
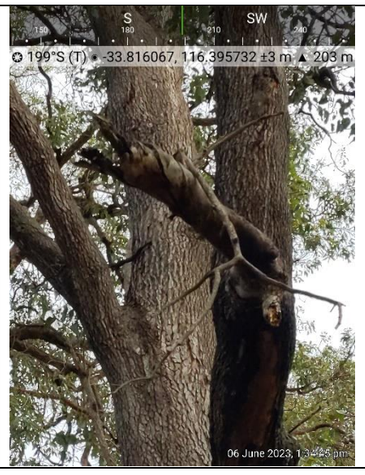
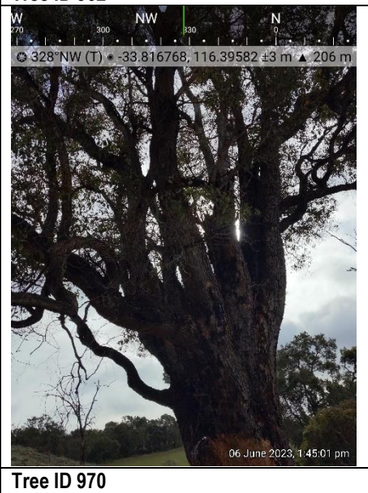
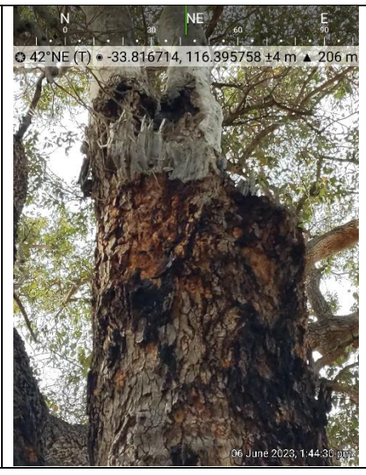
<tr><td></td><td></td><td></td><td></td></tr>
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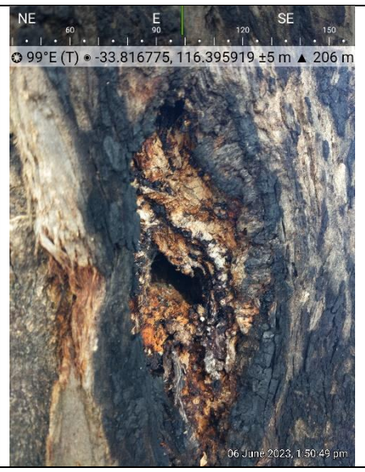
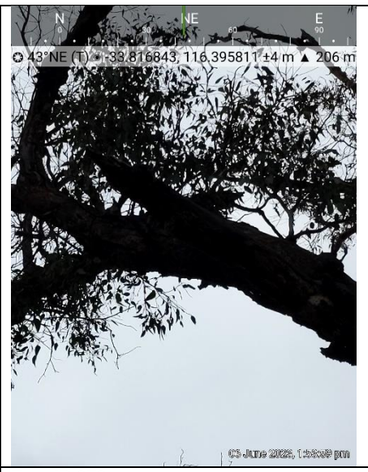
No photo available			**No photo available**
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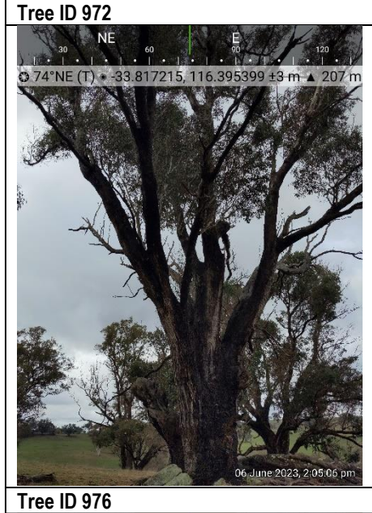	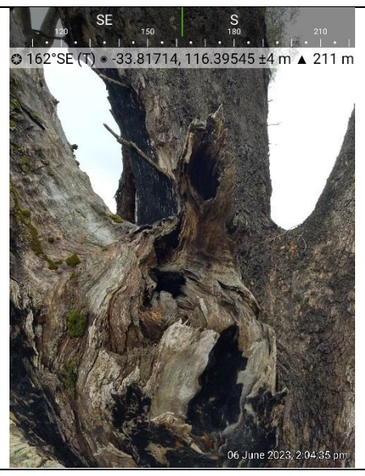	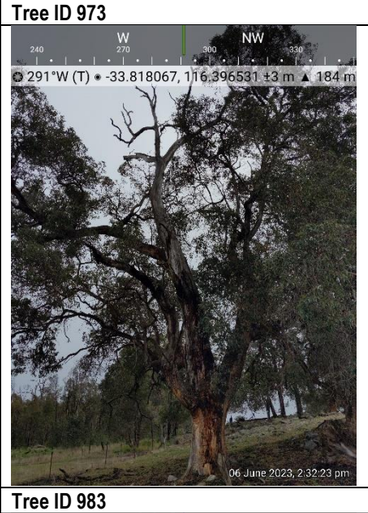	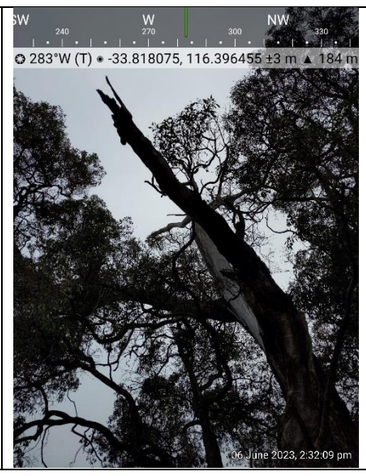
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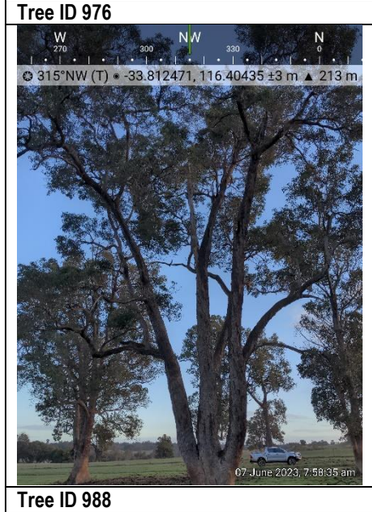	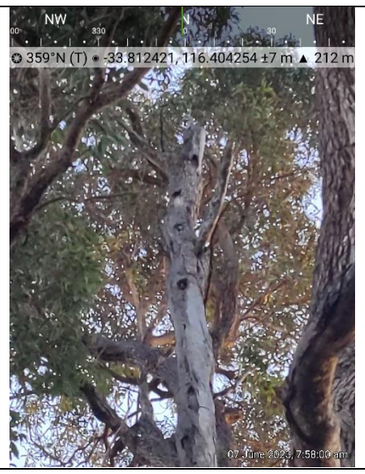	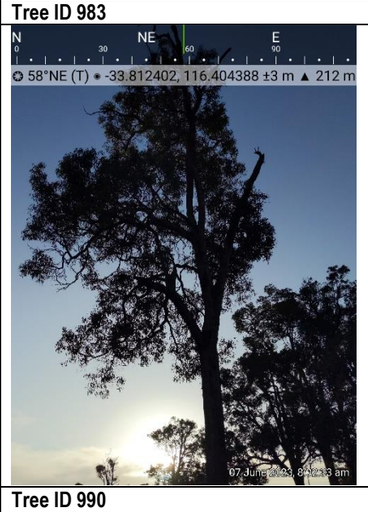	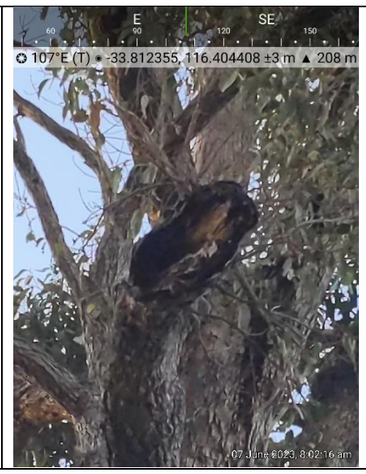
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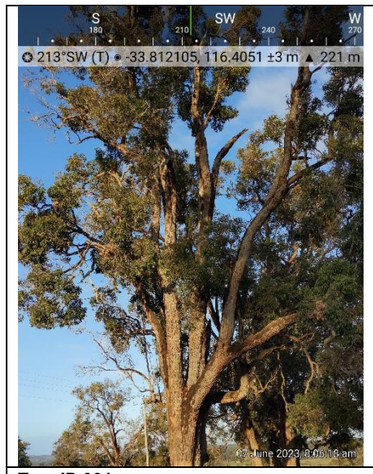

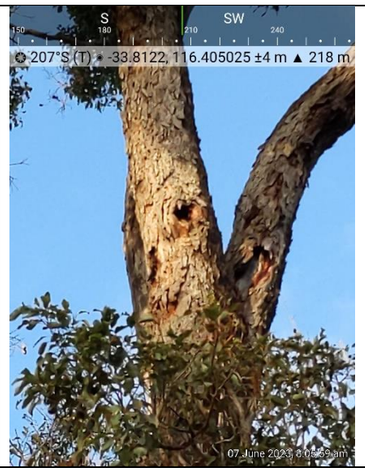

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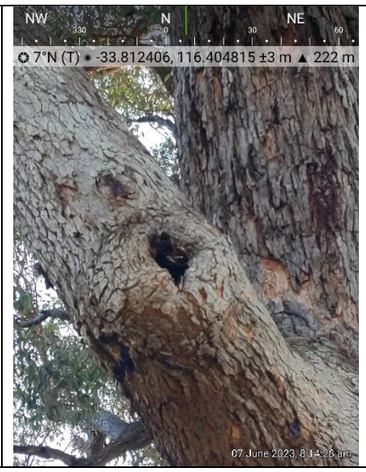
Tree ID 993



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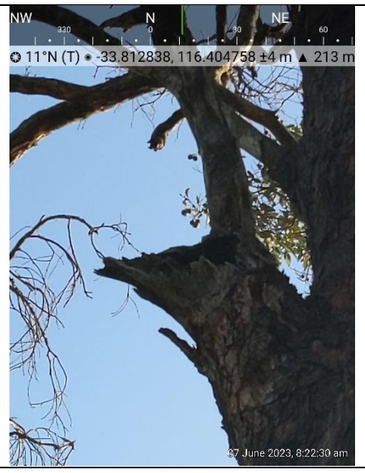

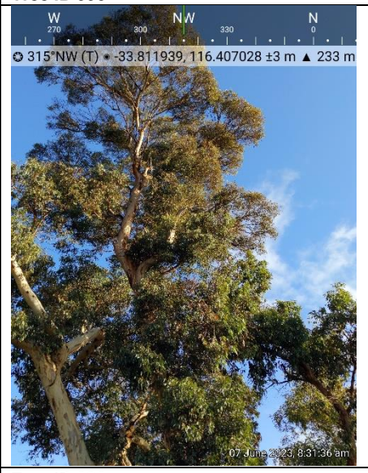

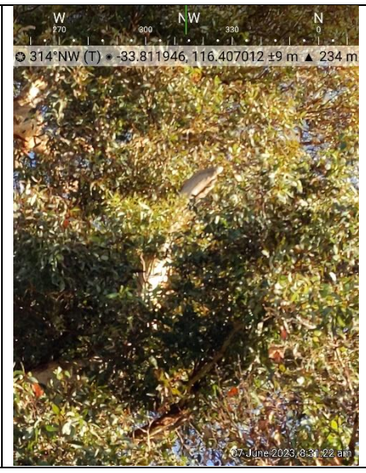

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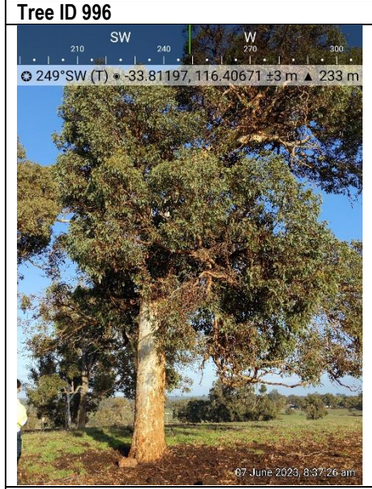

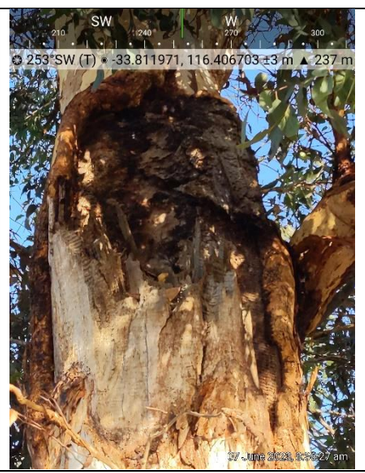

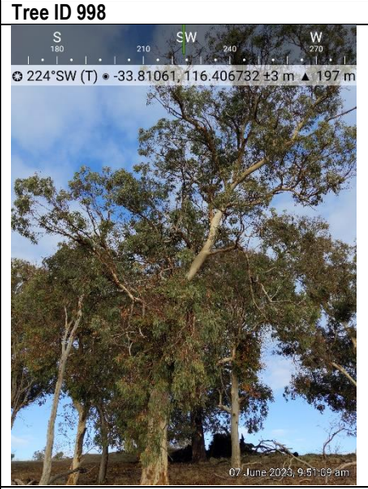



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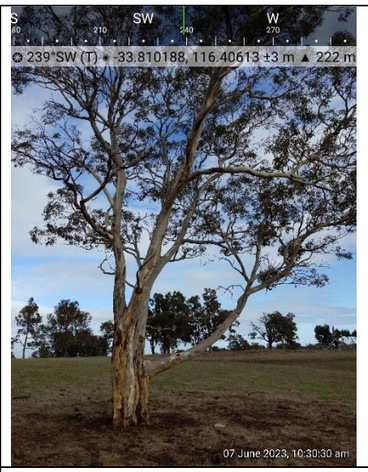
No photo available	**No photo available**		
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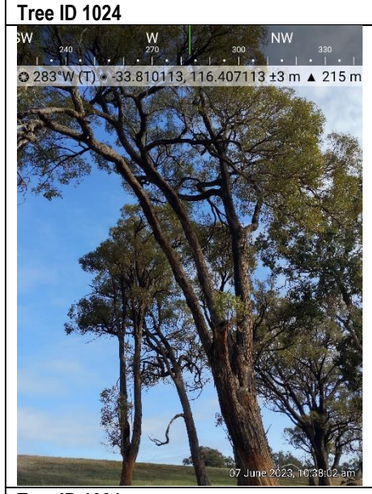	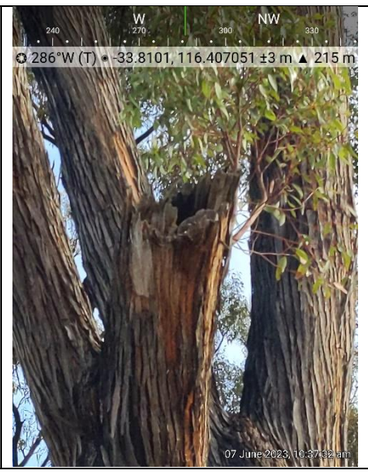	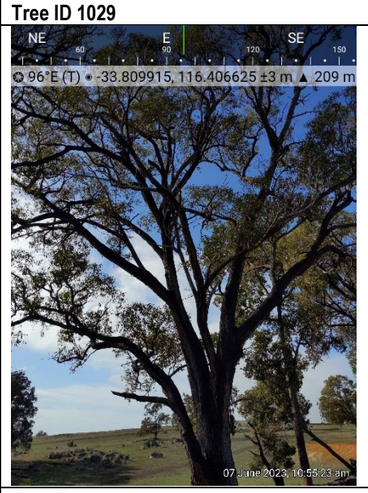	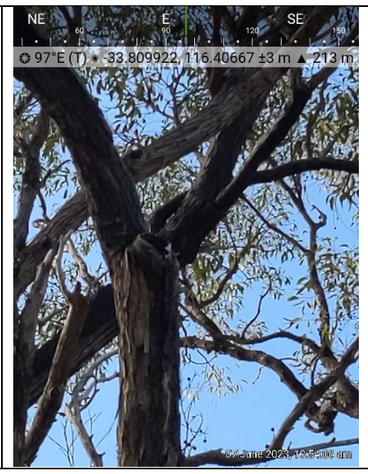
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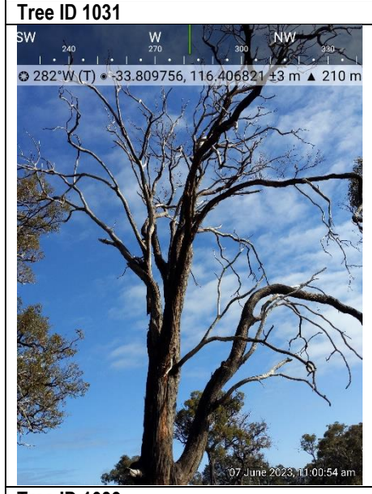		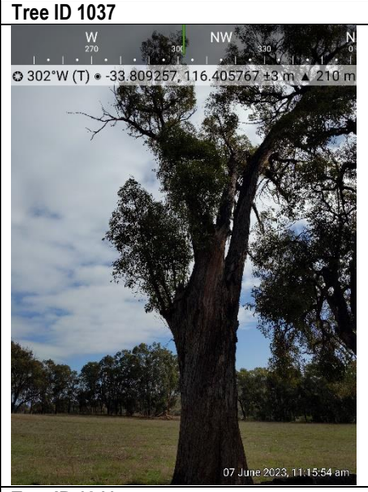	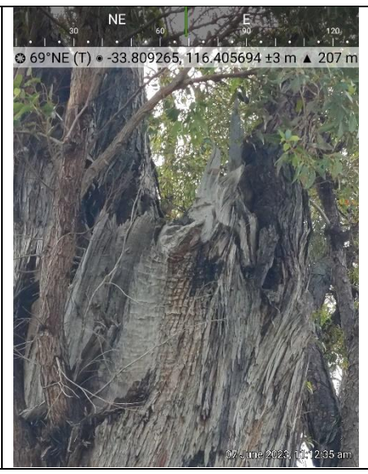
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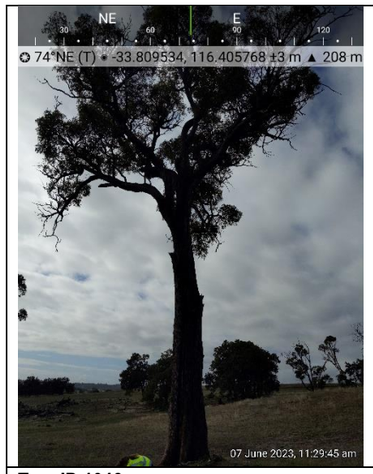

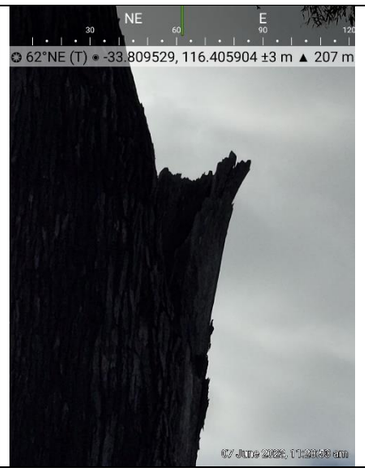

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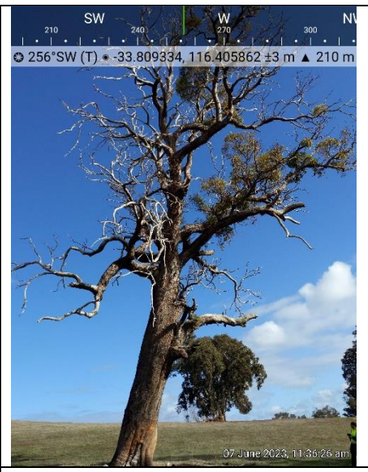



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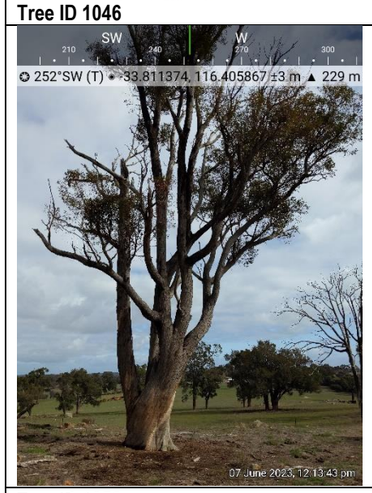



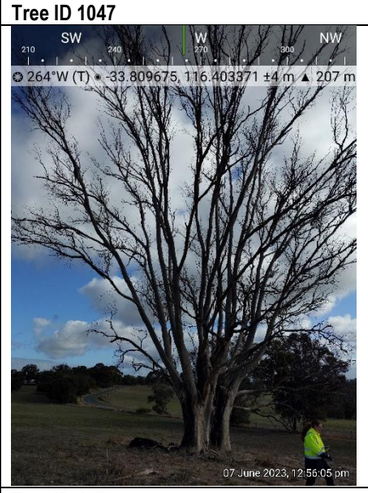

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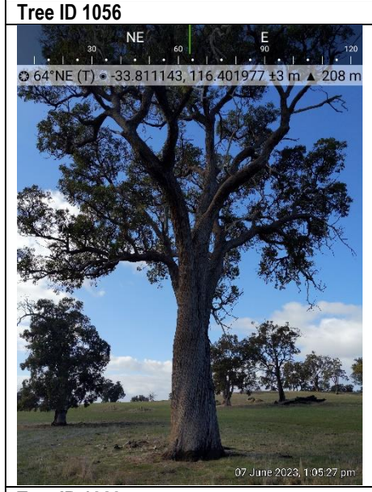

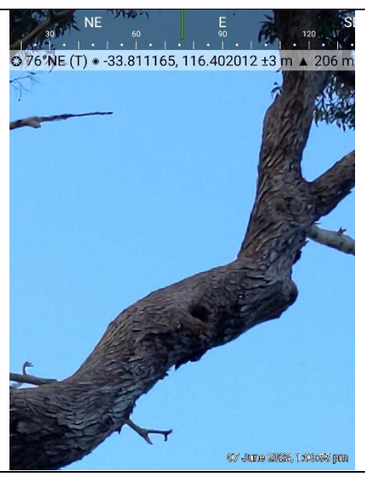



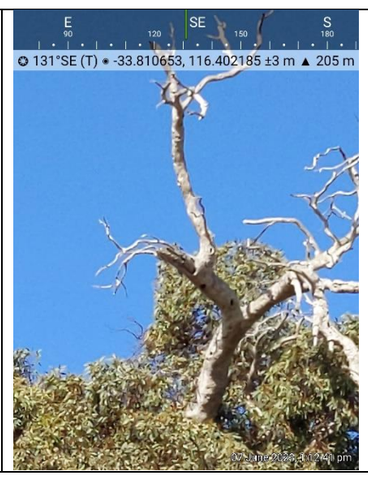

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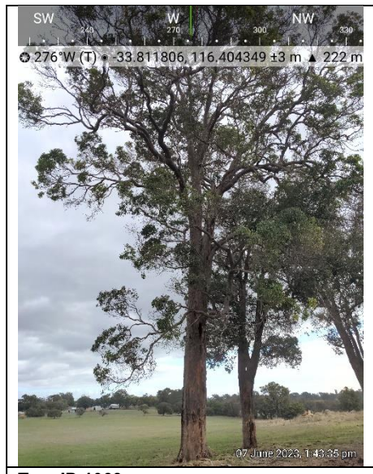



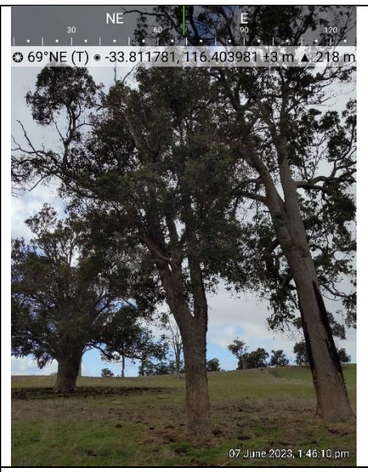



Tree ID 1063

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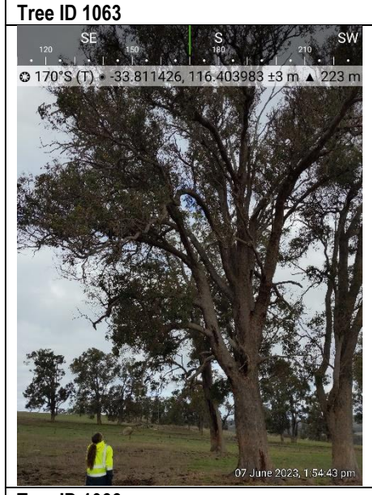

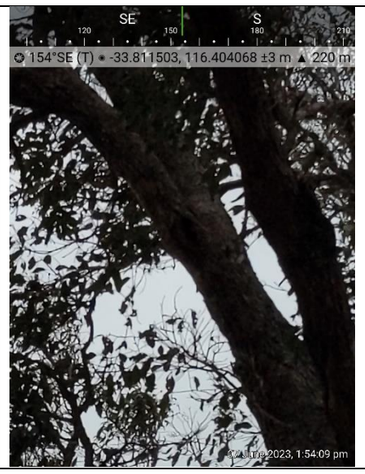

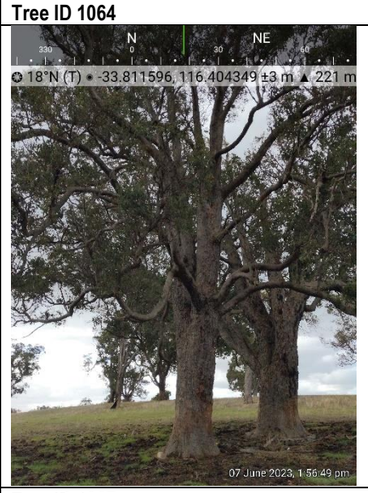

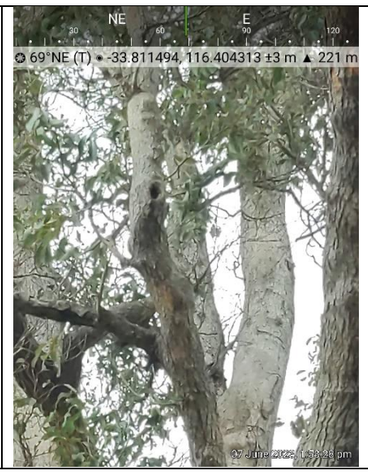

Tree ID 1066

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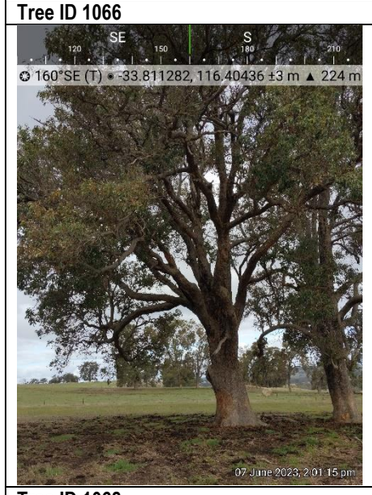

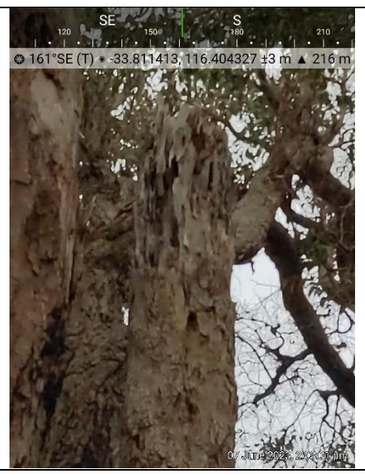



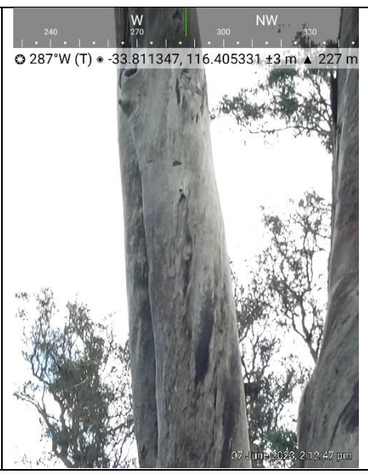

Tree ID 1068

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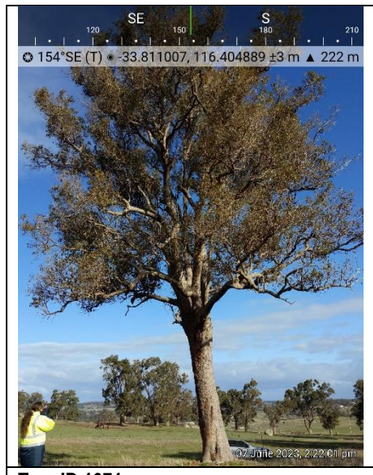
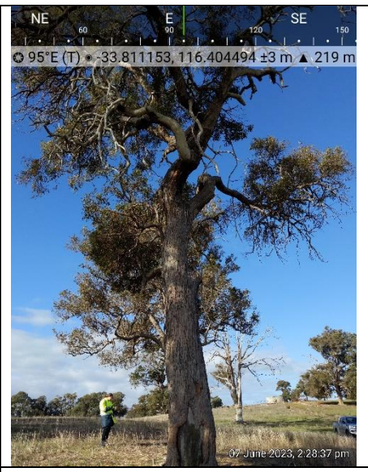
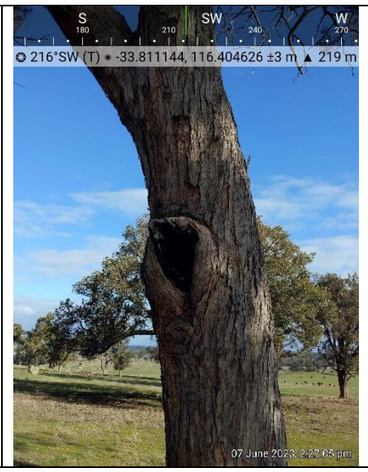
<tr><td></td><td>No photo available</td><td></td><td></td></tr>
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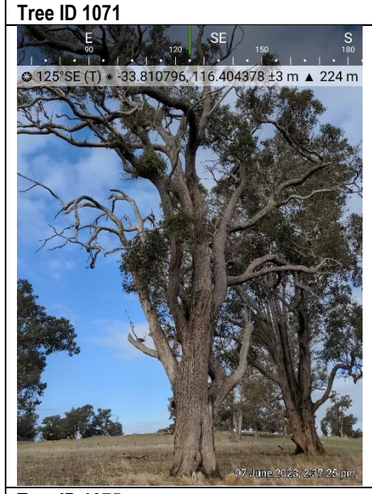
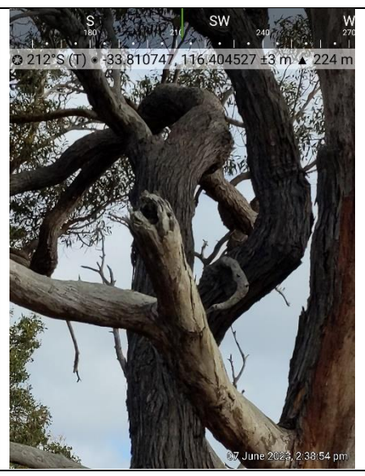
<tr><td></td><td></td><td></td><td></td></tr>
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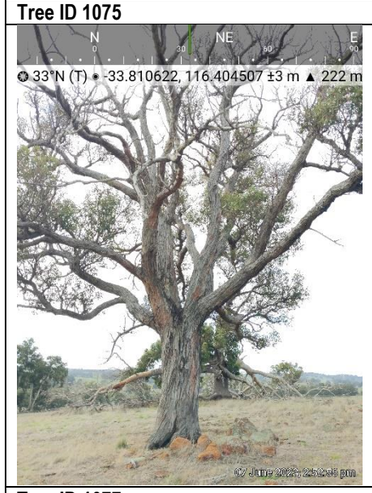
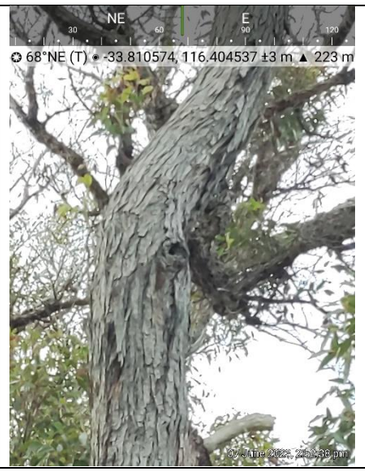
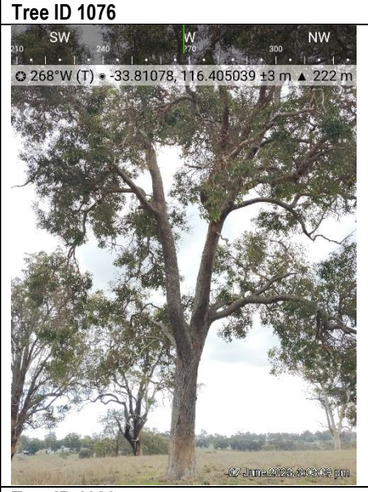
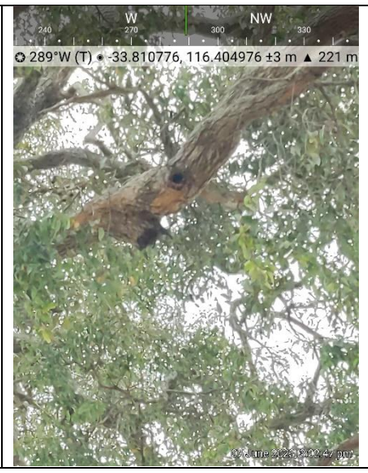
<tr><td></td><td></td><td></td><td></td></tr>
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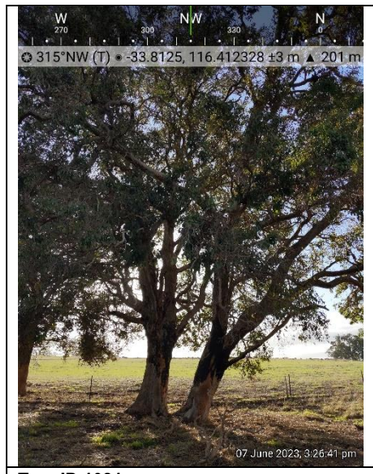

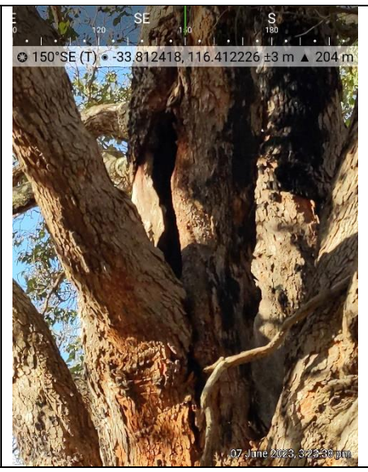

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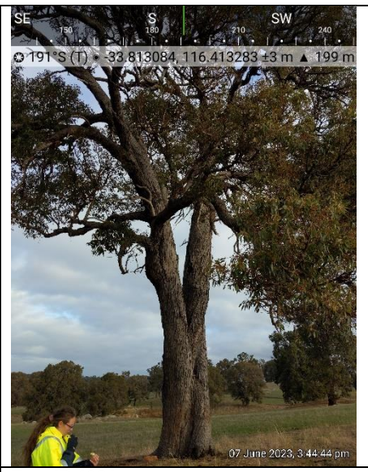

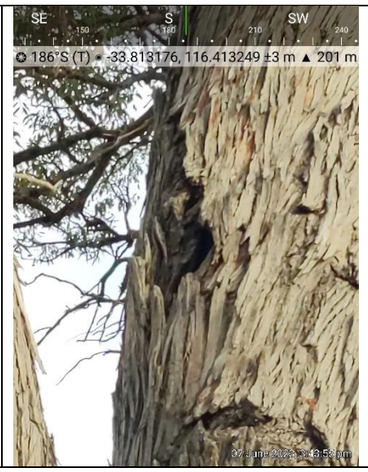

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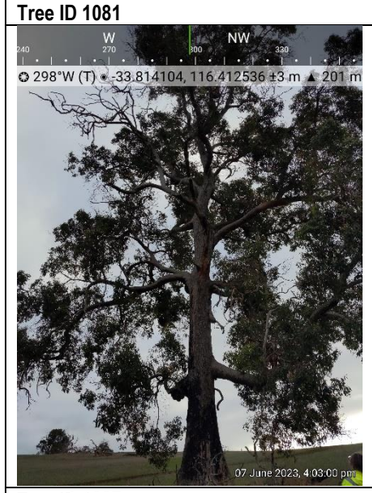

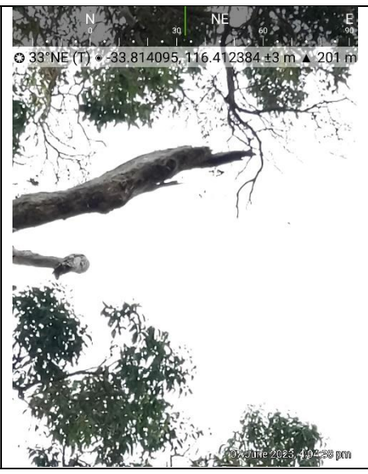

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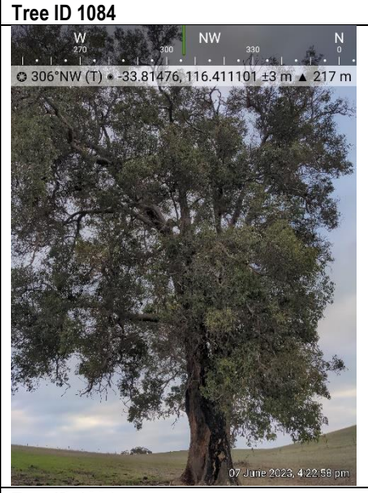

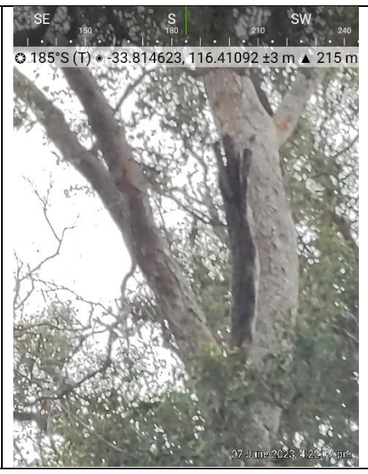

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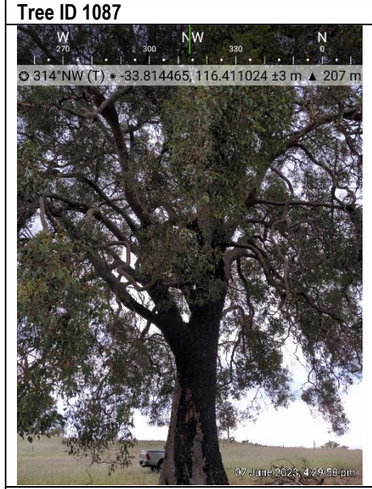

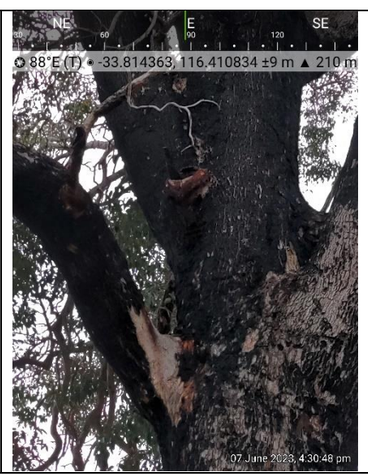

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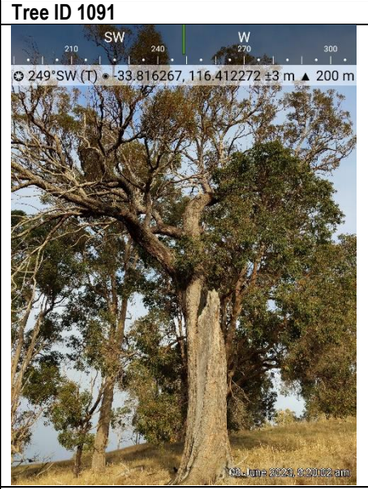

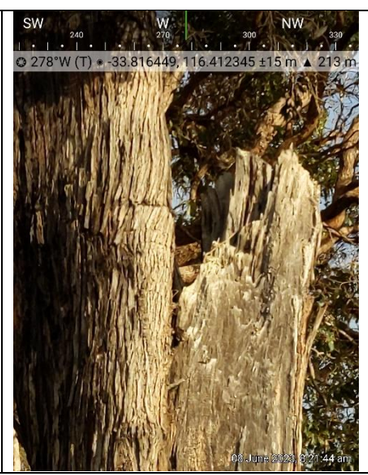

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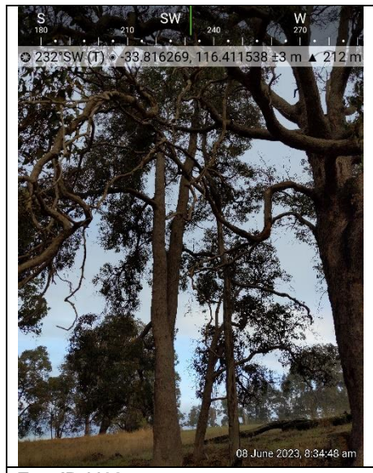

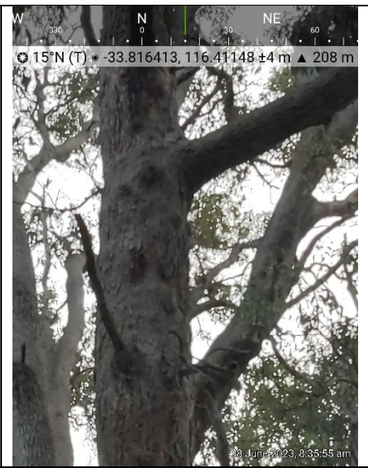

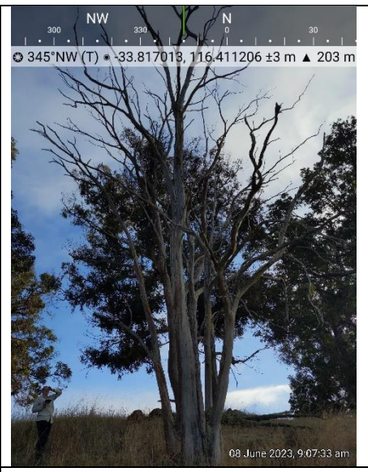



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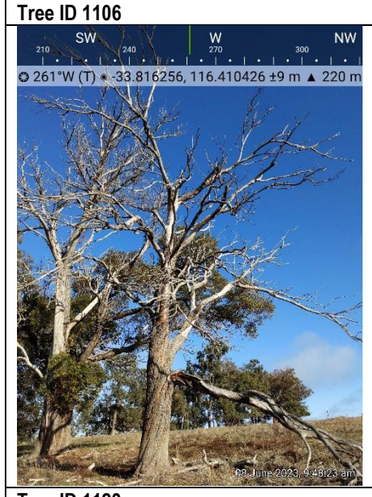

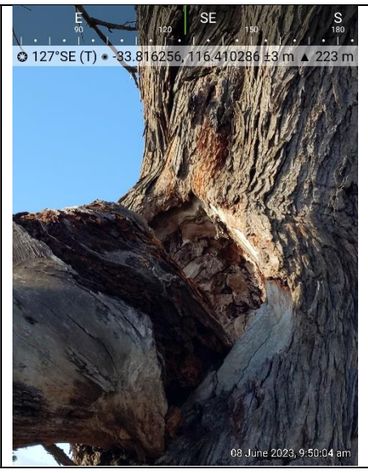

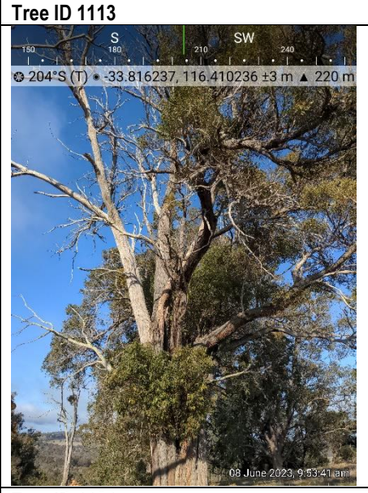



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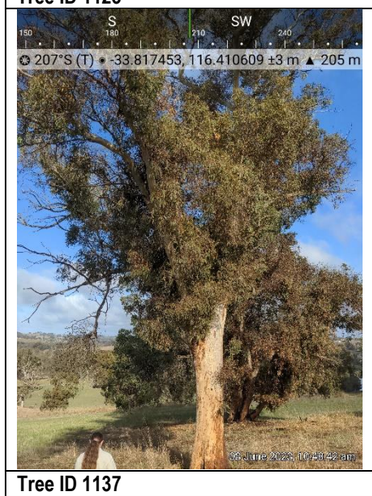

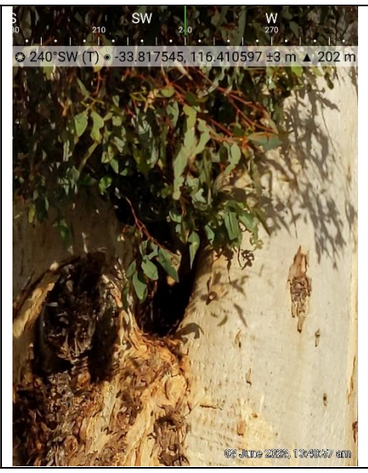

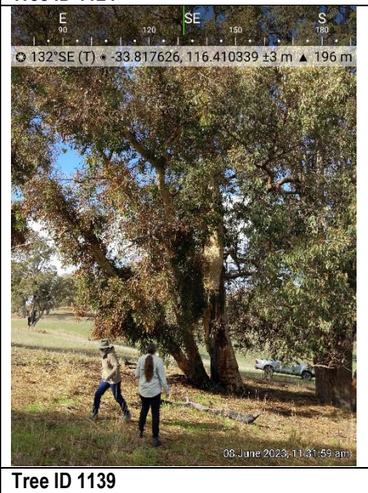

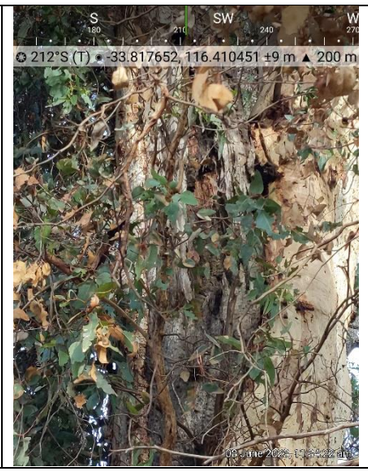

Tree ID 1137

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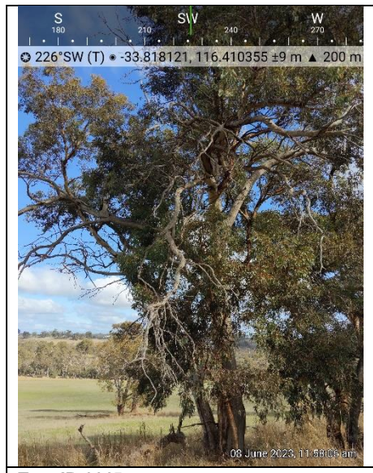



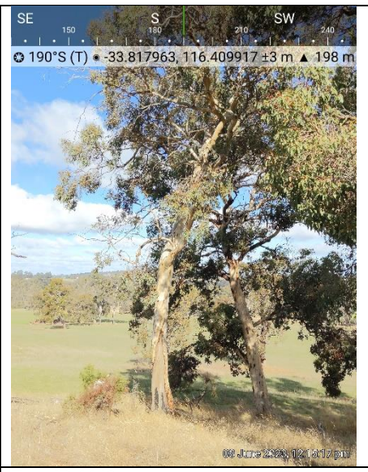

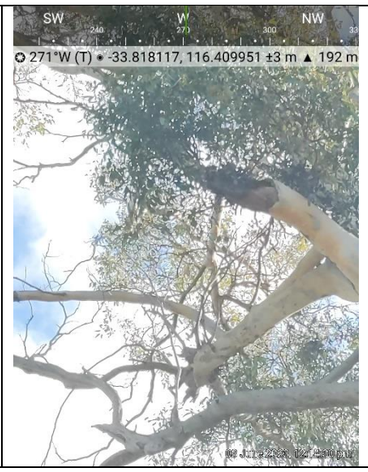

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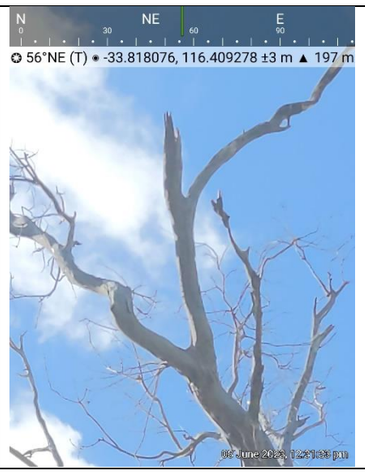

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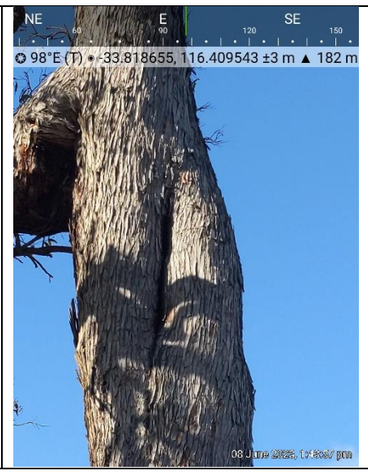

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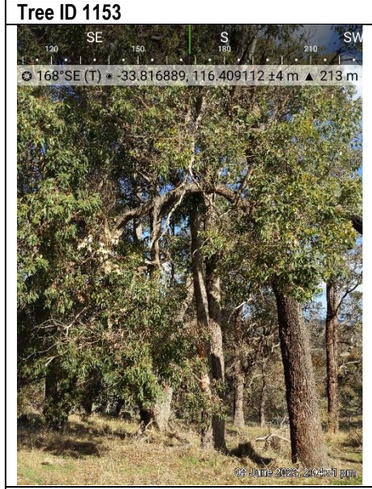



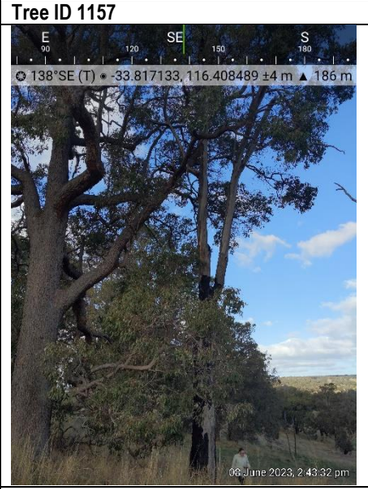

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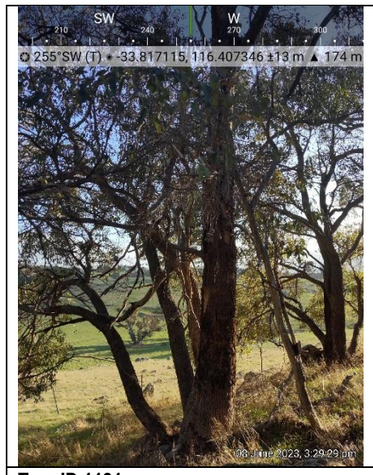

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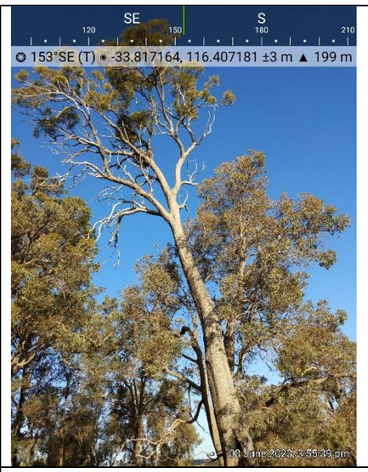

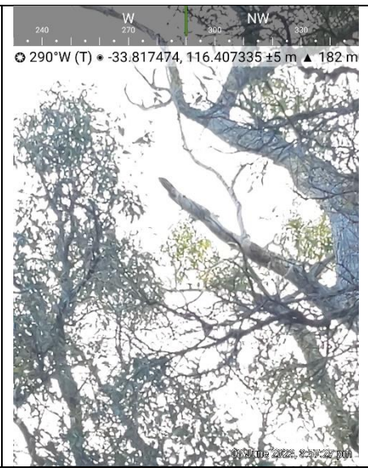

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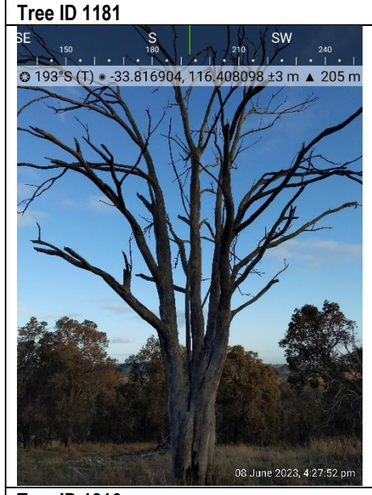



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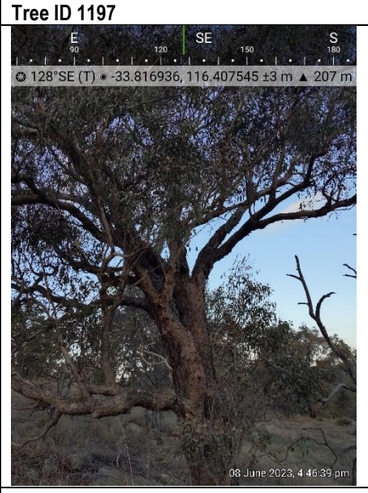

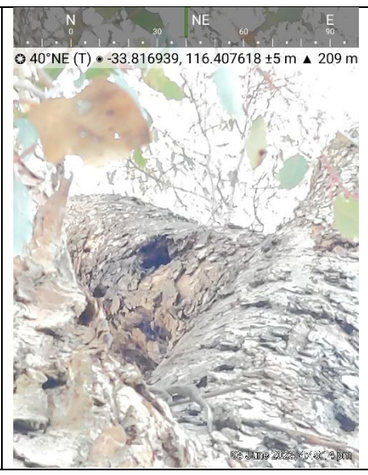

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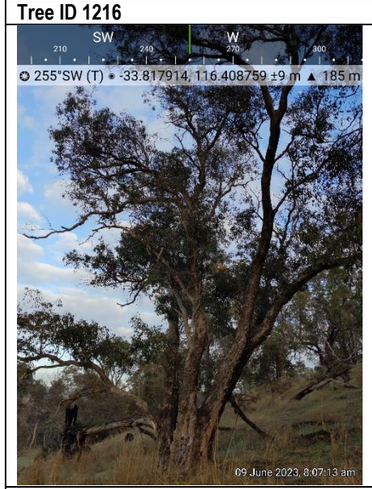

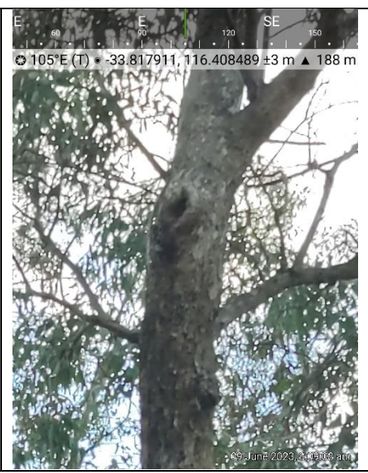

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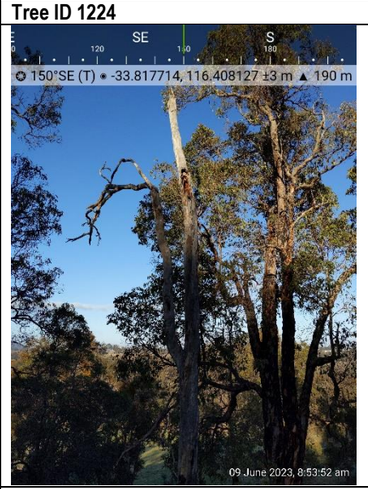



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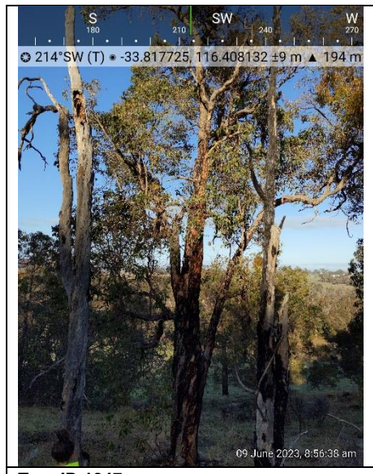

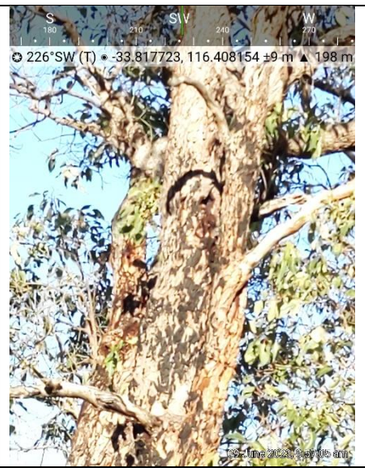

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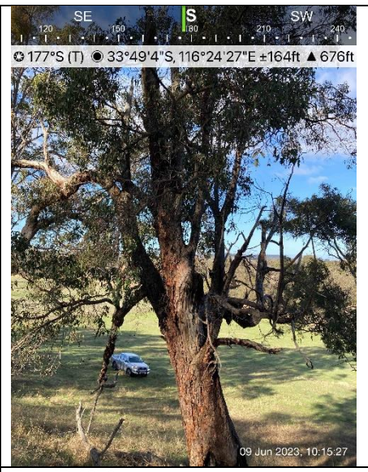

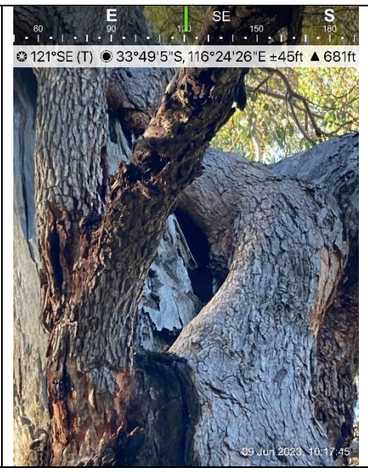

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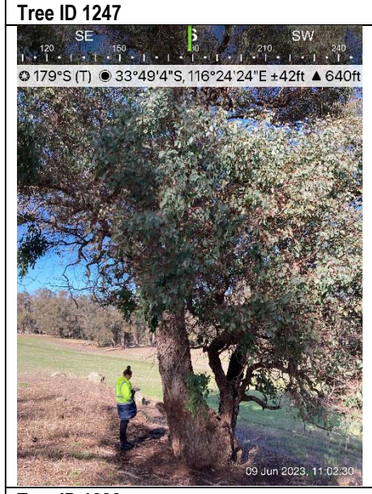

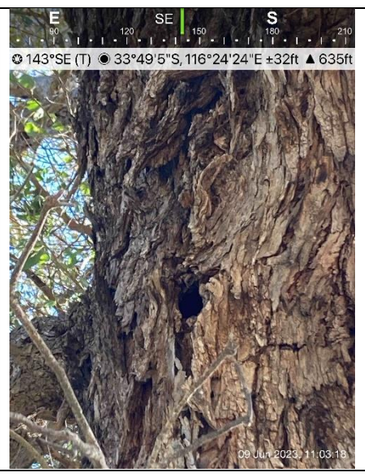

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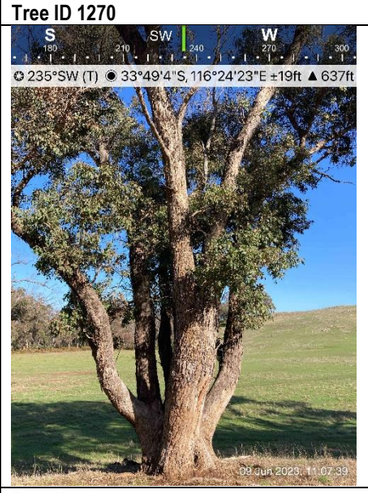

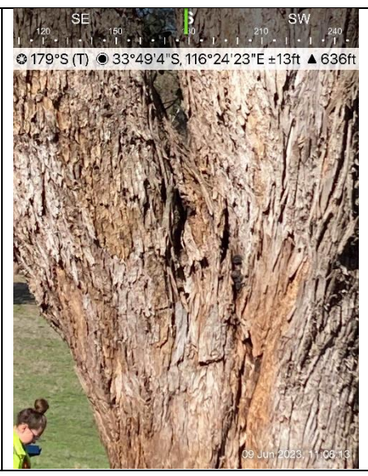

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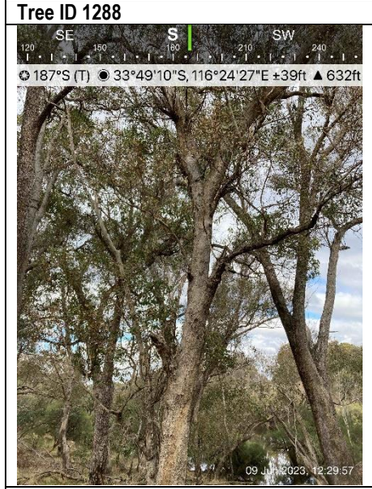

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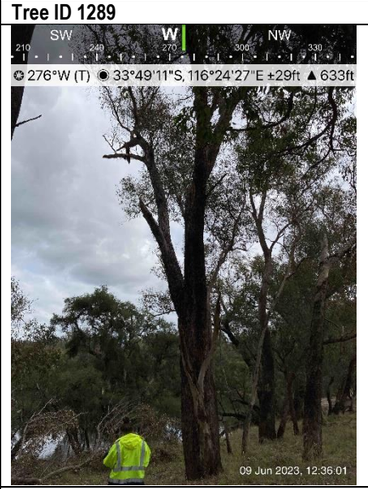

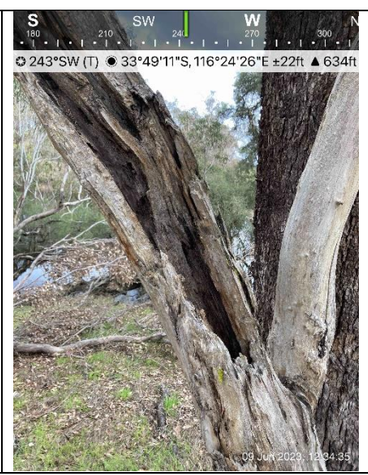

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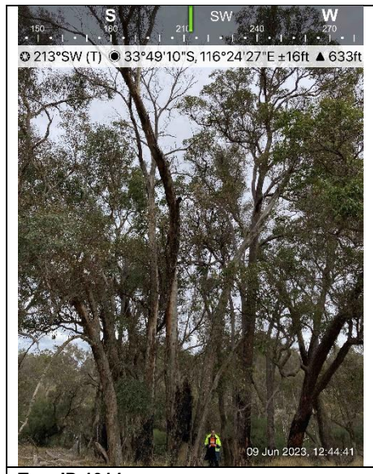



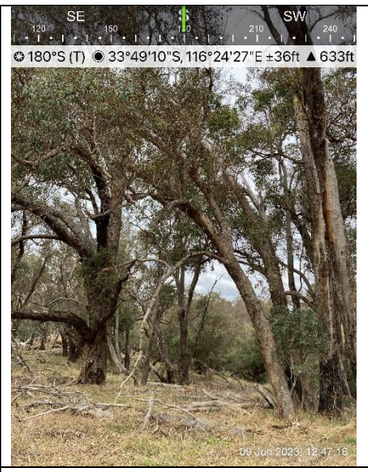

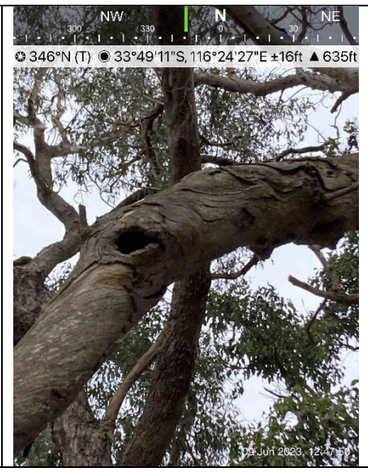

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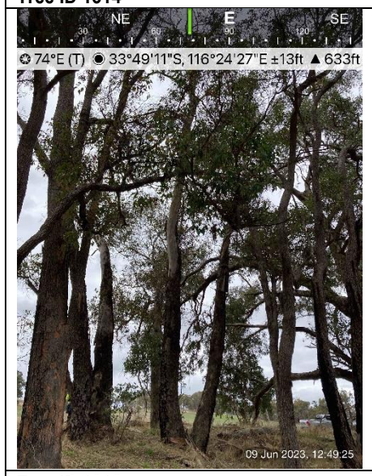



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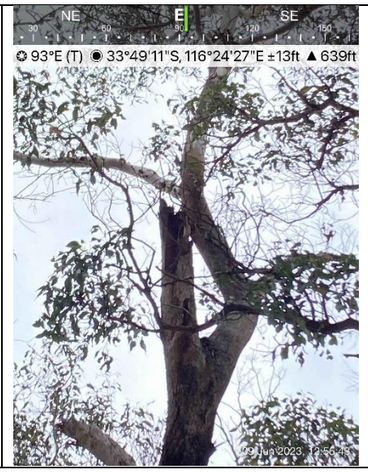

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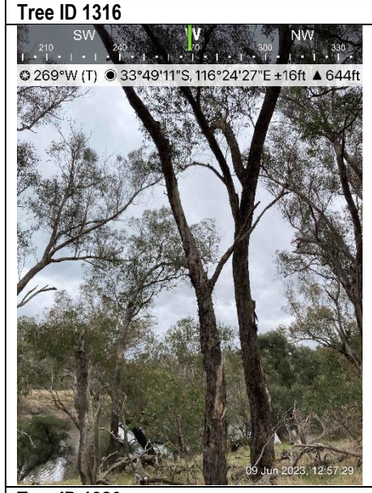

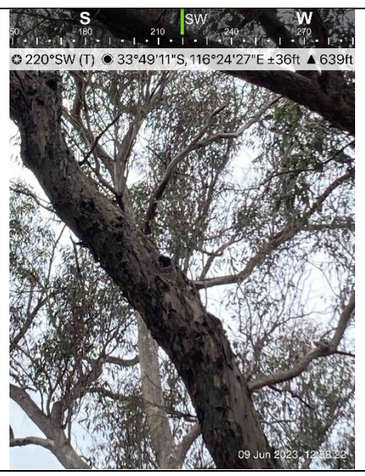

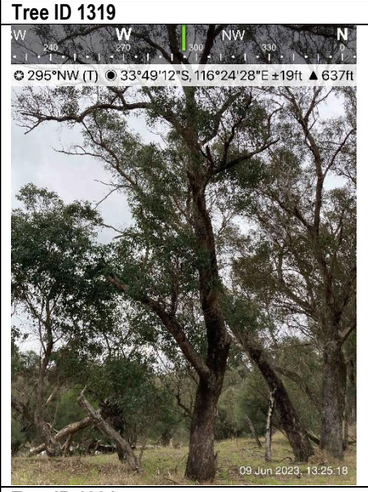

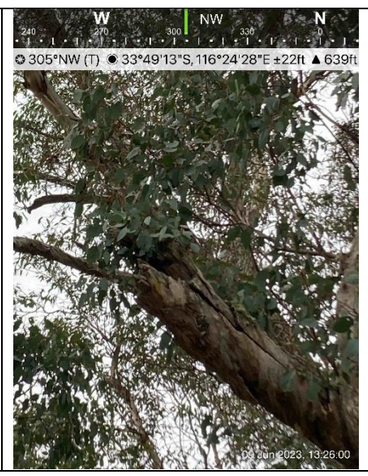

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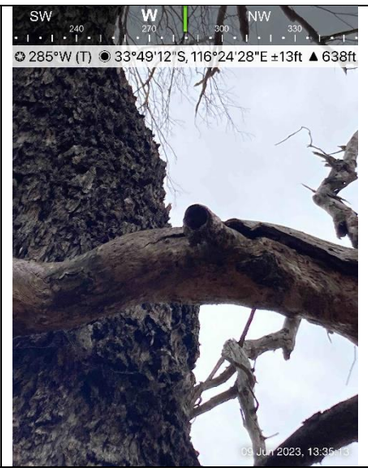



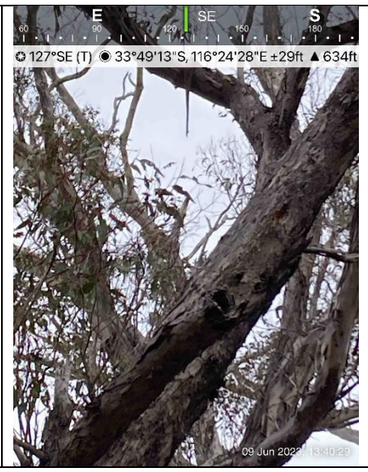

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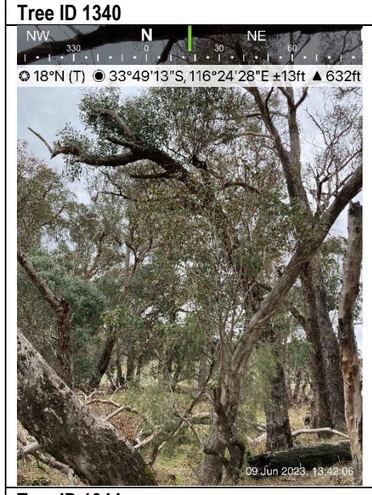

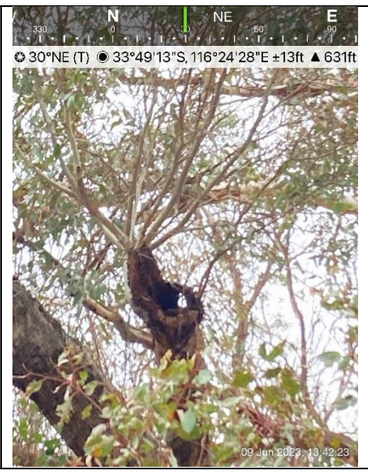

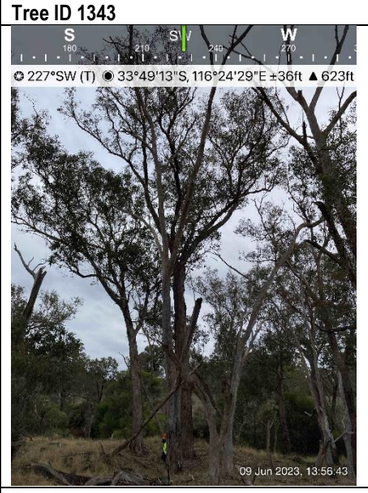

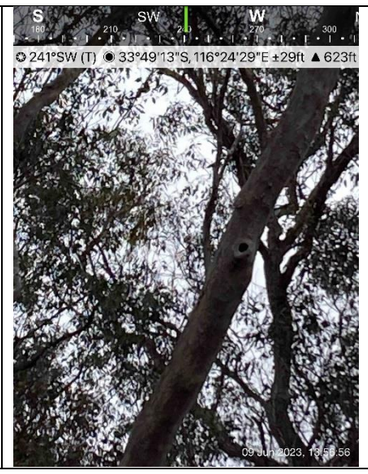

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Appendix C

Conservation Status Definitions

Table 8: Conservation code definitions for flora and fauna as listed as Threatened or specially protected.
Threatened, Extinct and Specially Protected fauna or flora are species which have been adequately searched for and are deemed to be, in the wild, Threatened, extinct or in need of special protection, and have been gazetted as such.

Threat Category	Definition
Threatened - Critically endangered species (CR)	Facing an extremely high risk of extinction in the wild in the immediate future
Threatened - Endangered species (EN)	Facing a very high risk of extinction in the wild in the near future
Threatened - Vulnerable species (VU)	Facing a high risk of extinction in the wild in the medium-term future
Threatened - Extinct (EX)	There is no reasonable doubt that the last member of the species has died
Threatened – Extinct in the wild (EW)	Species is known only to survive in cultivation, in captivity or as a naturalised population well outside its past range; and it has not been recorded in its known habitat or expected habitat, at appropriate seasons, anywhere in its past range, despite surveys over a time frame appropriate to its life cycle and form
Specially protected species - Migratory species (MI)	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; Includes 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 fauna subject to the Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention), an environmental treaty under the United Nations Environment Program. Migratory species listed under the BC Act are a subset of the migratory animals that are known to visit Western Australia, protected under the international agreements or treaties, excluding species that are listed as Threatened species.
Specially protected species – Conservation Dependent (CD)	Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as Threatened,
Specially protected species – Other specially protected species (OS)	Fauna otherwise in need of special protection to ensure their conservation

Table 9: Conservation code definitions for flora and fauna as listed as Priority.
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.

Threat Category	Definition
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.
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.
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.
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.

ATTACHMENT 12



November 2022

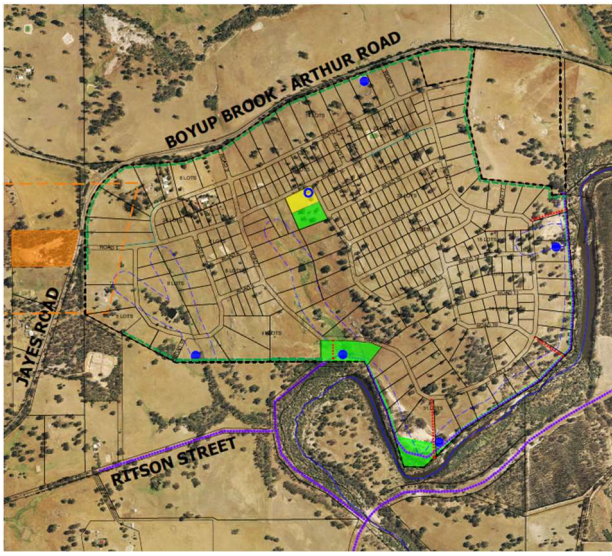
Final

Lots 51, 1007 and 1118 Boyup Brook Arthur Road, Boyup Brook

Prepared For:

Leafield Pty Ltd

Transport Impact Assessment Report



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DOCUMENT ISSUE AUTHORISATION

Issue	Rev	Date	Description	Author	Checked By	Approved By
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Donald Veal Consultants Pty Ltd

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1 INTRODUCTION

1.1 BACKGROUND

This Transport Impact Assessment (TIA) has been prepared by Donald Veal Consultants on behalf of Leafield Pty Ltd, with regard to the proposed subdivision development on Lots 51, 1007, 1118 Boyup Brook Arthur Road, Boyup Brook.

DVC understands there are two development scenarios which need assessment, with 360 lots and 111 lots, respectively. Under the WAPC guidelines, the two scenarios would typically attract different levels of analysis (a transport 'Statement' versus a transport 'Assessment'), determined by the volume of traffic generated.

1.2 SCOPE OF ASSESSMENT

This TIA has been prepared in accordance with the Western Australian Planning Commission's (WAPC's) *Transport Assessment Guidelines for Developments Volume 3 Subdivision* (2016). Its intent is to provide the approving authority with sufficient traffic information to confirm that the proponent has adequately considered the traffic aspects of the Structure Plan Amendments and that it would not have an adverse traffic impact on the surrounding area.

1.3 REFERENCES

The following documents are referred to in this report:

- *Liveable Neighbourhoods,* January 2009, WAPC and DOPI;
- *Transport Assessment Guidelines for Developments Vol 3 Subdivision,* August 2016, WAPC;
- *Guide to Traffic Generating Developments,* October 2002, Roads and Traffic Authority;
- *Residential Design Code (R-Codes) 2019,* WAPC; and
- *Austroads Guide to Road Design Part 4A Unsignalised and Signalised Intersections, 2017*.

2 EXISTING SITE CONDITIONS

2.1 SITE LOCATION

The greater site lies within the Shire of Boyup Brook, with the western boundary of the site around 1.5km north-east of the Boyup Brook townsite. It is bounded by Boyup Brook Arthur Road to the north, Jayes Road to the west and the Blackwood River to the southeast. Boyup Brook North Road intersects with Boyup Brook Arthur Road and Jayes Road to the northwest of the site.

The site is mostly bounded by agricultural land uses, mainly grazing.

Figure 2.1 shows an aerial view of the subject site and its location in a local context.

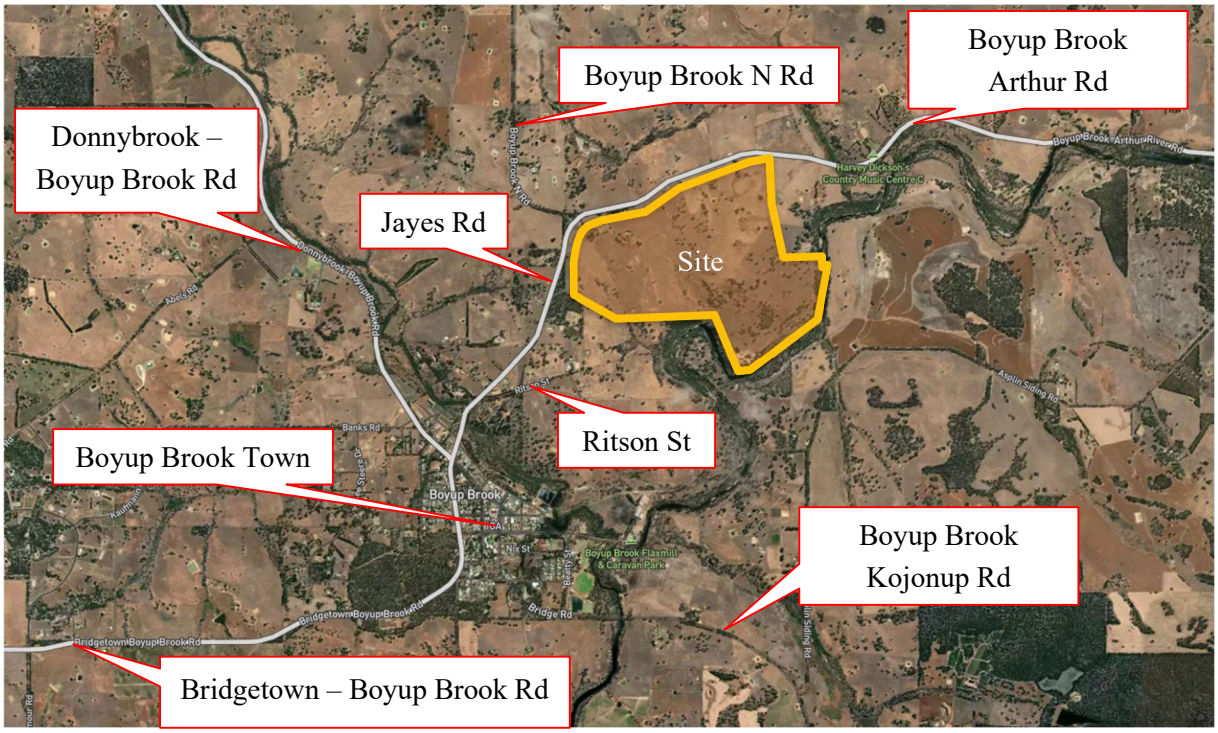


Figure 2.1: Existing Location in a Local Context ***Source: MetroMap***

2.2 CURRENT LAND USES

The site is currently used for agricultural purposes, mainly grazing.

2.3 ROAD HIERARCHY CLASSIFICATION

Boyup Brook Arthur Road and Jayes Road are classified as Regional Distributor Roads and Boyup Brook North Road is classified as a Local Distributor under Main Roads Western Australia's (MRWA's) Functional Road Hierarchy. Accordingly they are Shire-managed roads. See **Figure 2.2**.

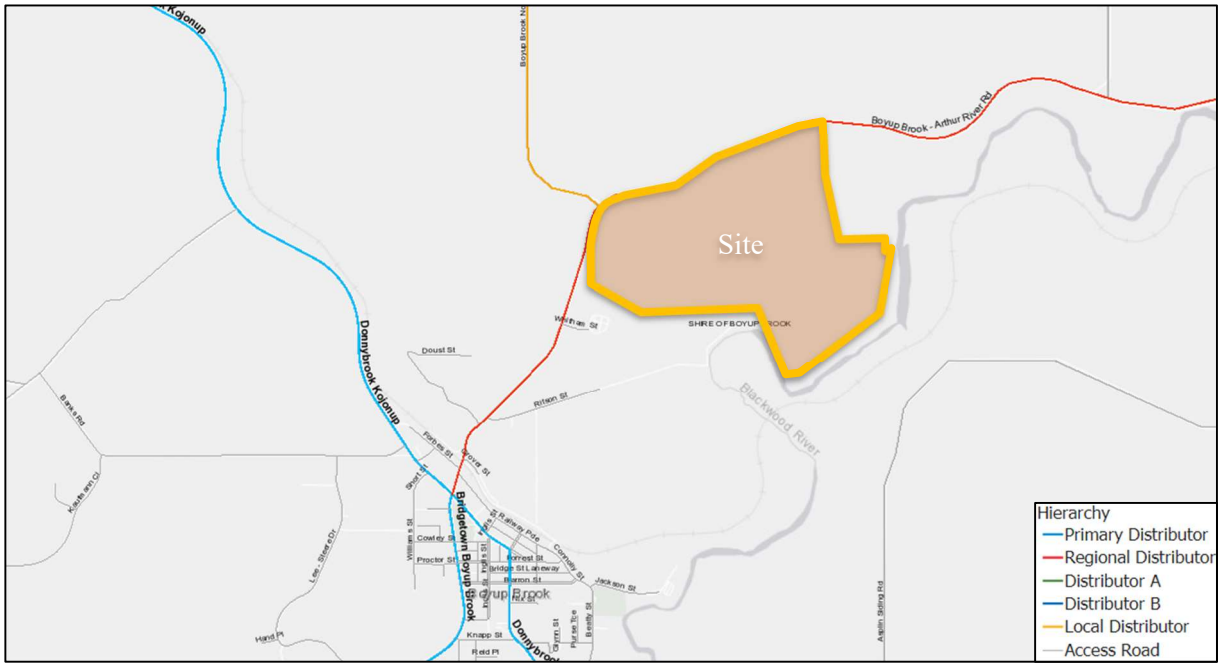


Figure 2.2: Road Hierarchy of surrounding road network *Source: MRWA Crash Map*

Boyup Brook Arthur Road has a posted speed limit of 100km/h. Jayes Road generally has a posted speed limit of 80km/h, which reduces to 60km/h at the intersection of Jayes Road and Ritson Street and to the south. It then decreases to 50km/h through the Boyup Brook townsite.

Boyup Brook North Road has a rural, open area default speed limit of 110 km/h according to the MRWA Speed Limits Map. See **Figure 2.3**.

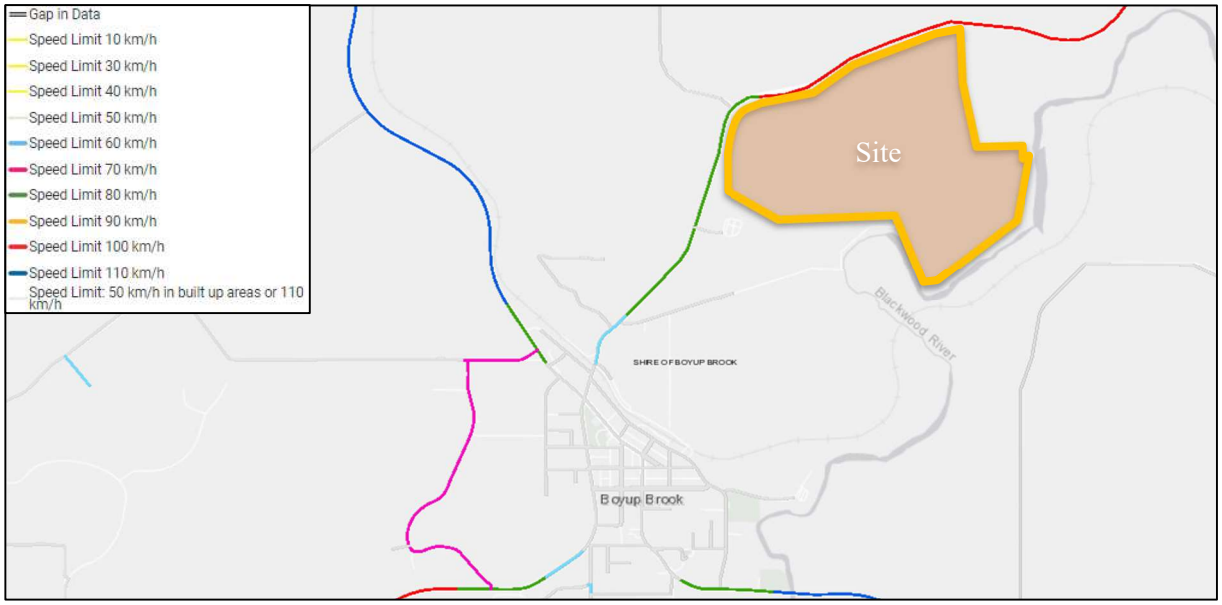


Figure 2.3: Speed Limit of surrounding road network *Source: MRWA Crash Map*

2.4 TRAFFIC VOLUMES

No existing traffic counts were available from the MRWA Traffic Map on the Boyup Brook Arthur Road. Nearby traffic counts from the MRWA Traffic map are shown in **Table 2.1**. From discussions with the Shire it is evident that the Boyup Brook Arthur Road does not carry as much traffic as either the Donnybrook Road or the Bridgetown Road. Site observations also confirmed that traffic volumes were low. Therefore for the purposes of this assessment it has been assumed that the Boyup Brook Arthur Road carries similar levels of traffic to the Boyup Brook Kojonup Road i.e. about 550vpd. Hourly volumes here are not the same as metropolitan areas where there are pronounced, directional AM and PM peak hours. On the Boyup Brook-Kojonup Road traffic volumes in each direction are similar and maintain a steady volume between 8:00AM and 4:00PM. Each direction carries around 20-25vph in 2021/2022. Calculations in this assessment assume current hourly volumes of 30vph in each direction.

Table 2.1: Summary of MRWA Traffic Counts

Location	Date	Vehicles Per Day	% Heavy Vehicles
Boyup Brook Kojonup Road	2021/22	543	21.4%
Donnybrook Boyup Brook Road	2021/22	787	32.8%
Bridgetown Boyup Brook Road	2021/22	693	10.7%

2.5 PLANNED CHANGES TO THE ADJACENT ROAD NETWORK

DVC is not aware of any planned upgrades to the adjacent road network.

2.6 CRASH HISTORY

The MRWA CARS database was interrogated to identify the history of crashes occurring along Boyup Brook Arthur Road and Jayes Road between Ritson Street and Thompson Road in the latest 5-year reporting period, 2017 – 2021.

The database returned records of 2 crashes within this period as shown in **Figure 2.4**. Of these, one involved hitting an object and one a non-collision crash. Both crashes were property damage only.

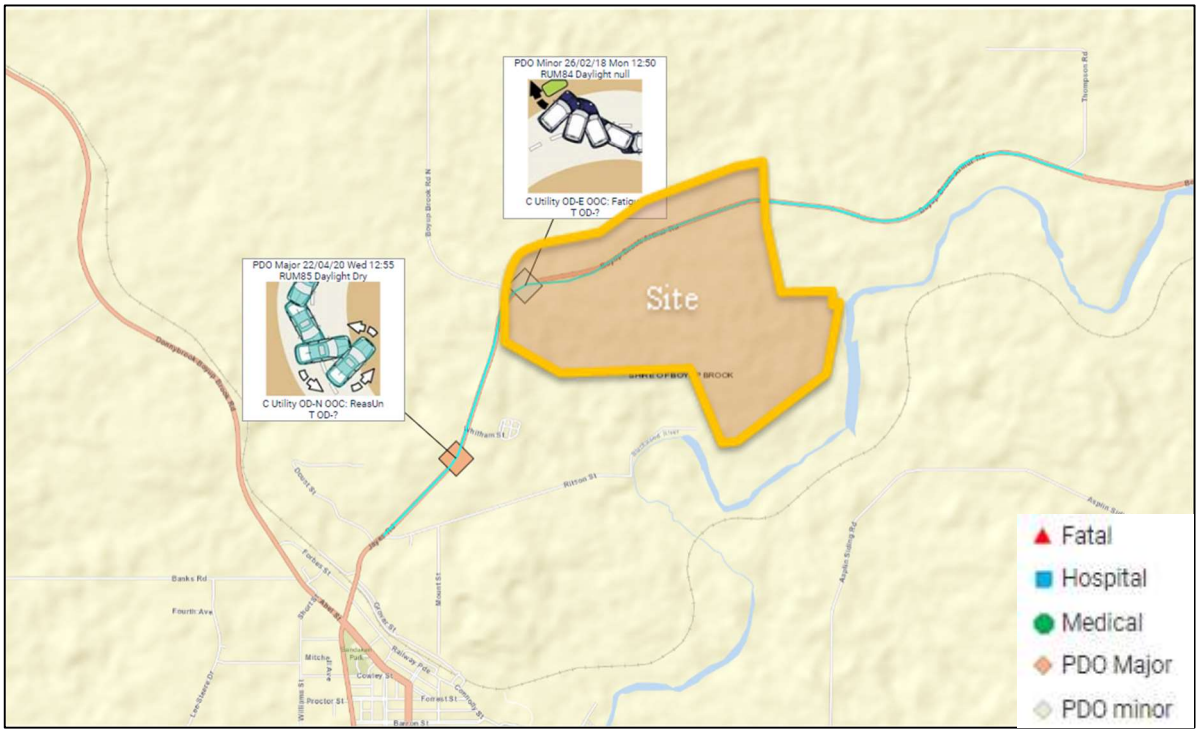


Figure 2.4: Crash Diagram **Source: MRWA Crash Map**

3 PROPOSED DEVELOPMENT

3.1 PROPOSED LAND USES

The subdivision plan proposes two differents scenarios:

1. **Scenario 1**: 360 residential lots with the subdivision connected to scheme water as shown in **Figure 3.1**.

2. **Scenario 2**: 111 residential lots yield in the draft Local Planning Stategy with no scheme water. At this stage there is no planned lot layout although DVC understands that access onto Jayes Road and the Boyup Brook Arthur Road will be the same as shown for Scenario 1.

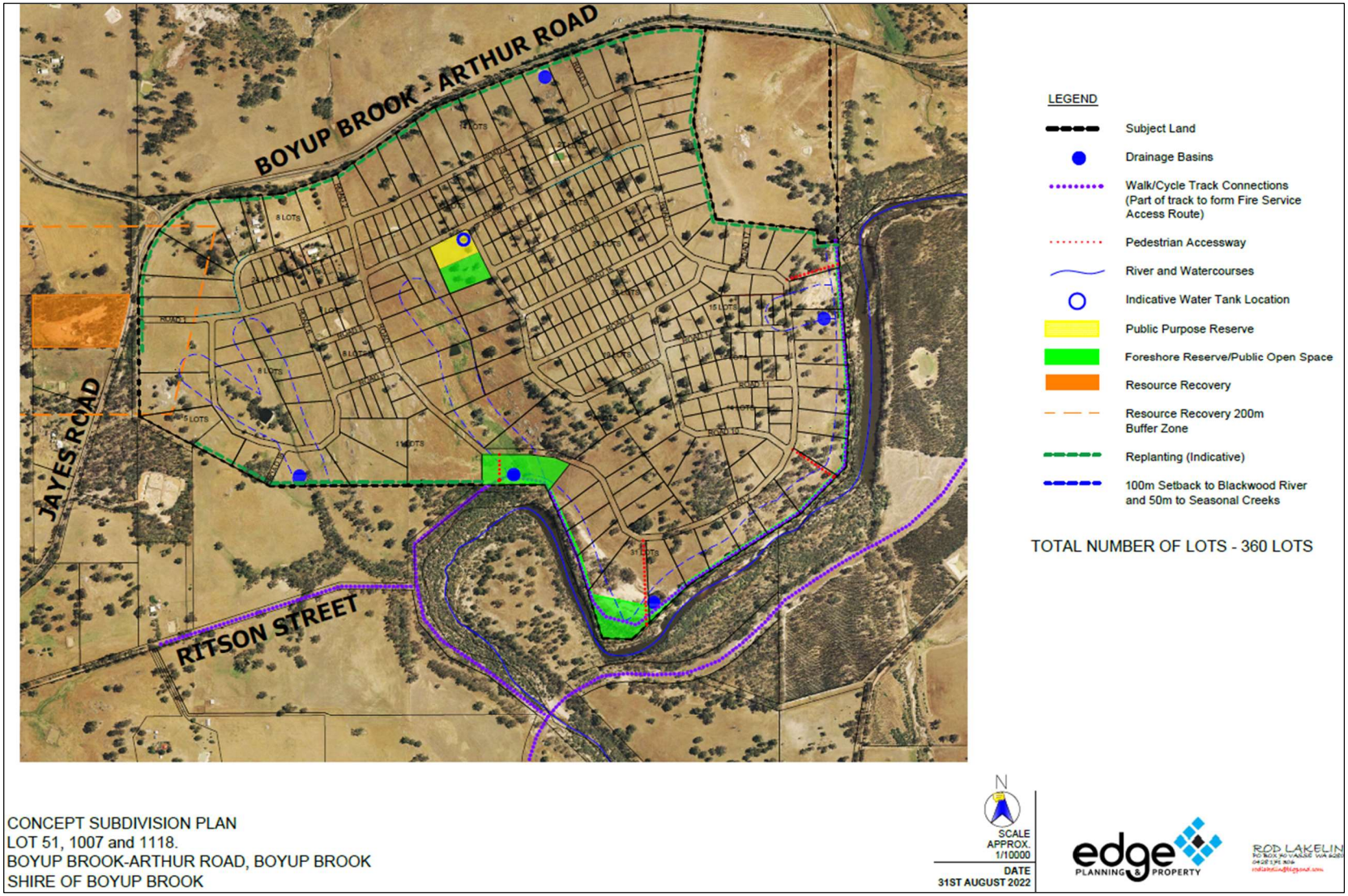


Figure 3.1: Site Concept Plan Scenario 1 *Source: Edge Planning & Property*

3.2 INTERNAL ROAD NETWORK

3.2.1 Scenario 1: 360 Lots

The layout out of the roads shows good internal circulation. Based on the local catchment of each internal road and published trip generation rates (Guide to Traffic Generating Developments, October 2002, Roads and Traffic Authority) most of the internal roads will attract less than 1,000 vpd. The exception to this is Road 1 as shown in **Figure 3.1**. Given that the majority of traffic from the subdivision is expected to travel either to Boyup Brook or further afield via Boyup Brook, it can be expected that Road 1 would carry between 1,000 vpd at the eastern end and around 3,600 vpd at the western end. This is based on a trip rate of 10 trips per dwelling per day which is often applied to metropolitan subdivisions. It could be argued that in a rural setting like Boyup Brook trip generation may not be this high given the relative lack of local destinations and attractions. A trip rate of 10 is therefore considered to be a conservative (high) estimate for trip making for this proposal.

Liveable Neighbourhoods Guidelines (January 2009) Table 4 recommends that internal roads carrying up to 1,000 vpd with a low parking demand should be classified as Access Streets D with a 14.2 m road reserve, a 5.5 m-6 m paved carriageway and a 50 km/h speed limit. Streets carrying up to 3,000 vpd may be classified as Access Streets C with a road reserve of up to 16 m, a 7.2 m carriageway and a 50km/h speed limit. Streets carrying more than 3,000 vpd should be classified as Neighbourhood Connector roads with up to a 24 m road reserve.

A school bus route currently services the rural areas to the east of the site and it is possible that this route will detour through the subdivision. A sensible internal route would follow (from the east at Road 3) the internal loop comprised of Road 3 and Road 2, before exiting the area to the west at Road 1. If this is used as a bus route then it should have an Access Road C classification despite the traffic volumes not requiring this.

Based on the forecast traffic volumes and potential bus route, DVC recommends the following classifications:

Road 1 (Jayes Road to Road 2 west intersection) – Neighbourhood Connector B (20m road reserve if on-street parking lanes are required, otherwise 18m).

Road 1 (Road 2 west to Road 2 east) – Access Street C (16m road reserve)

Road 2 (if used as a bus route) – Access Street C (16m road reserve)

Others – Access Street D (15m road reserve).

Figures 3.2 to 3.4 provide concept cross sections for each road type.

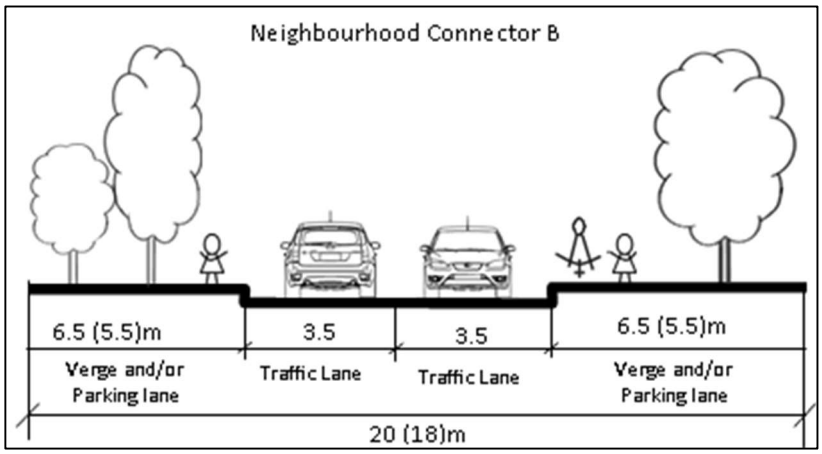


Figure 3.2: Neighbourhood Connector Cross Section

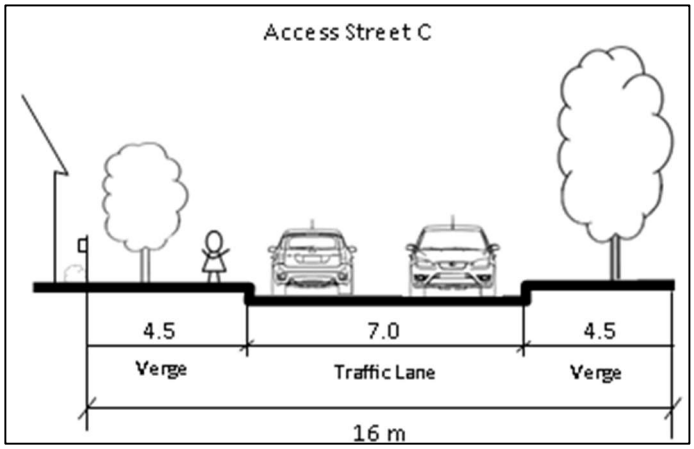


Figure 3.3:Access Street C Cross Section

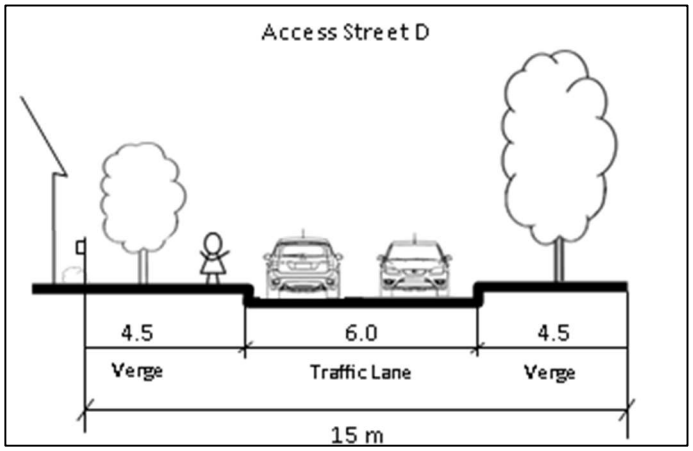


Figure 3.4: Access Street D Cross Section

The proposed subdivision layouts present some long straight sections of internal streets on which speed limits of 50 km/h may easily be exceeded. Liveable Neighbourhoods Table 6 indicates that sections of up to 200 m of Access Streets C&D may not require speed constraint measures if the traffic volumes are low and if on-street parking is likely to be generated. DVC considers that while forecast volumes are likely to be low, there is unlikely to be much on-street parking as the lots will mostly accommodate parking on site. Despite this, it may be acceptable to the Shire not to insist on speed constraint measures.

The four-way intersections between Road1/Road2 and Road2/Road4 will require traffic control, probably small roundabouts. These will reduce speeds to some extent along these roads. In any event additional measures can be introduced at the detailed design stage, if required.

3.2.2 Scenario 2: 111 Lots

Scenario 2 will generate significantly less traffic than Scenario 1 and it is unlikely that any internal road would carry more than 1,000vpd. That being the case all internal roads could have an Access Road D classification with a cross section as shown in **Figure 3.4**.

3.3 ACCESS ARRANGEMENTS

As shown in **Figure 3.1**, the site plan proposes three access roads: Road 1 at Jayes Road and Road 2 and Road 3 along the Boyup Brook Arthur Road.

Intersection sight distances were measured along the major road at each location and are summarised in **Table 3.1.**

Table 3.1: Summary of Sight Distances

Access Road	Sight Distance Left (m)	Sight Distance Right (m)	Comments
Road 1	350m	> 200m	SD is an estimate of the achievable SD once modest vegetation in the verge has been removed. (See discussion later in this section)
Road 2	>400m	>350m	Excellent SD both directions
Road 3	>350m	Approx 200m	SD in both directions is an estimate of achieveable SD once vegetation in the verge has been removed. The road crests and curves to the right, limiting this sight distance.

Photos 1-6 illustrate the views from the access road locations and the vegetation currently growing in the verge.



Photo 1: Road 1 View Looking South



Photo 2: Road 1 View Looking from North to Intersection



Photo 3: Road 2 View Looking East



Photo 4: Road 2 View Looking West



Photo 5: Road 3 View Looking East



Photo 6: Road 3 View Looking West

Equation 2 in the Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections provides guidance on calculating the Safe Intersection Sight Distance (SISD) at intersections. SISD is the minimum sight distance which should be provided on the major road at any intersection. Given the high percentage of trucks using the nearby roads (see **Table 2.1** above) the required SISD has been checked for trucks in the 100km/h and 80km/h speed limit area as follows:

Posted Speed Limit	SISD for Trucks *	SISD for Cars**
80km/h	245m	214m
100km/h	330m	285m

* Equation 2 from Austroads Part 4A
** MRWA Supplement to Austroads Part 4A

(* – this assumes that the Design Speed is 10km/h higher than the posted speed limit (as required by MRWA), the coefficient of deceleration for trucks is 0.29, there is a downhill grade of 2% and the Decision Time is 5seconds).

Road 3 does not maintain a SISD of 330m to the right for trucks or 285m for cars. This being the case it may be possible to relocate the Road 3 intersection further to the west and to recommend a reduction of the speed limit along that section of road. The latter would appear to be sensible given that there will be a residential frontage along the road on the south side i.e. this will become a built-up environment and 80km/h speed limits would be expected by road users. While Road 3 is not expected to carry significant traffic it may provide a bushfire plan alternative exit and should therefore be retained.

Road 1 generally has good sight distance to the right but on-site measurement past the 200m mark is made difficult by the vegetation. This road will be in a cutting when constructed and through modest reshaping of the cut to the right and cleared verges, DVC considers that the required sight distances will be achieved for the current 80km/h speed limit. There is also scope to review the speed limit on Jayes Road between Boyup Brook North Road and south of the Road 1 intersection. In addition, the land falls away from the Boyup Brook-Arthur Road on the eastern side, further reducing visual obstruction there. In any event this should be checked during detailed design.

4 ANALYSIS OF EXTERNAL ROAD NETWORK

This transport assessment has been undertaken assuming the full development of Scenario 1. When full development will occur is dependent on a range of factors affecting demand, including economic activity in the area. If a forecast uptake of about 50 properties per year is achieved, full development would be achieved in about 8 years. Based on this, it has been assumed that for the purposes of this traffic assessment that full development will occur in 2030.

4.1 TRIP GENERATION RATES

4.1.1 Scenario 1: 360 Lots Trip Generation

Peak hour trip generation for the proposed development has been based on the Residential Rates in Table 2 of Western Australia Planning Commission (WAPC) *Transport Assessment Guidelines for Developments (2016) Volume 3*.

The residential lots are estimated to generate about 290 trips during the peak hour as shown in **Table 4.1**.

Table 4.1: Trip Generation of Proposed Developments – Scenario 1

Site	Dwellings	Rates				Trips			
		AM In	AM Out	PM In	PM Out	AM In	AM Out	PM In	PM Out
Scenario 1	360	0.2	0.6	0.5	0.3	72	216	180	108
						288		288	

The Roads and Traffic Authority's (RTA) Guide to Traffic Generating Developments suggests a daily trip rate of 9-10 trips per dwelling. This translates to about 3,240-3,600 trips per day to the subject site split 50/50 inbound and outbound trips.

4.1.2 Scenario 2: 111 Lots Trip Generation

Trip generation rates applied to Scenario 2 are shown in **Table 4.2** and indicate that peak hour trips will reach about 90vph. Daily trips would be between 1,000 – 1,200.

Table 4.2: Trip Generation of Proposed Developments – Scenario 2

Site	Dwellings	Rates				Trips			
		AM In	AM Out	PM In	PM Out	AM In	AM Out	PM In	PM Out
Scenario 2	111	0.2	0.6	0.5	0.3	22	67	56	33
						89		89	

4.2 TRIP DISTRIBUTION & ASSIGNMENT

Based on discussions with engineering staff at the Shire, it has been assumed that 90% of traffic from the proposed development will have destinations in Boyup Brook itself, or will travel via the township to destinations further afield such as Bridgetown, Kojonup or Collie. The remaining 10% of development traffic is assumed to travel east towards Dinninup (5%) or north on the Boyup Brook Road North (5%). Based on these traffic distributions it has been assumed access Road 1 will carry 90% of the traffic with access Roads 2 and 3 each carrying 5% of the traffic demand. This is shown graphically in **Figures 4.1** and **4.2** for the AM and PM Peak hours respectively.

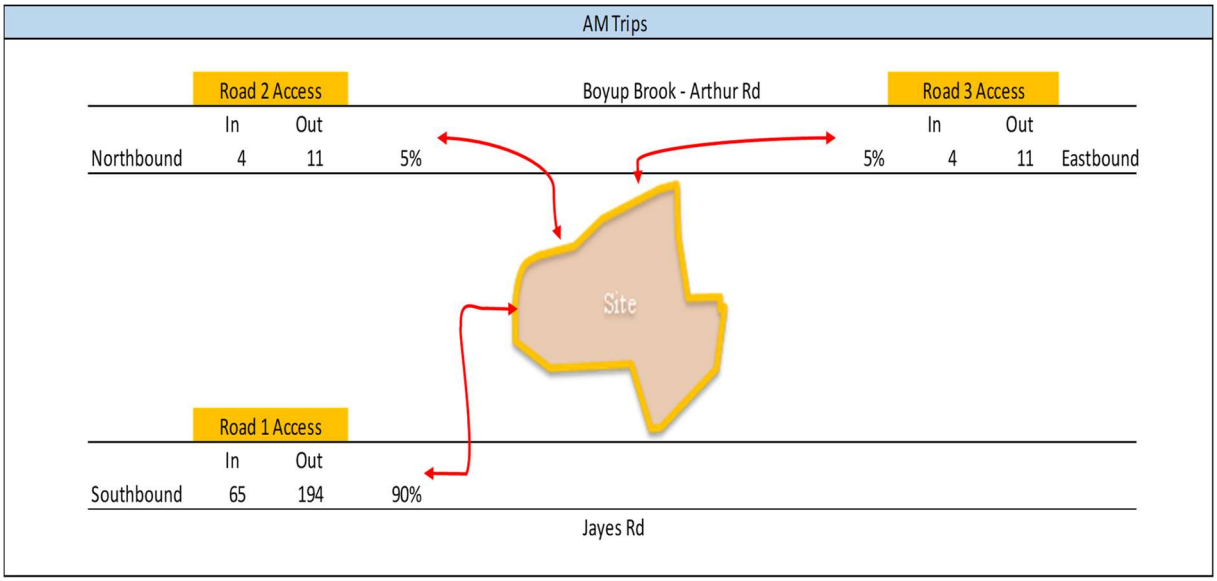


Figure 4.1: AM Peak Hour Trip Distribution

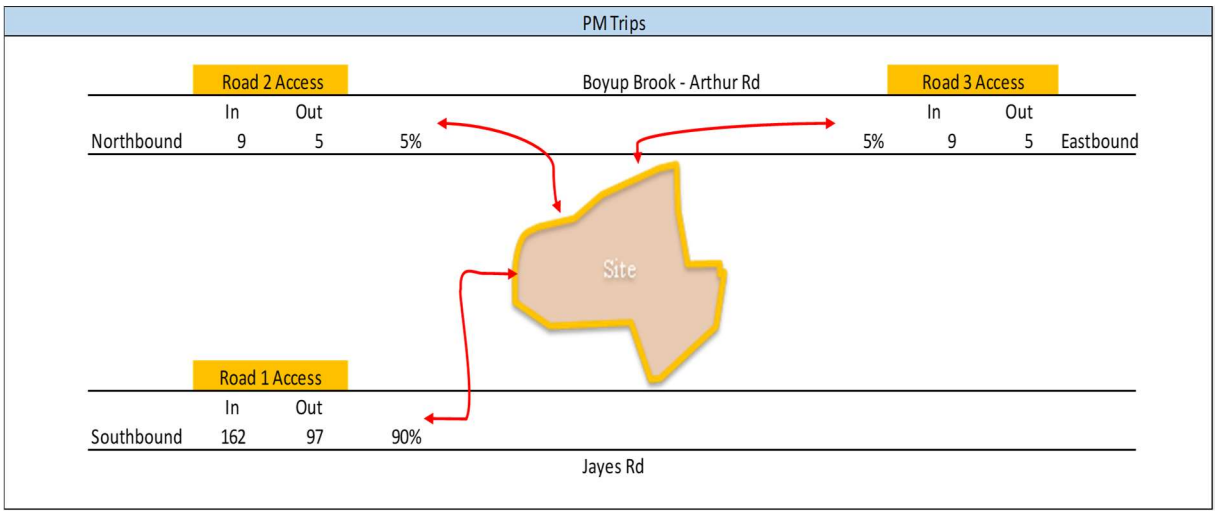


Figure 4.2: PM peak Hour Trip Distribution

4.3 ROAD AND INTERSECTION CAPACITIES

Boyup Brook Arthur Road is classified as a Regional Distributor Road and operates at a 100 km/h speed limit adjacent to the sites. The road is presently a two-lane undivided facility and is assumed to carry around 550vpd on weekdays (see Section 2.4 - Traffic Volumes).

The expected increase in traffic from the development is of the order of 288vph, most of which would travel towards Boyup Brook. This increase can be readily accommodated within the practical capacity of Jayes Road in this vicinity.

A SIDRA intersection analysis was undertaken on the Jayes Road/Road 1 intersection. SIDRA is an intersection-modelling tool commonly used by traffic engineers for all types of intersection analysis. It has been used here to determine the existing and future operating characteristics of the intersection.

SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

Degree of Saturation: is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for varied traffic flow up to one for saturated flow or capacity.

Level of Service (LOS): is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).

Average Delay: is the average of all travel time delays for vehicles passing through the intersection.

95% Queue: is the queue length below which 95% of all observed queue lengths fall.

Given the low background traffic volumes on Jayes Road (30vph in each direction during the peak hour), the intersection of Jayes Road and Road 1 will not experience any significant congestion. This intersection will operate at a Level of Service A based on a single lane approach in each direction at opening (when all 360 lots are developed). Even if the background traffic increases by a compound growth rate of 2% for 20 years the intersection is unlikely to experience any significant congestion. The other 2 access road intersections will also not experience any significant congestion.

4.4 TURNING LANE WARRANTS

While the SIDRA modelling has demonstrated the intersections will not experience any significant congestion, warrants for improvements are tested to ensure the safe operation of intersections. In some cases, such improvements may potentially be warranted on the basis of intersection operating speed and the opposing turning movments.

DVC has assessed the need for improvements to the intersection (Road1 Access) based on MRWA's *Supplement to Austroads Guide to Road Design (AGRD) Part 4.* The following assumptions have been made for this assessment:

- Existing traffic volumes on Boyup Brook Arthur Road – 30vph in each direction (based on Boyup Brook Kojonup Road traffic).
- Heavy vehicle traffic- 25% on the main road (based on Boyup Brook Kojonup Road) and 5% on the subdivision roads.

- Opening year 2030 – the year in which all subdivision lots are occupied.
- Background traffic growth rate – scenario tested 3% compound per annum.
- Design speed - 10km/h higher than the posted speed limit.

4.4.1 Scenario 1: 360 Lots

The analysis shows that based on a 3% compound growth rate for the background traffic, an Auxiliary Right Turn lane would be required at the intersection of Access Road 1 and Jayes Road in about 18 years time (say 2039). See Appendix A. No auxiliary lanes would be required at the other access road intersections during this time.

DVC considers it unlikely that a sustained compound growth rate of 3% would be achieved unless fresh industry (e.g. mining, tourism etc) were to be introduced which directly affected traffic in the area. On the South Western Highway just north of Greenbushes for example, the MRWA Traffic Map shows that traffic volumes have remained reasonable steady from 2017 to 2022 (see **Figure 4.3**). In any event it would seem unlikely that any auxiliary lane is required in the near future. This delay provides an opportunity to monitor traffic volumes and growth rates on Jayes Road and, in the event that high future traffic growth is achieved in the area, introduce additional lanes if and when warranted.

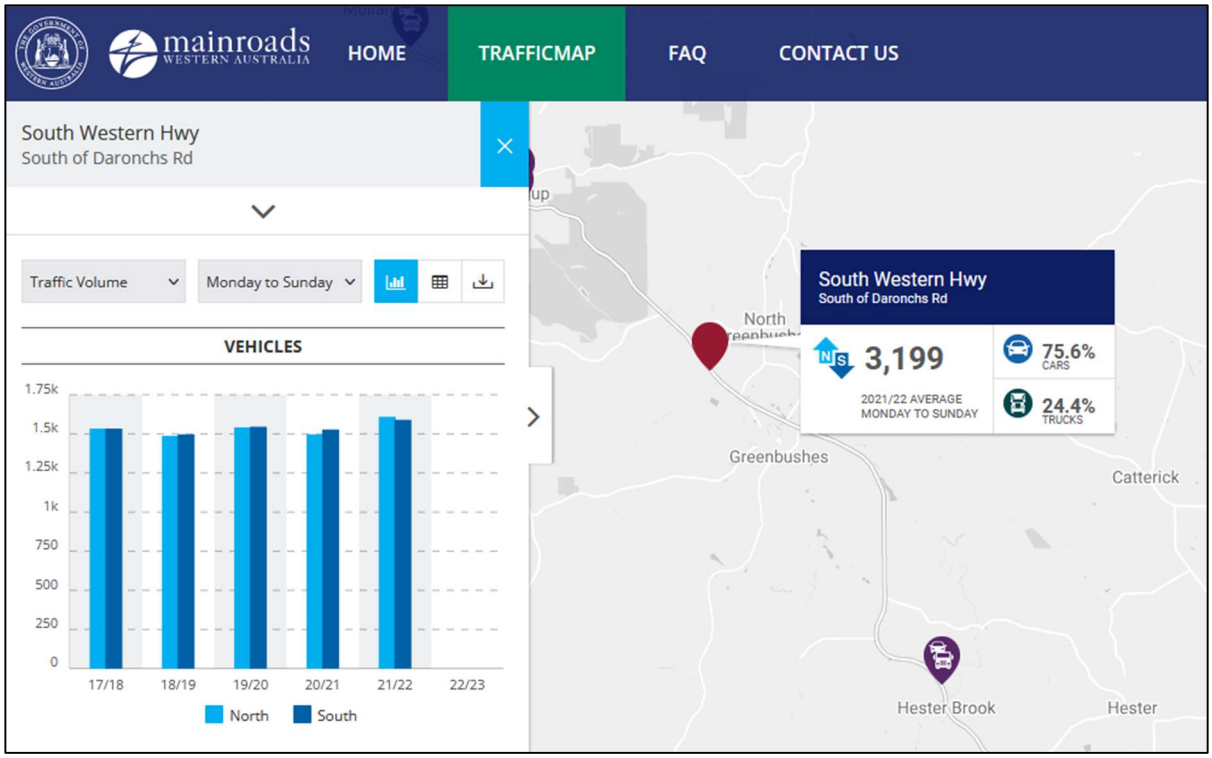


Figure 4.3: Traffic Volumes on South Western Highway (Source: MRWA Traffic Map)

4.4.2 Scenario 2: 111 Lots

No auxiliary traffic lanes are required in the foreseeable future at any of the access road intersections under this scenario.

4.5 ROAD SAFETY

The crash record for the surrounding road network does not point to any particular road safety issues.

5 SUSTAINABLE TRANSPORT

5.1 BUS ROUTES

Scheduled commuter bus services in regional towns are rare and it is unlikely that such a service will be introduced in Boyup Brook, even in the medium-term future. There may be bespoke services to cater for tourists, aged or diabled persons for example, but these will have little impact on peak hour traffic conditions.

The Shire has advised of a school bus service which uses Boyup Brook Arthur Road and supports the Boyup Brook District High School. This route could easily be adapted to service the proposed subdivision.

5.2 PEDESTRIAN AND CYCLE ACCESS FACILITIES

Liveable Neighbourhoods indicates that footpaths should be provided on at least one side of all Access Streets. However, we have observed that in rural settings such as these where pedestrian usage and destinations may be limited, footpaths are not always provided. The low traffic volumes forecast here generally point to shared on-street pedestrian, cycle and vehicle movements. It may therefore be acceptable to the Shire to only negotiate specific locations within the site where a footpath is required, for example adjoining Road 1 west of Road 2, or adjacent to public open space.

Boyup Brook is included in the Warren-Blackwood 2050 Cycling Strategy which proposes a cycle route along the railway line from Jayes Road to the Flaxmill Caravan Park, and two tourist routes along the Katanning Railway alignment to Donnybrook and along the Blackwood River valley to Bridgetown. There are also local routes proposed connecting residential areas in the townsite itself.

The gradient along Jayes Road from the townsite to the Access Road 1 doesn't favour cyclists. Therefore the Katanning Railway route would appear to offer the best opportunity for cyclists from the proposed subdivision. This is supported by the proposed walk/cycle track connections shown in **Figure 3.1**. The river route which meets the Katanning railway reserve at Skeleton Bridge, would provide good access to the lower (southern) side of the town and the High School. As it constitutes part of the 2050 Cycling Strategy, some limited funding may be available from the State Government to assist its implementation. The route shown via Ritson Street may also be suitable as it avoids the long hill up Jayes Road and enters the town from the northern side. While there are no Shire plans to extend Ritson Street past its current construction (to the south-west corner of Lot 46 (No107) Ritson Street) the road reserve does extend east to connect with the Blackwood River foreshore. Accordingly, subject to Shire requirements, there is scope to additionally create a walk/cycle connection between the site and Boyup Brook via Ritson Street.

6 SUMMARY AND RECOMMENDATIONS

6.1 SUMMARY

This Transport Impact Assessment (TIA) has been prepared by Donald Veal Consultants on behalf of Leafield Pty Ltd, with regard to the proposed subdivision development on Lots 51, 1007, 1118 Boyup Brook Arthur Road, Boyup Brook. Two development scenarios are covered in this assessment: 360 lots with scheme water and 111 without scheme water.

The site lies within the Shire of Boyup Brook, with the western boundary of the site around 1.5km north-east of the Boyup Brook townsite. It is bounded by Boyup Brook Arthur Road to the north, Jayes Road to the west and the Blackwood River to the southeast. Boyup Brook North Road intersects with Boyup Brook Arthur Road and Jayes Road to the northwest of the site.

Boyup Brook Arthur Road and Jayes Road are classified as a Regional Distributor Road and Boyup Brook North Road is classified as a Local Distributor under Main Roads Western Australia's (MRWA's) Functional Road Hierarchy. Boyup Brook Arthur Road has a posted speed limit of 100km/h. Jayes Road generally has a posted speed limit of 80km/h, which reduces to 60km/h at the intersection of Jayes Road and Ritson Street and to the south. It then decreases to 50km/h through the Boyup Brook townsite.

Boyup Brook North Road has a rural, open area default speed limit of 110 km/h.

No existing traffic counts were available from the MRWA Traffic Map on the Boyup Brook Arthur Road. Discussions with the Shire indicate that the Boyup Brook Arthur Road does not carry as much traffic as either the Donnybrook Road or the Bridgetown Road. Therefore for the purposes of this assessment, it has been assumed that the Boyup Brook Arthur Road carries similar levels of traffic to the Boyup Brook-Kojonup Road i.e. about 550vpd.

The MRWA CARS database was interrogated to identify the history of crashes occurring along Boyup Brook Arthur Road and Jayes Road between Ritson Street and Thompson Road in the latest 5-year reporting period, 2017 – 2021. The database returned records of only 2 crashes within this period. One involved hitting an object and one a non-collision crash. Both crashes were property damage only.

The proposed Scenario 1 Subdivision Plan comprises 360 lots. An access is proposed onto Jayes Road just south of the Boyup Road North intersection. Two accesses are proposed onto the Boyup Brook Arthur Road east of this intersection. For Scenario 2 (111 lots) no subdivision plan is available but it is understood that access is likely to be at the same locations as proposed for Scenario 1.

Under Scenario 1 the internal roads will typically carry low volumes of traffic and should be classified as Access Streets C and D as defined by the WAPC Liveable Neighbourhoods Guidelines. Road 1 access onto Jayes Road will carry slightly higher volumes and towards the western end attracts a Neighbourhood Connector classification. Under Scenario 1 all roads should attract an Access Street D classification.

Sight distances at the proposed accesses onto the Boyup Brook Arthur Road have been examined. The easternmost access does not maintain a satisfactory sight distance for the 100km/h speed limit there. It should be possible to move this intersection further to the west and reduce the speed limit in this area.

Road 1 generally has good sight distance to the right but on-site measurement past the 200m mark is made difficult by the vegetation. This road will be in a cutting when constructed and through modest reshaping of the cut to the right, DVC considers that the required sight distances will be achieved. In any event this should be checked during detailed design.

Peak hour trip generation for the proposed development has been based on WAPC guidelines for residential development. Scenario 1 is expected to generate about 288 trips during the peak hour (inbound and outbound) or conservatively about 3200-3600 trips per day.

A SIDRA analysis was undertaken for the opening year (assumed to be 2030) and the opening +10 years (2040) to demonstrate the impact of traffic growth at the intersection Access Road 1 and Jayes Road for Scenario 1.). Even if the background traffic increases by a compound growth rate of 2% for 20 years the intersection is unlikely to experience any significant congestion. The other 2 access road intersections will also not experience any significant congestion.

Turning lane warrants were examined for this intersection using MRWA's *Supplement to Austroads Guide to Road Design (AGRD) Part 4.* The analysis shows that based on a 3% compound growth rate for the background traffic, an Auxiliary Right Turn lane would be required at the intersection of Access Road 1 and Jayes in about 18 years time (say 2039). No auxiliary lanes would be required at the other access road intersections during this time. DVC considers that a compound growth of 3% per year is optimistic. While some growth at this rate may be achieved it is unlikely that sustained, compound traffic growth will be achieved over 20 years. DVC therefore considers that auxiliary lanes are not warranted.

Scheduled commuter bus services in regional towns are very rare and unlikely to be introduced here. The Shire has advised of a school bus service which uses Boyup Brook Arthur Road and supports the Boyup Brook District High School. This route could easily be adapted to service the proposed subdivision.

Boyup Brook is included in the Warren-Blackwood 2050 Cycling Strategy which proposes a cycle route along the railway line from Jayes Road to the Flaxmill Caravan Park, and two tourist routes along the Katanning railway line alignment to Donnybrook and along the Blackwood River valley to Bridgetown. There are also local routes proposed connecting residential areas in the townsite itself. There may be merit in investigating state funding for the early implementation of the Blackwood River link to support pedestrian and cycle traffic from the subdivision into Boyup Brook.

The crash record for the surrounding road network does not point to any particular road safety issues.

6.2 RECOMMENDATIONS

DVC recommends that the location of the Access Road 3 intersection with the Boyup Brook Arthur Road be moved further west in conjunction with a reduction of the speed limit to 80km/h to provide adequate sight distance.

Based on the above assessment we recommend approval of the proposed subdivision scenarios from a traffic, transport and road safety perspective.

APPENDIX A: INTERSECTION WARRANTS

Opening Year PM Peak – 3 % growth rate

INTERSECTION WARRANTS

Main Roads WA Supplement to Austroads Guide to Road Design - Part 4 A.8

DESIGN SPEED =	90km/h
SPLITTER ISLAND YES / NO =	No
DUAL CARRIAGEWAY YES / NO =	No

MOVEMENT	COUNT (v/h)	HV (%)
Q_{T1} =	40	25
Q_R =	162	5
Q_{T2} =	40	13.5
Q_L =	10	5

RIGHT TURN ASSESSMENT

Q_m =	90
% HV =	17.667
x =	1.15
TREATMENT =	BAR

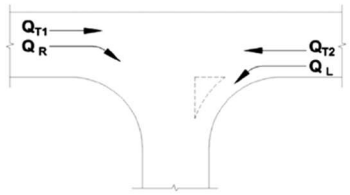
LEFT TURN ASSESSMENT

Q_m =	40
% HV =	13.500
x =	0.17
TREATMENT =	BAL

Source: Austroads GTM Part 6 - 2017

Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings

Figure 2.27: Calculation of the major road traffic volume Q_M



Road type	Turn type	Splitter island	Q_M (veh/h)
Two-lane two-way	Right	No	= $Q_{T1} + Q_{T2} + Q_L$
		Yes	= $Q_{T1} + Q_{T2}$
	Left	Yes or no	= Q_{T2}
Four-lane two-way	Right	No	= 50% x $Q_{T1} + Q_{T2} + Q_L$
		Yes	= 50% x $Q_{T1} + Q_{T2}$
	Left	Yes or no	= 50% x Q_{T2}
Six-lane two-way	Right	No	= 33% x $Q_{T1} + Q_{T2} + Q_L$
		Yes	= 33% x $Q_{T1} + Q_{T2}$
	Left	Yes or no	= 33% x Q_{T2}

Source: TMR (2016a).

Opening + 10 Years PM Peak – 3 % growth rate

INTERSECTION WARRANTS

Main Roads WA Supplement to Austroads Guide to Road Design - Part 4 A.8

DESIGN SPEED =	90km/h
SPLITTER ISLAND YES / NO =	No
DUAL CARRIAGEWAY YES / NO =	No

MOVEMENT	COUNT (v/h)	HV (%)
Q_{T1} =	55	25
Q_R =	162	5
Q_{T2} =	55	25
Q_L =	10	5

RIGHT TURN ASSESSMENT

Q_m =	120
% HV =	23.333
x =	1.55
TREATMENT =	AUR

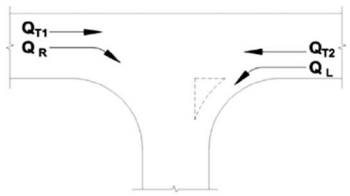
LEFT TURN ASSESSMENT

Q_m =	55
% HV =	25.000
x =	0.25
TREATMENT =	BAL

Source: Austroads GTM Part 6 - 2017

Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings

Figure 2.27: Calculation of the major road traffic volume Q_M



Road type	Turn type	Splitter island	Q_M (veh/h)
Two-lane two-way	Right	No	= $Q_{T1} + Q_{T2} + Q_L$
		Yes	= $Q_{T1} + Q_{T2}$
	Left	Yes or no	= Q_{T2}
Four-lane two-way	Right	No	= 50% x $Q_{T1} + Q_{T2} + Q_L$
		Yes	= 50% x $Q_{T1} + Q_{T2}$
	Left	Yes or no	= 50% x Q_{T2}
Six-lane two-way	Right	No	= 33% x $Q_{T1} + Q_{T2} + Q_L$
		Yes	= 33% x $Q_{T1} + Q_{T2}$
	Left	Yes or no	= 33% x Q_{T2}

Source: TMR (2016a).