Shire of Dardanup

Appendices

Item 12.2.2C

UNDER SEPARATE ELECTRONIC COVER

ORDINARY COUNCIL MEETING

To Be Held

Wednesday, 17th of December 2025

Commencing at 5.00pm

At

ADMINISTRATION CENTRE EATON

1 Council Drive - EATON

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Upon request.

LOCAL STRUCTURE PLAN
Amendment No. 1

Parkridge Estate, Eaton

Harley Dykstra®

PLANNING & SURVEY SOLUTIONS

DOCUMENT CONTROL

Control Version	Date	Status	Distribution	Comment
A	30/08/2022	Draft	Internal	QA check
B	02/09/2022	Draft	Client	For review
C	29/09/2022	Draft	Client	For review
D	21/10/2022	Final	Shire of Dardanup	Lodgement
E	26/05/2022	Final	Shire of Dardanup	Lodgement
F	21/02/2025	Final	State Solicitors Office	Lodgement
G	23/09/2025	Final	WAPC	Reconsideration
H	23/10/2025	Final	WAPC	Reconsideration

Prepared for: Parkridge Pty Ltd
Prepared by: KS
Reviewed by: AR / BF

Date: 23 October 2025
Job No: 22294
Ref: H

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ENDORSEMENT PAGE

This Structure Plan is prepared under the provisions of the Shire of Dardanup Local Planning Scheme No. 3.

IT IS CERTIFIED THAT THIS STRUCTURE PLAN AMENDMENT
WAS APPROVED BY RESOLUTION OF
THE WESTERN AUSTRALIAN PLANNING COMMISSION ON:

..... Date

Signed for and on behalf of the Western Australian Planning Commission:

.....

An officer of the Commission duly authorised by the Commission pursuant to section 16 of the *Planning and Development Act 2005* for that purpose, in the presence of:

..... Witness

..... Date

..... Date of Expiry

TABLE OF AMENDMENT(S)

Amendment No.	Summary of Amendment	Amendment Type	Date approved by WAPC
1	Relocation of POS and reconfiguration of residential cells.	Standard	

TABLE OF DENSITY PLANS

Density Plan No.	Area of density plan application	Date endorsed by WAPC

Executive Summary

Local Structure Plan
Parkridge Estate, Eaton

This amendment to the Parkridge Local Structure Plan (LSP) has been prepared to guide the subdivision and development of the land.

On approval, this amendment, is intended to extend the life of the Structure Plan for a further 10 years or longer as determined by the Western Australian Planning Commission (WAPC) in accordance with Schedule 2, cl.28(2) of the *Planning and Development (Local Planning Schemes) Regulations 2015*. The amendment to the Structure Plan has been written in a way that it both incorporates the existing elements of the approved Structure Plan whilst incorporating the current requirements and revisions as identified within the report.

The Local Structure Plan (LSP) area falls within the locality of Eaton in the Shire of Dardanup. The subject land is situated to the west of Eaton Drive, approximately 2.5km from the Eaton Fair Shopping Precinct and approximately 12km by road, northeast of the Bunbury City Centre.

This LSP area will accommodate low and medium density residential housing, and areas of Public Open Space (POS). The LSP outlines a land use and movement network framework for the development of the subject site.

The lots subject to this modification were formed from the original Lot 1 of Wellington Location 19 (Location 19), purchased by Parkridge Pty Ltd in 1993. The land area of Location 19, being 257.77ha, has subsequently been developed for residential purposes, POS, Regional Open Space (ROS), a recreation centre, a high school, a primary school, and an aged care facility.

The original LSP for Location 19 formed part of the initial Amendment 47 to the Shire of Dardanup's Town Planning Scheme No. 3 (TPS 3), which was approved and endorsed by the Minister in 1993.

Subsequently, a revised LSP for the northern portion of Location 19 was approved by the Western Australian Planning Commission (WAPC) on October 1, 2019.

The northern portion of the site and land subject to this modification including Lots 9010 and lots developed since the 2019 LSP approval. Lot 9010 and Lot 9504 (known as the 'Homestead Lot') are the remaining land parcels yet to be developed from the original Location 19 landholding.

The Homestead Lot will not be considered as part of this LSP modification, but will be investigated for future development separately from this process.

This modification seeks to distribute the POS throughout the remaining land to be developed and to re-orientate the residential cells predominantly in a north-south grid pattern to assist with solar passive design effectiveness. The design has been updated to make it contemporary, efficient, and accurately reflect the current planning and servicing requirements.

The contemporary design of the amended LSP maximises the accessibility of green spaces while addressing Bushfire Management, Traffic and Water Management policies and guidelines. The road layout largely promotes the development of regular shape lots of different sizes to accommodate a variety of community needs.

The Structure Plan area includes 131 lots developed to date with another estimated 297 proposed and a grouped dwelling site, yielding up to 47 dwellings. The LSP Summary Table below details the nature and key outcomes of the LSP.

TABLE 1 – LSP SUMMARY TABLE

ITEM	DATA		STRUCTURE PLAN REF (section no.)
Structure Plan Area	31.5327ha		Section 1.
Area of each land use proposed: - Residential (R20) - Residential (R30) - Residential (R40)	Hectares 6.3138 ha 10.7646ha 3.5200ha	Lot Yield 122 lots (developed) 253 lots (estimate) 53 lots (estimate) 99 dwellings	 Section 4.5 Section 4.5
Total estimated lot yield	428 lots		Section 4.5
Estimated number of dwellings	475 dwellings		Section 4.5
Estimated residential site density	15.1 dwellings per site hectare		Section 4.5
Estimated population	1188 people *		Section 4.5

* Based on ABS 2021 Census – Eaton Average number of people per household 2.5.

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Table of Technical Appendices

Appendix No.	Document Title	Nature of Document	Referral/Approval Agency	Approval Status & Modification
A	Certificates of Title	Supporting	-	-
B	Concept Plan	Supporting	-	-
C	Environmental Assessment and Black Cockatoo Habitat Tree review	Supporting	-	-
D	Local Water Management Strategy	Supporting	Shire of Dardanup and Department of Water and Environmental Regulation	Submitted to Shire and DWER
E	Bushfire Management Plan	Supporting	Department of Fire and Emergency Services	-
F	Transport Impact Assessment	Supporting	-	Updated version attached
G	Servicing Report	Supporting	-	-
H	Landscaping Concept Plans	Supporting	-	-

PART ONE: IMPLEMENTATION

1 LOCAL STRUCTURE PLAN AREA

This modification to the approved Local Structure Plan applies to Lot 9010 Peninsula Lakes Drive, Eaton and the lots developed in accordance with the LSP approved in 2019. The LSP area being the land contained within the inner edge of the line denoting the Local Structure Plan boundary shown on the Local Structure Plan Map (**Plan 1**).

2 OPERATION

In accordance with Schedule 2, Part 4 of the *Planning and Development (Local Planning Schemes) Regulations 2015* ('Regulations'), this Structure Plan comes into operation when it is approved by the Western Australian Planning Commission ('WAPC'), pursuant to Schedule 2, Part 4, Clause 22 of the Regulations.

It is requested that this amendment extends the validity of the LSP for a further 10 years from that date, or another period determined by the WAPC in accordance with the Planning and Development (Local Planning Scheme) Regulations 2015 Schedule 2 – Deemed Provisions.

The (amended) Structure Plan is to be given due regard when making decisions on the development and subdivision of land within the Structure Plan area.

3 STAGING

The development staging shall follow an orderly sequence and provide a manageable level of service of essential infrastructure for roads, drains and utility services as well as the provision of Public Open Space.

Implementation will occur through subdivision applications prepared by the developer in response to market demand. It is anticipated that development will expand generally to the north from the existing residential lots created previously in Parkridge.

POS will be ceded free of cost as adjacent lots are developed in each stage.

An indicative Staging Plan has been developed and further detail in provided in Section 4.6.

4 SUBDIVISION AND DEVELOPMENT REQUIREMENTS

Subdivision within the Structure Plan area is to be in accordance with the layout and residential density code prescribed by the Structure Plan.

Land use permissibility within the Structure Plan area shall be in accordance with the corresponding zone or reserve under the Scheme.

4.1 GENERAL REQUIREMENTS

The following subdivision and development requirements are to be implemented in conjunction with the Structure Plan map:

1. Subdivision, development, and land use within the structure plan area is to be generally in accordance with the Structure Plan.
2. All proposed lots are to be connected to reticulated water, sewer, power and telecommunications.
3. Lots requiring the preparation of a Local Development Plan shall be determined in accordance with Liveable Neighbourhoods.

4.2 PUBLIC OPEN SPACE

Public Open Space (POS) will be provided generally in accordance with the Public Open Space Schedule (**Table 2**) and **Tables 3** and **Figure 4** of this LSP amendment.

At the time of subdivision, POS is to be ceded free of cost. POS is to be given up in generally in accordance with the Indicative Staging Plan, when surrounding lots are developed.

4.3 STREET TREES

A sum of $300.00 per lot, incremented by CPI, shall be paid to the local government for the provision of street trees.

Trees to be planted shall be *Agonis flexuosa*, to provide for wildlife habitat corridors, particularly Western Ringtail Possum and Brushtail Possum that are known to frequent the wider locality.

4.4 BUSHFIRE MANAGEMENT

Land within the Structure Plan area is mapped as being bushfire prone under the Department of Fire and Emergency Services Bushfire Prone Mapping.

This amended Local Structure Plan is supported by a Bushfire Management Plan, prepared in accordance with *State Planning Policy 3.7 – Planning in Bushfire Prone Areas (SPP3.7)*. Any development on land within the Structure Plan area shall be constructed in accordance with the recommendations made by the Bushfire Management Plan and shall comply with the requirements of *Australian Standard 3959 – Construction of Buildings in Bushfire Prone Areas*.

4.5 DENSITY

The land identified as residential within the Structure Plan area has been designated a density code of R20, R30 or R40.

The allocation of residential densities at subdivision shall be in accordance with that shown on the Structure Plan Map.

Density and development standards to be in accordance with Council Policy SDev CP028 – Local Planning Policy – Variation to Deemed to Comply Requirements of the R-Codes : Medium -Density single house development standards.

On submission of an application for building permit for a single house on land with a density coding of R30 or R40, the application will be assessed against the provision of the policy (CP028).

4.6 FOOTPATHS

The applicant/owner shall make provision for footpaths through the structure plan area. The location and width of footpaths are to be determined at subdivision stage and shall be in accordance with the requirements of Liveable Neighbourhoods.

4.7 SCHOOL CONTRIBUTION

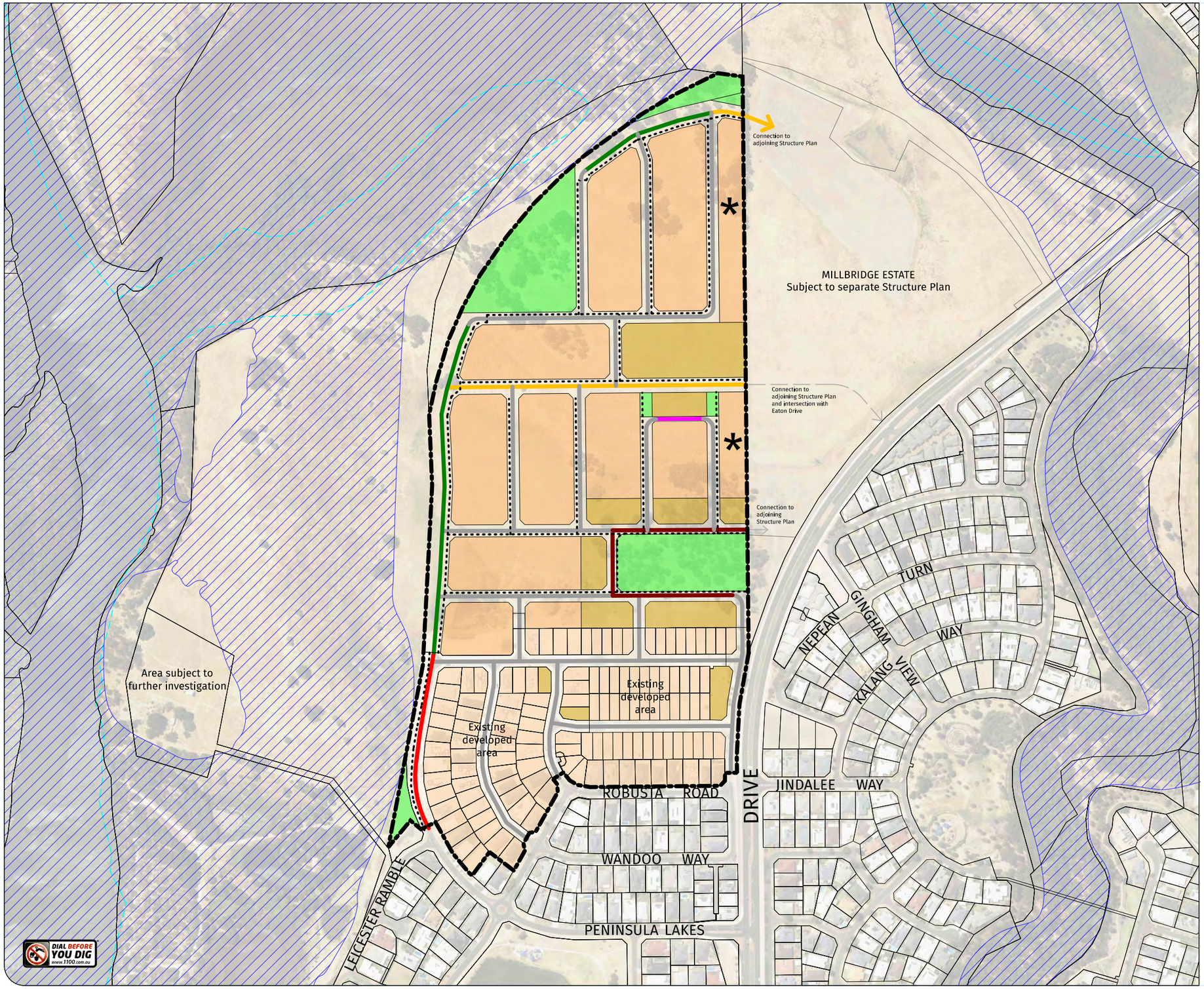
It should be noted that Parkridge has previously provided land for the purpose of a Primary School site being the Glen Huon Primary school. It should be noted that the need for primary school developer contributions will be reviewed and determined at the subdivision stage.

4.8 INTERFACE WITH ADJOINING DEVELOPMENT

The amended LSP provides for orderly connection of local roads from Parkridge to the adjoining Millbridge Estate and to the wider road network, via the connections shown on the amended Structure Plan Map at **Figure 1**.

TABLE 2 – PUBLIC OPEN SPACE SCHEDULE

Calculation of Required POS Provision		
Structure Plan Area		**31.5327**
Deductions		
Environmental	0.0000	
Conservation Category Wetland	0.0000	
Bush Forever	0.0000	
Regional Open Space Reserves	0.0000	
Restricted Access Conservation Areas	0.0000	
Surface area of natural water bodies	0.0000	
Infrastructure		
Rail Reservation	0.0000	
Regional Road Reservations, widenings - Primary/Other	0.0000	
Public utilities (include pump station sites, transmission corridors)	0.0000	
Drainage (steep sided drains and basins)	0.0000	
Non Residential Land Uses		
Primary School	0.0000	
High School	0.0000	
Activity centres, commercial, retail (excluding residential component)	0.0000	
Community Purposes Sites	0.0000	
Public Purpose Reserves	0.0000	
Other		
Surplus Restricted Public Open Space Not Credited	0.0000	
Total Deductions		
Total Deductions		**0.0000**
Gross Subdivisible Area (total site area minus deductions)		**31.5327**
Required Public Open Space (10%)		**3.1533**
Breakdown of POS Provided		
Restricted Public Open Space		
Conservation Category Wetland Buffer (up to 50m)	0.0000	
Resource Enhancement, multiple use wetland or similar and associated buffers (up to 30m)	0.0000	
Reserved land encumbered by easements /drainage - deemed suitable for POS (Pt POS D)	0.2104	
Total Restricted POS	0.2104	
Maximum 20% credit	0.6307	
Total Restricted POS Credited to a maximum of 20%		**0.2104**
Surplus Restricted POS Not Credited i.e. over the maximum 20%	0.0000	
Unrestricted Public Open Space: by function (refer Note 4)		
Sport	0.0000	
Recreation & Nature (POS A, B, C, E and Unresricted Pt of POS D)	2.9958	
Total Unrestricted POS	2.9958	
Total Unrestricted POS		**2.9958**
TOTAL		**3.2062**
POS Provision as Percentage of Gross Subdivisible Area		**10.17%**



LEGEND

- EXISTING CADASTRE
- STRUCTURE PLAN MODIFICATION BOUNDARY
- PROPOSED CADASTRE
- RESIDENTIAL: R40
- RESIDENTIAL: R30
- RESIDENTIAL: R20
- PUBLIC OPEN SPACE
- MANAGED LOW FUEL ZONE
- * RESIDENTIAL DENSITY TO BE CONSISTENT WITH ADJOINING STRUCTURE PLAN
- PATH NETWORK
- PATH NETWORK & FIRE SERVICE ACCESS ROUTE
- FLOODWAY
- CONSERVATION CATEGORY WETLAND

LOCAL ROADS

- 25.6m Reserve (includes Drainage)
- 21m Reserve
- 18m Reserve
- 15m Reserve
- 12.5m Reserve
- 9m Reserve

Figure 1 - Structure Plan Map

STRUCTURE PLAN MODIFICATION

Robusta Road, Eaton
PARKRIDGE

Plan No.	22294-07
Date	21/08/25
Drawn	NP
Checked	KS
Revision	N
Scale	1:5000@A3

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0 50m 100m 150m

NOTE: This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey

Harley Dykstra
PLANNING & SURVEY SOLUTIONS

PART TWO: EXPLANATORY SECTION

1 PLANNING BACKGROUND

1.1 Introduction and Purpose

This Local Structure Plan (LSP) modification has been prepared by Harley Dykstra on behalf of Parkridge Group Pty Ltd. The land subject to this LSP modification are Lot 9010 Peninsula Lakes Drive, Eaton and the developed lots as shown on the Structure Plan Map (the 'subject land').

This LSP has been prepared in accordance with the obligations set out in the Shire of Dardanup Local Planning Scheme No.9 for 'Urban Development'.

This proposal is accompanied by a Structure Plan Map (**Figure 1**) prepared in accordance with the *Planning and Development (Local Planning Scheme) Regulations, 2015*, which is included at Part One of this Report.

The Explanatory Section of this Structure Plan report includes a detailed description of the proposal, provides an evaluation of the relevant town planning, environmental, bushfire management, local water management and servicing considerations applicable to the land, and details the rationale supporting the proposed LSP layout and development requirements.

Specialist reporting was undertaken for the Structure Plan approved in October 2019. These reports have been updated to reflect the proposes LSP modifications and relevant changes to policy.

The objectives of the Structure Plan are to:

- Provide a framework to guide the use, subdivision and development of the land to create a high quality, liveable urban precinct; and

- Provide for a range of lot products and sizes to facilitate the creation of a diverse housing mix of typologies and range of affordability to cater for a varied demographic.

1.2 Land Description

Location & Context

The subject land, known as 'Parkridge' is located within the locality of Eaton, within the Shire of Dardanup. It is approximately 2.5km north of the Eaton town centre.

Parkridge is a successful residential development providing low to medium density homesites.

Eaton Drive links Parkridge and the residential development of Millbridge to the east, to Treendale to the north of the Collie River.

The location of Parkridge can be seen in **Figure 2** (overleaf).

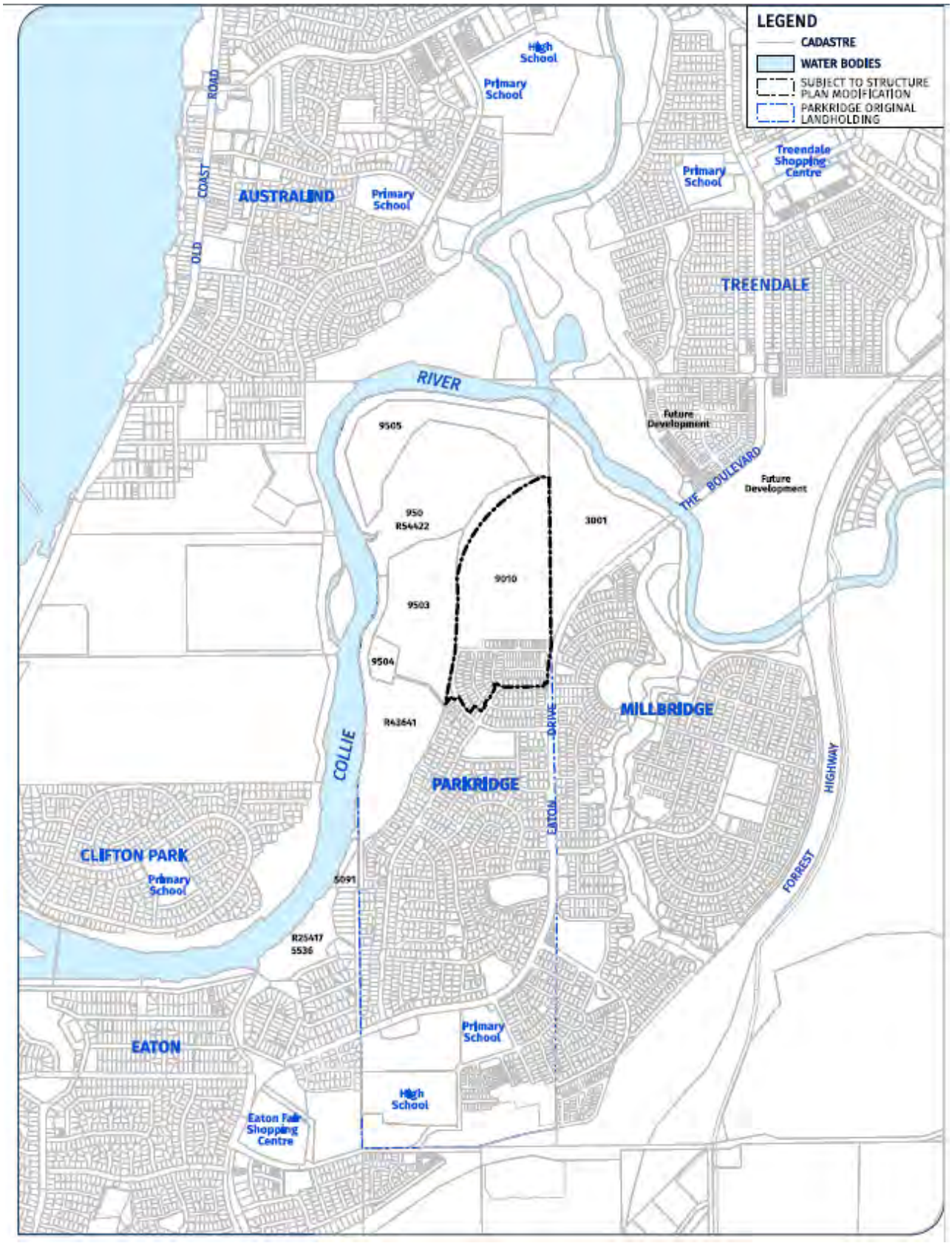


FIGURE 2 – LOCATION PLAN

Area and Land Use

The land subject to this LSP modification is the northern portion of the original landholding, known as Parkridge Estate that has an area of 31.5327ha which includes Lot 9010 (24.7571ha) being the main parcel of land, and the lots developed to date within the LSP area.

The land is parkland cleared with some small patches of remnant vegetation, most of which relate to the Collie River foreshore area.

Other than lots developed on the southern portion of the LSP area, the site is vacant and has historically been used for broad acre farming/grazing with improved pasture.

Development has occurred from the south of the site generally in a northern direction with staged subdivision and allocation of POS.

Approximately 75% of Parkridge Estate has been developed to date. The remaining northern portion of the site is subject to this Structure Plan modification.

Legal Description and Ownership

Details of the LSP land yet to be developed within the LSP area is shown in **Table 3** below. A copy of the Certificate of Title is included at **Appendix A.**

TABLE 3 – LAND OWNERSHIP DETAILS

Lot No.	Plan/ Diagram	Volume	Folio	Registered Proprietor(s)
9010	428930	2182	432	PARKRIDGE GROUP PTY LTD

1.3 Background Planning Information

The original Structure Plan for Location 19 (Parkridge) was adopted by the Shire of Dardanup in December 1991 and endorsed by the WAPC.

The Shire of Dardanup also initiated Amendment 47 to TPS 3 to rezone Location 19 to Residential Area and Recreation. Amendment 47 was approved in July 1993.

Between 1993 and 2007, Parkridge subdivided Location 19 in accordance with the approved Structure Plan with several stages of development resulting in residential lots and POS being created.

In early 2007, planning consultants, Koltasz Smith prepared a revised Structure Plan for the northern portion of the site which, following consultation with the Shire of Dardanup, included a proposed sports ground. However, after matters relating to the provision of POS were unable to be resolved the 2007 Structure Plan was not progressed.

Further subdivisions were approved by the WAPC with the condition that Public Open Space be vested in the Crown in accordance with the Planning and Development Act 2015. This was accepted by the developer and subsequent portions of land were provided as POS and the conditions of the approval cleared by the Shire and WAPC.

In 2015, The Shire of Dardanup rezoned the remaining portion of Location 19 yet to be developed to a 'Development' zone. This change of zoning resulted in a Local Structure Plan to be approved prior to any further subdivision.

In 2016, the WAPC refused an application for subdivision primarily on the grounds that there was no approved Local Structure Plan over the application area.

To progress development of the remaining portion of Parkridge, planning consultants TME/Calibre were instructed to prepare a Local Structure Plan over the northern portion of the site. This Local Structure Plan was approved on October 1, 2019.

In June 2025, the Shire of Dardanup's Local Planning Scheme No. 9 was gazetted. The majority of the site was zoned as 'Urban Development' in the scheme with a portion in the north east of the site reserved as Public Open Space.

This amendment to the approved LSP seeks to reconfigure the residential development to a more contemporary layout and distribute the POS in a two main parcels and pocket parks across the site.

2 PLANNING FRAMEWORK

2.1 ZONING AND RESERVATIONS

Greater Bunbury Region Scheme

Land within the LSP area is zoned 'Urban' under the Greater Bunbury Region Scheme (GBRS).

Shire of Dardanup - Local Planning Scheme No. 9

The undeveloped part of the LSP area is zoned 'Urban Development' and Public Open Space within the Shire of Dardanup's Local Planning Scheme No.9. Lots developed to date are shown as 'Residential' with a density coding of R20 as shown in **Figure 3.**

The objective of the Urban Development zone is:

- To provide an intention of future land use and a basis for more detailed structure planning in accordance with the provisions of this Scheme.
- To provide for a range of residential densities to encourage a variety of residential accommodation.
- To provide for the progressive and planned development of future urban areas for residential purposes and for commercial and other uses normally associated with residential development.
- To provide an intermediate transitional zone following the lifting of an urban deferred zoning within the Greater Bunbury Region Scheme.

The LSP meets the objectives of those required of the Uban Development zone of the scheme.

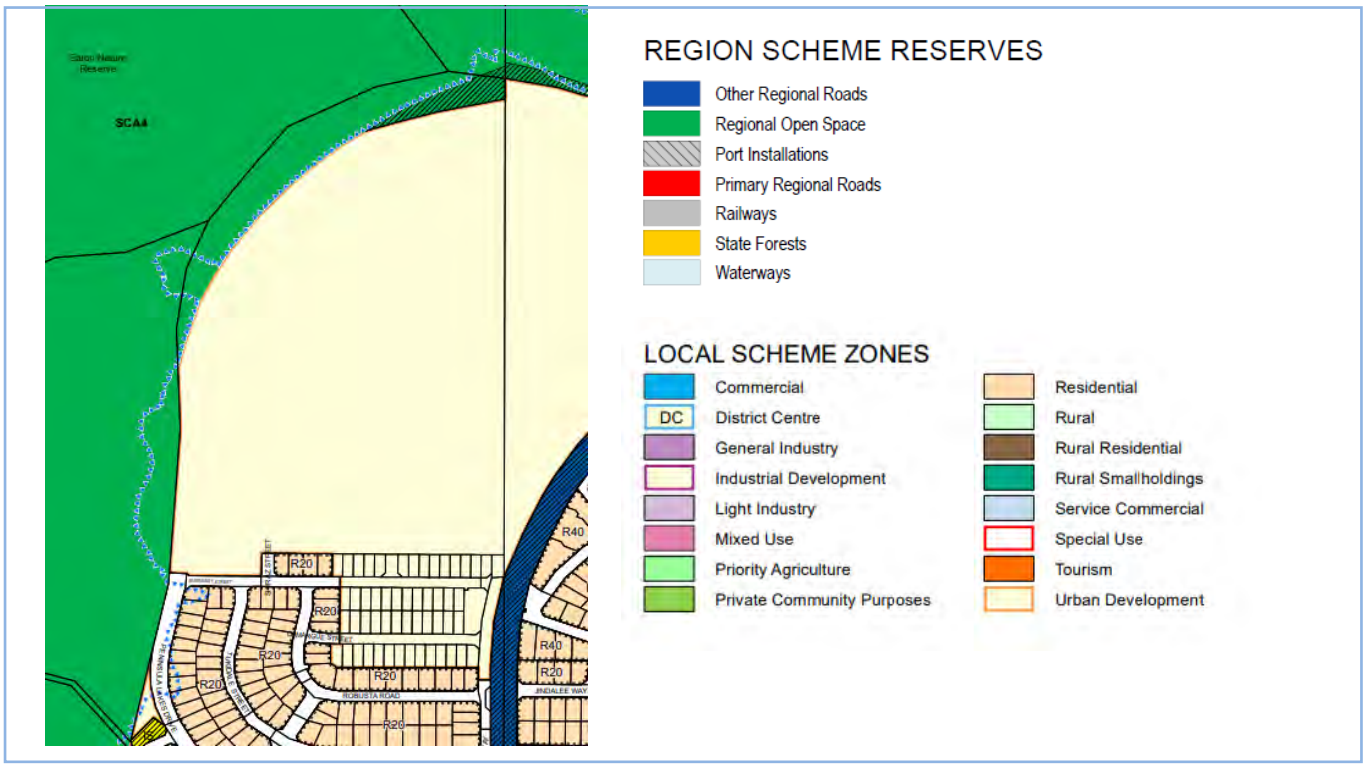


FIGURE 3 – LOCAL PLANNING SCHEME No. 9

Regional and sub-regional structure plan

The Greater Bunbury Strategy 2013 was prepared by the Department of Planning to guide urban, industrial and regional land use planning, and associated infrastructure delivery in the Greater Bunbury sub-region in the short, medium and long terms.

The Greater Bunbury Sub-Regional Structure Plan 2013 identifies the land as 'Urban Undeveloped Land' and 'Regional Open Space' reservation, consistent with the zonings of TPS No.9.

Shire of Dardanup Local Planning Strategy

The Shire of Dardanup Local Planning Strategy was adopted by Council in March 2014 was prepared to provide a strategic plan that will plan for the future of the Shire in a responsible manner and reflect the aspirations of the shire and its community, accommodates future needs, and creates opportunities to enhance local attributes.

At the time of the Strategy's completion, it estimated that the Eaton/Millbridge urban area would reach a population of 15,000 persons when fully developed, possibly higher if the residential densities are increased.

The residential portion of the subject land is identified for urban development in the Greater Bunbury Region Scheme and Shire of Dardanup Town Planning Strategy, development of this site is likely to have been incorporated into the population and housing predictions included within the Local Planning Strategy.

Residential density proposed for the subject land is consistent with the current TPS 3, discussions will continue with officers at the Shire of Dardanup during the structure planning process, to ensure the proposed development is consistent with the densities proposed as part of LPS 9.

2.2 PLANNING POLICIES

Livable Neighbourhoods

Livable Neighbourhoods (LN) is the WAPC's primary policy for the design and assessment of structure plans (regional, district and local) and subdivision for new urban (predominantly residential) areas in Perth metropolitan and Peel regions and major regional centres, on greenfield and large infill sites.

Element 1 of LN defines the principles of community design and guides the broad planning of urban areas to foster a sense of community, local identity, and space. Objective 5 of LN states: Provide public open space that meets the recreational, social and health needs of existing and future communities.

LN defines the walking distance, using the pedestrian network, between residents and the nearest POS (of any size) should be no more than 300m over the neighbourhood as a whole. Further, where regional open space (ROS) adjoins the site it should be considered as a major component of the POS network to provide function at a neighbourhood scale. The following table from LN defines the POS size hierarchy and catchment area for accessibility.

	Small	Local	Neighbourhood	District
Size	Up to 4000m² (0.4ha)	0.4-1ha	1ha – 5ha	5ha and above
Accessibility catchment	300m	300m	800m	2km

Figure 4 demonstrates the walkable catchments in relation to the POS and ROS at Parkridge.

Element 5 of LN specifically addresses the provision and requirement of POS to contribute to the quality of life, vitality, identity, community interaction and sense of place in neighbourhoods.

LN identifies the function of POS as sport, recreation and nature. All publicly accessible land can contribute to function, even if it is not a POS site.

Further, LN states ROS were identified at regional/subregional planning level, should be accessible and useable for local residents as local POS.

LN states the provision of POS in residential areas is 10% of the gross subdivisible area. This is to be provided free of cost and vested in the in the Crown under the provisions of Section 152 of the *Planning and Development Act 2005*.

POS land considered to be restricted can provide a portion of the POS contribution, however this is limited to 2% of the overall minimum 10% contribution.

LN requires the calculation of POS is to be demonstrated through the preparation of a POS Schedule consistent with the proforma shown as Table 16 in LN. A POS schedule for Parkridge is provided in Section 4.2 of this report, which demonstrates sufficient POS has been provided for within the LSP area.

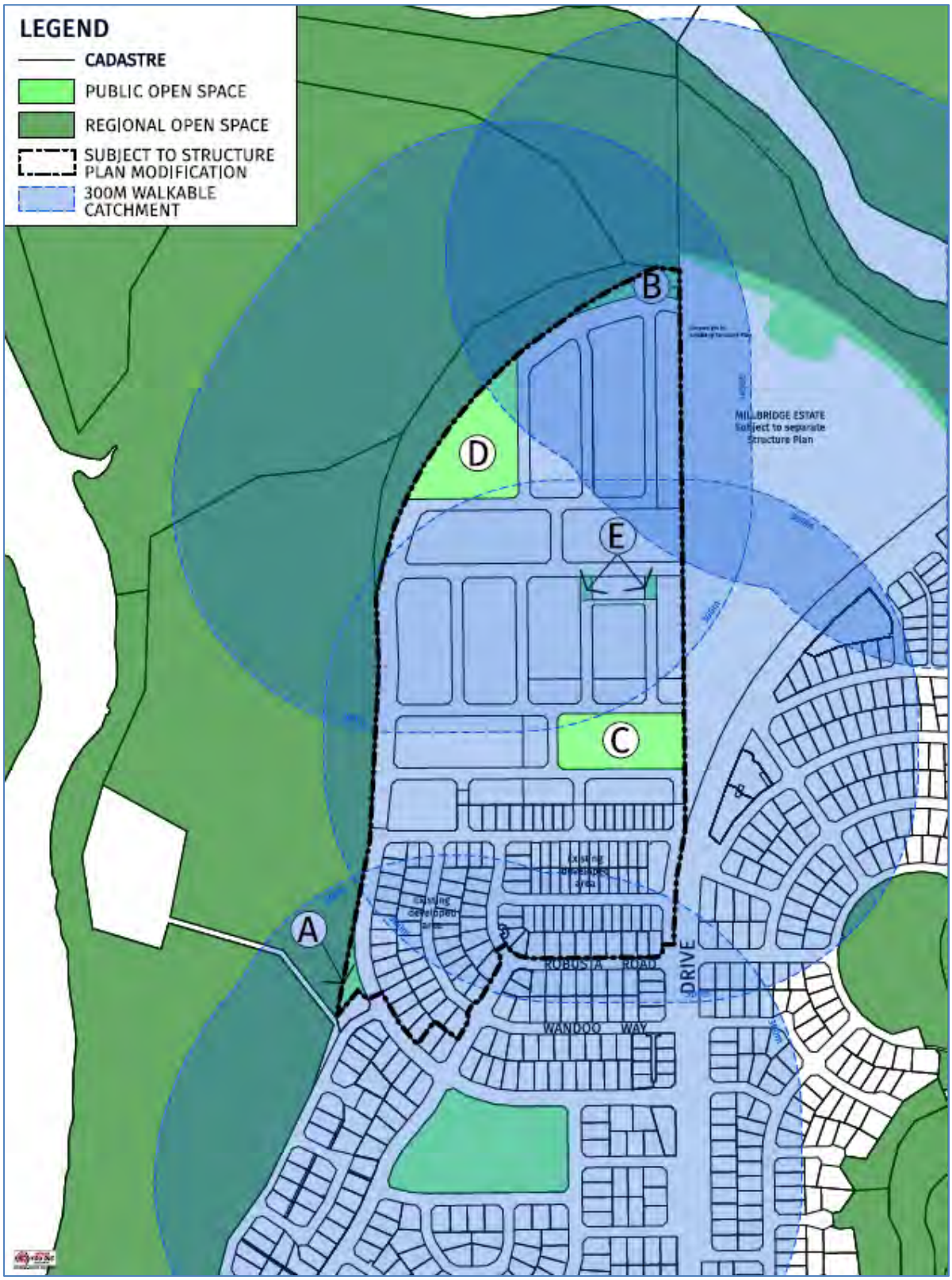


Figure 4 – Walkable Catchments

Development Control Policy 2.3 – Public Open Space in Residential Areas

The basic component of this policy is the requirement that 10% of the gross subdivisible area of a conditional subdivision shall be given up free of cost by the subdivider for public open space. This has been the basis of public open space policy in the State for many years and emanates from the

recommendations of the Plan for the Metropolitan Region Perth and Fremantle, 1955 Report (the Stephenson - Hepburn Plan).

The general requirements of the policy states:

> *"The Commission's normal requirement in residential areas is that, where practicable, 10 percent of the gross subdivisible area be given up free of cost by the subdivider and vested in the Crown under the provisions of Section 20A of the Town Planning and Development Act, 1928 (as amended) as a Reserve for Recreation. In determining the gross subdivisible area the Commission deducts any land which is surveyed for schools, major regional roads, public utility sites, municipal use sites, or, at its discretion, any other nonresidential use site."*

POS has been allocated as shown on the LSP Map and calculations in Table 2 demonstrating that greater that 10% of the LSP area is provided for.

Development Control Policy 5.3 - Use of Land Reserved for Parks and Recreation and Regional Open Space

This policy establishes the Western Australian Planning Commission's (WAPC) position regarding the use and development of land reserved for Parks and Recreation in the Metropolitan Region Scheme (MRS) and Regional Open Space in the Greater Bunbury and Peel Region Schemes (GBRS and PRS).

The policy outlines the circumstances that may be appropriate to permit incorporated clubs, community groups and in some circumstances private business to locate on land reserved for Parks and Recreation or Regional Open Space (ROS). Further the policy states that land reserved for Parks and Recreation or Regional Open Space may be used for:

- passive recreation.
- active sporting pursuits.
- cultural and or community activities.
- activities promoting community education of the environment; and/or
- uses that are compatible with and or support the amenity of the reservation (i.e. cafe, restaurant) where specific facilities for such purposes have been approved by the WAPC.

Formal dual use paths and nature walkways currently are located in the ROS along the Collie River Foreshore.

The use of the ROS for such purposes is a desirable outcome for the benefit of both Parkridge residents and the general community. The design of the LSP road network allows easy access to the ROS by being orientated in such a way that most streets lead directly to the ROS.

State Planning Policy 3.7 – Planning in Bushfire Prone Areas

State Planning Policy 3.7 (SPP 3.7) seeks to guide the implementation of effective risk-based land use planning and development to preserve life and reduce the impact of bushfire on property and infrastructure. SPP 3.7 applies to strategic planning proposals, including Structure Plans, over land designated as bushfire prone by the Department of Fire and Emergency Services. **Figure 3** (*overleaf*) is an excerpt of this map.

Given the Structure Plan area is partially designated as Bushfire Prone, SPP 3.7 is applicable to the LSP area. The requirements of SPP 3.7 are addressed by a Bushfire Management Plan prepared by Bushfire Works. Further details are provided in Section 6.1 of this report.

2.3 PRE LODGEMENT CONSULTATION

This Structure Plan proposal has been prepared following consultation with the Shire of Dardanup, the Department of Planning, Lands and Heritage (DPLH) and State Solicitors Office.

3 SITE CONDITIONS AND CONSTRAINTS

3.1 BIODIVERSITY AND NATURAL AREA ASSETS

The undeveloped portion of the subject land is currently vacant. Historically the land was used for grazing and until recently cattle were on this portion of the site. There is a pocket of vegetation located on the eastern edge and some well-established groupings of trees along the northern boundary. The northern and western boundaries adjoin the Collie River foreshore reserve, which contains remnant vegetation.

The area subject to the structure plan has previously been assessed by the EPA during the preparation of the Region Scheme, and subsequent amendments to the Local Planning Scheme.

Accendo environmental consultants were engaged by the proponent to prepare an environmental assessment to support the preparation of the approved Structure Plan in 2018. A review of the Environmental Assessment was conducted in December 2022, a copy of this assessment can be found at **Appendix C.**

A Black Cockatoo Habitat Tree Review was carried out by Greg Harwood, Zoologist, in November 2022 which concluded that no evidence of cockatoo was present and no evidence of suitable tree hollows were found. A copy of the assessment can be found at **Appendix C.**

The environmental assessment can be summarised by the following:

- As a result of historical and current anthropogenic disturbances, the vegetation within the subject site is in a 'Degraded' to 'Completely Degraded' condition. It is very unlikely to contain any flora or vegetation of conservation significance and it does not provide any ecological connectivity to surrounding environmental features (i.e. the Collie River).

- The fauna assessment determined that the fauna habitat values at the subject site have been severely compromised by the removal of most of the original native vegetation and the degradation of the main remnant patches.

- There is no evidence of WRPs utilising vegetation with the subject site as habitat and overall, habitat quality in areas to be developed are low/very low.

- Based on the results of the assessment and the scale of the proposed development, likely impacts on WRPs and black cockatoos and/or their preferred habitat are negligible (Harewood 2018). Accordingly, no further approval requirements are considered necessary in accordance with the EPBC Act or the EP Act.

- A portion of the subject site is mapped as containing a MU wetland. MU wetlands have few remaining functions, values and typically their attributes have been considerably degraded such that they provide limited ecological value. On this basis, MU wetlands do not usually preclude development. The impacts to the MU wetlands within the subject site are minimal as these wetlands are in a "Completely Degraded" condition and are considered suitable for development.

The reporting concludes there exist no major constraints relating to fauna, and in particular fauna of conservation significance with respect to the proposed development. Accendo considers that there are no fatal flaws or key environmental values that cannot be accommodated to enable development of the subject site for its intended purpose.

3.2 LANDFORM AND SOILS

The site sits at a reasonably flat contour of 5m AHD, before sloping down towards the Collie River.

The subject landforms part of the Pinjarra System and is made up of the following units.

P6a: Very undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with major current river systems and larger streams. Acidic red and yellow duplex soils, less common. Typically, loamy duplexes supergroups (40%).

P6b: Very undulating alluvial terraces and low rises contiguous with the plain, with deep moderately well to well drained soils associated with prior stream deposits. Soils are uniform brownish sands (40% brown deep sand, 30% yellow deep sand).

B6: Sandplain and broad extremely low rises with imperfectly drained deep or very deep grey siliceous sands. Pale deep sand (55%), poor sand effective duplex.

3.3 GROUNDWATER AND SURFACE WATER

A Local Water Management Strategy (LWMS) has been prepared for the subject land and is included as **Appendix D** to support the LSP amendment. It provides an update to the approved Lot 9004 Eaton Drive Local Water Management Strategy and highlights how water is to be managed in response to the revised layout.

This updated LWMS also considered the larger foreshore area that was analysed as part of the original structure planning and approved LWMS.

The majority of the undeveloped subject land is cleared and seeded with grass and pasture species with minimal to sparse tree and understorey species. The landform of the site consists of undulating sand dunes with a low lying swampy area in the centre of the site within the Collie River floodplain. A high point exists in the south western corner adjacent to the Collie River which will be developed at a later date.

Winter groundwater levels at the site are approximately 3 m from the surface at the eastern boundary sloping steeply towards the Collie River, in line with surface topography. The objective of this LWMS is to detail the updated best management practices approach to water management that will be undertaken for this development, in accordance with Better Urban Water Management (WAPC, 2008).

This will include managing, protecting and conserving the total water cycle of the local environment and the greater catchment. The practices will involve:

- Stormwater management that incorporates the latest's water sensitive urban design practices;
- Groundwater resource management;
- Protection and enhancement of ecosystems dependent on water resources from the subject land;
- Sustainable water servicing.

The effectiveness, efficiency and benefits provided by the best management practices require a collaborative effort between local governments, developers and relevant regulatory authorities. Further summary of the practices to be undertaken for the subject land can be found in the LWMS at **Appendix D.**

3.4 BUSHFIRE HAZARD

A Bushfire Management Plan (BMP) has been prepared for the approved Structure Plan for Parkridge Estate and can be found at **Appendix E**. An appendix to the BMP has been provided to address recent design modifications to provide a perimeter road to the proposed residential development.

The aim of the report is to reduce the threat to the residents in the proposed subdivision in the event of a bushfire within or adjacent to the development. It demonstrates:

- How the hazard level will be reduced and maintained for the life of the development; and
- That compliance with the Bushfire Protection Criteria in the Guidelines can be achieved.

All of the proposed lots will have a Bushfire Attack Level of BAL-29 rating or less. The majority of the lots in the Estate will have a BAL-12.5 or BAL-Low rating.

Due to the expected lot yield, there are potentially a number of stages of residential development.

Until the adjoining Lot 3001 to east is developed, a temporary Emergency Access way will be created through Lot 3001 along the alignment of the proposed subdivision road giving secondary access to Eaton Drive. In principle agreement has been reached with the adjoining developer for reciprocal works required in relation to bushfire management and access.

The BMP illustrates the potential radiant heat impacts and associated BAL ratings of the proposed subdivision in reference to any classified vegetation remaining within 100 metres of the assessment area after the development is completed.

Figure 7 (of the BMP Report) and the BAL assessment confirms that all proposed lots have a BAL-29 or lower rating. The proposed subdivision complies with the objectives of the State Planning Policy 3.7 as:

1. It avoids any increase in the threat of bushfire to people, property and infrastructure

2. It reduces vulnerability to bushfire through the identification and consideration of bushfire risks in the design of the development and the decision-making process.

3. The design of the subdivision and the development takes into account bushfire protection requirements and includes specific bushfire protection measures

4. Achieves an appropriate balance between bushfire risk management measures and biodiversity, conservation values and environmental protection.

3.5 HERITAGE

Hough Homestead is located on Lot 9504 adjoining the site and although not included in this LSP, may be subject to further planning and investigation in the future. The homestead is listed in the Shire of Dardanup Local Heritage Survey (Place No,44, 2016) and is detailed as having 'some/moderate significance' within the Heritage Survey.

3.6 TRANSPORT IMPACT ASSESSMENT

A Transport Impact Assessment (TIA) was prepared in support of the LSP amendment by Stantec Consulting Engineers. The report determined the proposed road network would adequately cater for the needs of the expected population. A complete copy of this report is in **Appendix F**.

The TIA considered the internal traffic movements as well as external to the site. This included road links to the Millbridge Estate which is proposed to connect to the site in three locations.

The performance of two intersections were assessed in detail being:

- Eaton Drive/Peninsula Lakes Drive intersection, and
- Eaton Drive/Millbridge Estate Access intersection.

The intersections of Eaton Drive/Peninsula Lakes Drive and Eaton Drive/ Millbridge Estate Access are anticipated to operate at satisfactory levels of service, with minimal queues and delays in the 2040 ultimate design year.

The TIA has determined that the LSP area is adequately connected to the surrounding road network and overall the estimated trips to be generated by the Parkridge Structure Plan area will not significantly affect the surrounding road network.

3.7 CONTEXT AND OTHER LAND USE CONSTRAINTS AND OPPORTUNITIES

Land to the immediate south and east of Parkridge is all zoned for residential development and forms part of the Eaton and Millbridge Estates. Further to the north, within the Shire of Harvey is Treendale Estate and Clifton Park is located on the western side of the Collie River. The location of subject land in conjunction with these residential estates is consistent with the development proposed for the site.

4 LAND USE AND SUBDIVISION REQUIREMENTS

The landowner is looking to pursue development within the area subject to modification proposed by this LSP amendment. Residential development is proposed for the area consistent with the zoning in the Local Planning Scheme and surrounding developments.

The breakdown of land use areas is detailed in the Structure Plan Table (**Table 1**) and identified on the Structure Plan Map (**Figure 1: Local Structure Plan**).

The structure plan report is supported by a Local Water Management Strategy, Bushfire Management Plan, Transport Impact Assessment, Environmental Assessment, and the Structure Plan Map which has been prepared in accordance with the requirements of Clause 3.16 of TPS 3 and Schedule 2, Part 4, clause 16 of the deemed provisions of the Regulations.

4.1 DESIGN PRINCIPLES

The amended Local Structure Plan layout seeks to maximise the outlook opportunities for residential development taking advantage of the significant areas of local and regional open space. The grid road pattern seeks to maximise opportunities for solar orientation of housing and provide for high levels of permeability, equity, and accessibility. The road layout provides for diversity and interest in the local street environments to assist in the development of local character and a sense of place consistent with Liveable Neighbourhood objectives.

The main road connections into the development will be the extension of Peninsula Lakes Drive and Robusta Road. Other than the existing intersection of Peninsula Lakes Drive/ Eaton Drive and the proposed northern intersection (on land to be developed by Millbridge) no roads are proposed to connect directly with Eaton Drive.

The adjoining regional open space to the Collie River is located to serve the community needs, provide a buffer to adjoining and surrounding land uses, integration and protection to existing vegetated areas and enhance sensitive water cycle management.

This amendment to the LSP proposes a number of changes to the design and, allocation and location of POS from the existing approved version. Review of the approved version raises a number of issues including:

- the existing plan provides 3.186ha of public open space and while this has been considered to be unrestricted, that figure does not properly take into account the areas required to be occupied by drainage basins. See extract below:



- The existing structure plan also requires drainage swales to be constructed within the Regional Open Space (shown as purple boxes on the LWMS), a measure which is unacceptable to both DWER or the DBCA.

- The existing structure plan does not show the northern most POS area (shown as POS Parcel B within this amendment) which is reserved for recreation under the Shire of Dardanup Town Planning Scheme No.9.

- The existing Structure Plan shows a perimeter road along the north western boundary of the area which is within a floodplain. If a road is constructed within this area, it will require excessive levels of fill, and would also either require a multi-meter high retaining wall (over 2m) along the entire boundary of the Regional Open Space, or require battering/filling into the Regional Open Space – both scenarios are unacceptable from an urban design or environmental perspective.

- If a perimeter road is constructed low, with battering occurring within the adjacent residential lots, this will cause the problem when there is a flood. Residents abutting that road would have no way to escape their dwellings except into the area of risk/danger.

- Similarly, regardless of whether a perimeter road was constructed up high or down low, that road is within an extreme fire danger area. If there was a fire within the regional reserve, residents abutting that road would have no way to escape their dwellings except into the area of risk/danger.

- The existing structure plan does not provide for a principle shared path along the boundary of the regional open space, nor does it provide for any public open space in the north of the structure plan area (ie. no distribution of POS).

- While some concept plans for the existing structure plan were historically prepared which indicatively show a soccer field within POS Q (which seems to be the basis for the reporting officer's contention that the existing plan provides some active open space), This:
  (a) never actually formed part of the approved structure plan;
  (b) it was not supported by the Shire;
  (c) it conflicts with the drainage basin location shown on the LWMS; and
  (d) is located in an area which the environmental reporting demonstrates contains tree hollows. Although not suitable for black cockatoo nesting, are suitable for use by possums. The Amendment re-aligns this public open space so that the trees with hollows are retained.

This amendment to the LSP seeks to resolve some of the design and practical implementation issues with the approve version.

4.2 PUBLIC OPEN SPACE

The LSP proposes to provide a minimum of 10% POS in accordance with the WAPC's Liveable Neighbourhoods. POS is to be provided generally in accordance with **Tables 2 and 4, and Figures 5 and 7.** At the time of subdivision, the POS areas shown on the amended Structure Plan Map (refer **Figure 1**) are to be ceded free of cost to the Crown with management orders to the Shire of Dardanup.

Regional Open Space (ROS) frames the development on the western and northern boundaries, providing foreshore to the Collie River, wetlands and cleared pasture. The majority of the ROS is within an area designated as floodway. The land is currently utilised by the public for passive and active recreation purposes.

The POS proposed by the LSP amendment area will provide for a variety of nature and active recreation pursuits. Two main parcels are proposed with one located on the eastern boundary of the site and is to contain an area of native vegetation. The vegetation is mainly parkland cleared

due to historic grazing of the property. It is proposed that this parcel of POS become a nature based play area.

The other main parcel is located on the north-western part of the site and will contain a number of large mature trees with no understorey allowing for an active recreation space. The main parcels of POS have been sited to distribute POS throughout the site for use by the local community and achieve a walkable catchment from green spaces.

A parcel in the north eastern most part of the site that is zoned POS in the Local Planning Scheme will be ceded free of cost as development progress north, generally in accordance with the Indicative Staging Plan (**Figure 7**). This parcel will also connect to POS within Millbridge Estate to the east.

Other smaller pocket parks are proposed throughout the LSP area. These will provide green space and pedestrian linkages within the LSP area.

Table 4 below shows the existing and proposed POS parcels. Reference numbers shown on the table can be cross-referenced and are visually represented on the POS Plan in **Figure 5**.

Plan Ref	Reserve No.	Lot Details	WAPC ref	Date Ceded	Area (ha) restricted	Area (ha) unrestricted
A	53879	8001 on P420816	159295	2021		0.1411
B						0.2994
C						1.1604
D					0.2104	1.3049
E						0.0900
				POS AREA	**0.2104**	**2.9958**
				POS (ha total)		**3.2062**
				Percentage of POS (restricted / unrestricted)	**0.07%**	**9.50%**
				Percentage of POS (total)		**10.17%**
				LSP Area		**31.5327**
				10% POS required		3.1533
				Surplus		0.0529

TABLE 4 – POS Table



Figure 5 – POS Plan

Each parcel of POS is further detailed below and within the Landscaping Plans in **Appendix H.**

Parcel A
Ceded as Public Recreation in 2021, Reserve 53879 has an area of 0.1411ha. The Responsible Agency being the Department of Planning Lands and Heritage and Management Orders for the reserve are with the Shire of Dardanup.

This parcel contains no drainage function.

Parcel B
The POS identified on **Figure 5** as parcel B being the north-eastern part of the LSP is mostly zoned Public Open Space in the Shire's Local Planning Scheme No. 9 (see **Figure 6** below). Additional POS has been added to the land already zoned to align with the road connection to Millbridge to the east. POS B has been included within the Structure Plan Area being part of the land parcel yet to be developed (Lot 9010 on Deposited Plan 428930)

The proposed POS parcel is parkland cleared with several mature trees and no understorey, suitable for passive recreation. POS B contains no drainage function and is considered to be unrestricted POS. A bioretention basin is within the road reserve along part of the southern boundary, however access to the POS is still available on the eastern portion. Further pedestrian access in the form of culvert crossings may be installed if additional access is required. This can be considered at detail design through the subdivision process.

POS B will be ceded free of cost and without the opportunity for compensation. This will be facilitated by a Deed of Agreement, with the ceding to be undertaken through the subdivision process in Stage 7 of development. This will enable road access to be provided to the POS for public access and maintenance purposes.

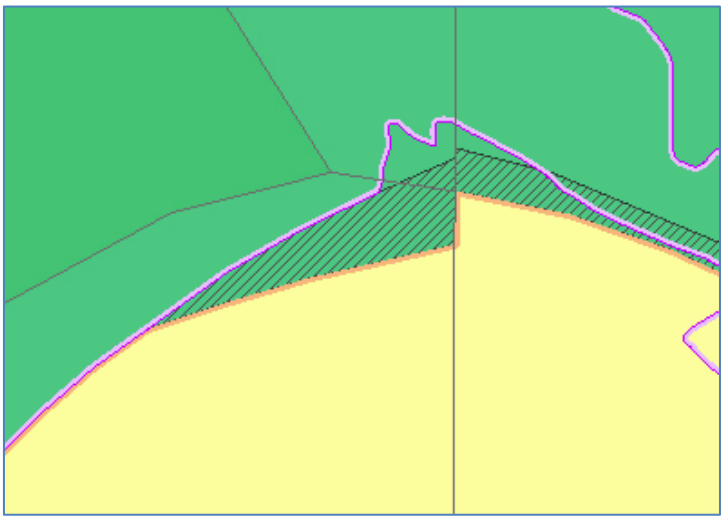


Figure 6 – POS B-Extract from Local Planning Scheme Map

Parcel C
Parcel C is one of two main areas of POS to be provided. The site, although not environmentally significant, it provides mature trees with some degraded understorey and portions of parkland cleared/grassed areas.

The developer routinely cleans up this area as dumping of rubbish has been an issue. However, this will improve as the residential development nears this part of the site, providing passive surveillance of the area. Photos of the site can be seen in the images below showing cleared sections that may be able to provide nature play areas and space for active recreational activities.





Site Photos – Existing Parcel C

Examples of similar developed nature and recreational spaces are shown in the photos below. Paths and low-key, informal sport and recreation activities are encouraged while the vegetation and fauna habitat are retained. This style of open space requires minimal maintenance and provides the community access to a nature based play area. A concept of play equipment to be installed in POS Parcel C has been provided in **Appendix H**, along with a Landscaping Concept Plan.

POS Parcel C is configured to be overlooked by surrounding lots contributing to passive surveillance to create a safer and more secure environment with street frontage for parking and access.

A dual use path will surround the POS and through the site to provide for a shaded walking trail through the treed areas and give access to play equipment.

POS C is consistent with part of the POS identified on the approved LSP, protecting the mature trees on the site. While the existing LSP, provided one main parcel of POS that included a drainage function, this amendment distributes the POS through the remaining land to be developed, providing better access to open space for the residents in the northern portion of the site.

Parcel C will provide 1.1604ha of unrestricted POS and will be ceded in Stage 5 of development to provide residents with a neighbourhood nature and play space. In particular, POS Parcel C will provide greenspace for the surrounding higher density R40 lots.





Photo Examples – Potential Development Parcel C

Parcel D
Proposed to be located in the north west of the site adjacent to the Regional Open Space (ROS), Parcel D is a parkland cleared site. Mature trees offer shade with space for passive recreation pursuits and an informal 'kick-around' area. The site will have pedestrian access from the path network which will link to the continuation of the existing path along Peninsula Lakes Drive to the south and continuing to Millbridge to the north east.

A Landscaping Concept Plan for POS Parcel D has been provided in **Appendix H**.

Road access will be on the southern and eastern side of the POS with the western side connecting to the ROS.

The LWMS provides further details on the proposed bioretention basins within POS parcel D. These will be planted and include suitable media to treat and infiltrate the 1EY and detain the 20% AEP. Drainage integrated within POS drainage provides for community and environmental benefits beyond water management. The water sensitive urban design (WSUD) within public open spaces serve multiple functions, such as recreation, biodiversity, and enhanced neighbourhood amenity, while also managing stormwater.

It is proposed that two basins be located within POS Parcel D being 1992m² and 112m² in area. The bioretention basins are designed according to the latest *FAWB Adoption Guidelines for Filter Media in Biofiltration Systems* and the *Stormwater Management Manual for WA design guidelines*. The design for the gardens is composed of a filter media and planted to assist with nutrient absorption.

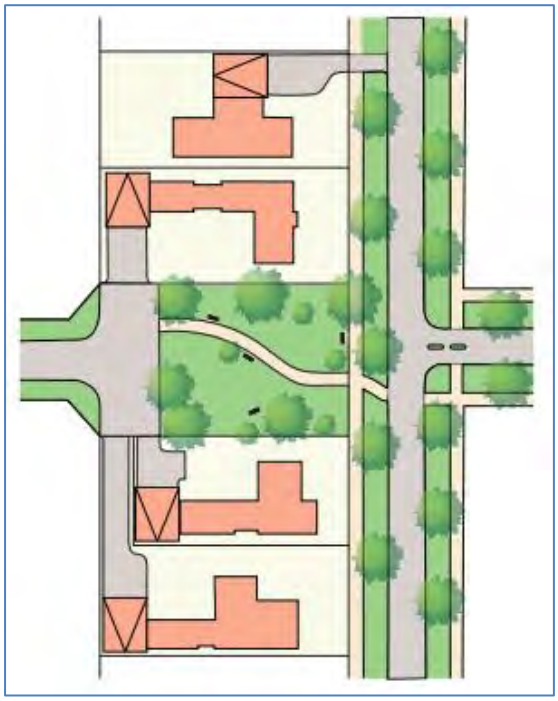




Photo Examples – Potential Development Parcel D

Parcels E
Two pocket parks are located centrally within the site to provide green space, pedestrian and cycle access. contribute to the landscape character and quality of the neighbourhood. The spaces are designed to make walking through the area more enjoyable and appealing to residents.

Liveable Neighbourhoods (Draft 2015) provides an example of a pocket park with a pedestrian and cyclist connectivity. Bollards are to be installed at each end of the park to prevent vehicular access. Photo examples are also shown below of potential development of Parcels E.





Development examples of Parcels E

4.3 RESIDENTIAL

Consistent with current WAPC policy (including the Residential Design Codes and Liveable Neighbourhoods), the amended Local Structure Plan provides for a range of residential densities and therefore housing choice and lifestyle opportunities.

The amended Local Structure Plan has been formulated to meet the requirements of Liveable Neighbourhoods. The Residential Design Codes (R-Codes), will provide a comprehensive basis for the control of residential development within the structure plan area. The R-Codes will "outline the 'rules' which apply to residential development".

The Shire of Dardanup have adopted *Local Planning Policy SDev CP028 - Variation to the Deemed to Comply requirements of the R-codes: Medium Density Single House Development Standards [R-MD Codes]* (LPP-CP028) The policy outlines acceptable variations to the deemed to comply provisions of the R-codes for medium density single houses. The policy applies to a number of Structure Plan areas including Parkridge. The variations permitted by the policy include setbacks, overshadowing, open space, garage widths and vehicular access.
The portion of Parkridge Estate, being subject to this Structure Plan modification is proposed to yield in order of 428 lots, and 475 dwellings. The expected lot yield and sizes are based on the density identified on the Structure Plan (refer *Figure 1*) and the concept plan in **Appendix B.**

The lots within the LSP modification area, developed to date and those currently under development, yield 122 lots freehold lots at a density of R20 and pockets of R40 yielding a further 9 lots.

A density of R30 is proposed for the majority of the site remaining to be developed with R40 lots surrounding POS ref C and a grouped housing site as shown on the Structure Plan Map (**Figure 1**). This is in-line with current planning policy and practices and will enable a range of lots sizes to be created at subdivision stage in accordance with the criteria set out in Part 1 of this Structure Plan.

Lots at a density of R40 surrounding Parcel C and adjacent to the pocket parks (POS parcels E) are proposed to be individual freehold lots to meet the minimum and average lot size requirements of the R-codes. Lot widths will generally be a minimum of 10.5m wide. Due to the application of the Shire's LPP-CP028, double garages are permitted on lots of 10.5m width.

Liveable Neighbourhoods provides a clear justification for smaller residential lots surrounding public open space (POS), grounded in urban design principles that promote walkability, housing diversity, and efficient land use -"*Smaller lots and medium-density housing types are encouraged to front onto parks and public spaces to ensure greater use and surveillance.*" (Liveable Neighbourhoods, WAPC)

According to Liveable Neighbourhoods, smaller lots are encouraged adjacent to public open space for several key reasons including:

- Maximise access to recreational and amenity opportunities;Encourage active street frontages that provide passive surveillance (eyes on the park), improving safety and community interaction;
- Support walkable neighbourhoods by ensuring more people live within walking distance (usually 400 metres) of green space, aligning with Element 1: Community Design.
- A diverse housing mix that caters to different household types, life stages, and income levels.
- Greater affordability through lower land costs per dwelling, helping to meet Liveable Neighbourhoods objectives for social inclusion and housing choice.

The inclusion of the proposed medium-density group housing site is consistent with the objectives and intent of the Liveable Neighbourhoods which promotes the delivery of diverse and affordable housing options.

Liveable Neighbourhoods recognises that housing choice is essential to supporting socially inclusive and resilient communities. The proposed group housing development responds directly to the policy's objective to: "*Provide a variety of lot sizes and housing types to suit a range of household types and income levels.*"

A range of housing types and densities is designed to cater to the needs of a diverse population, including:

- Smaller households
- Ageing populations (downsizers)
- Single persons
- Lower-income families
- Residents seeking manageable, low-maintenance housing options

The size and dimension of the R-40 grouped housing site (accommodating up to 43 dwellings @R40) will provide for a commercially viable number of smaller and affordable houses to be constructed.

This housing style and expected lower cost is very in demand in this locality. This provides for a range of housing typologies and price points within the structure plan that would not exist with a uniform R30 coding.

The R-40 coding provides greater built form flexibility over R30, and is particularly required in order to internalise access and minimise the number of driveways onto the east west road.

From a location perspective, the site sits on the "lowest value" part of the precinct, further enhancing the ability to maximise affordability. While the site does not directly abut public open space, it is centrally located between both areas of large public open space, a short walk, via quiet streets to both. It will also be on the future bus route of Peninsula Lakes Drive.

The road to the north of the site bends at 90 degrees, creating an irregular lot layout which can be addressed via built form, however is difficult to provide for regular shaped individual lots.

The location of the north-south road to the west of the grouped housing site is ideally located to assist with drainage of water from the south, which needs to flow in a north westerly direction. This is also located mid block to the south, so as to avoid the cost of an expensive round about while also reducing the number of intersections onto the east west road which will extend to Eaton Drive.

The estimated population based on the lot yield is 1,188 persons. This calculation is based on the Australian Bureau of Statistics 2021 Census for Eaton, Millbridge and Pelican Point average number of people per household of 2.5.

The design of the residential cells is based predominantly on a grid system to allow the effective use of solar orientation of future dwellings and to allow lots to be developed of a regular shape.

The proposed larger POS parcels are to contain most of the existing vegetation on the site are by the most part surrounded by local roads to allow access to this park and provide separation for bushfire management.

The very eastern portion of urban development (as identified on the Structure Plan) will be developed in conjunction with Millbridge Estate to ensure residential lots and road alignments are congruent. Liaison with the developer of Millbridge is on-going to allow the seamless development of each site. While each of the two sites will develop independently, an agreement is in place between the developers of each site to allow the temporary use for such matters as low-fuel zones, emergency access ways, temporary turning circles and temporary drainage basins.

4.4 MOVEMENT NETWORKS

Road reserves are to be designed generally in accordance with the Structure Plan Map included as **Figure 1**. The road reserve widths of the proposed internal road network are between 25.5m for Peninsula Lakes Drive, 18m for the east west link through to the Millbridge Estate, 15m for local access streets, 12.5m for local street adjacent to POS and 9m laneways, which are generally consistent with the Liveable Neighbourhoods (WAPC 2015) requirements.

The road adjacent to the ROS will accommodate a drainage swale along the outer edge. This is demonstrated in the servicing report at **Appendix G**.

The Transport Impact Assessment demonstrates that the proposed road widths are appropriate for the expected traffic numbers and flow.

As part of the Local Structure Plan, it is proposed that Peninsula Lakes Drive continue northward into the development to meet with the east-west link through Millbridge Estate and onto Eaton Drive, utilising the planned intersection location.

Peninsula Lakes Drive will form the western development boundary between the residential estate and the Regional Open Space.

No additional connection points directly onto Eaton Drive are proposed as part of the Structure Plan. Connection onto Eaton Drive will occur through the existing Peninsula Lakes Drive and the future connection further north through Millbridge Estate.

The proposed local road network is predominantly a grid layout utilising T intersections. No crossroads are proposed.

Provision is to be made for on-street parking within road reserves at regular intervals along the length of Peninsula Lakes Drive adjoining the Regional Open Space to allow public access.

A dual-use path networks is proposed to provide pedestrian and cycle access throughout the estate. The location of which is shown on the Structure Plan Map (**Figure 1**).

4.5 WATER MANAGEMENT

A Local Water Management Strategy (LWMS) was undertaken as part of the approved Structure Plan and updated to address the modification proposed. A copy of the updated LWMS is attached at **Appendix D.**

Figure 2 of the LWMS identifies the key elements for the Local Water Management Strategy, including the direction of flows and location of bioretention basins.

Stormwater detention systems, combined with treatment systems including a perimeter bioretention basin and POS basins will capture and treat stormwater flows. All flows leaving the site up to the 20% AEP event match or are below the pre development rate.

The bioretention basins will be designed to create new wetlands habitats by the use of locally native plant species and by maintaining pre-development surface and groundwater flows to the surrounds. Water quality will be improved through the use of constructed vegetated bioretention areas (swales) and other suitably designed and best practice water sensitive urban design techniques.

4.6 INFRASTRUCTURE COORDINATION, SERVICING AND STAGING

The proposed development of Parkridge Estate, Eaton will require connection to reticulated water and sewer, both of which are in the adjoining residential developments and readily available for connection.

Power, gas and telecommunications will be connected as part of the subdivisional works.

A Servicing Report has been prepared which demonstrates the land is capable of being supplied with the necessary infrastructure to proceed with development. This Assessment is included as **Appendix G.**

Staging of the development is proposed to proceed generally in a northerly direction. Stages 1 to 4 form part of the existing development within the LSP area. **Figure 7** provides an indication of the proposed staging, being stages 5 to 10, of subdivision for the existing Lot 9010. However, this may be modified pending market demand and servicing constraints at detailed design stage.

POS is to be ceded as a condition of subdivision and in accordance with the Indicative Staging Plan to provide for POS demand for lots as they are developed.

In terms of access to address Bushfire Management, the developer has reciprocal arrangements in place with the developer of Millbridge. These arrangements will provide for a secondary temporary access and low fuel zones depending on staging and timing until both developments have been completed.

Staging of development will be considered, and in particular the number of lots created, given the expected traffic generated by the development until the proposed Millbridge intersection with Eaton Drive is constructed. Access to Eaton Drive from Parkridge is currently available via intersections at Glen Huon Boulevard and Peninsula Lakes Drive. Recent upgrades to Eaton Drive / Glen Huon Boulevard intersection with traffic lights have eased right turn wait times.

It is predicted, indicative stages 5, 6 and 7 can be developed prior to the east-west link connecting through Millbridge onto Eaton Drive, as this will be less than the additional 211 lot trigger for an additional road intersection. Further assessment can be found in the Transport Impact Assessment at **Appendix F**.

Indicative stage 8 will require the road link through Millbridge to Eaton Drive. This connection will also be required to extend the vacuum sewer scheme proposed to service the northern part of the LSP area.

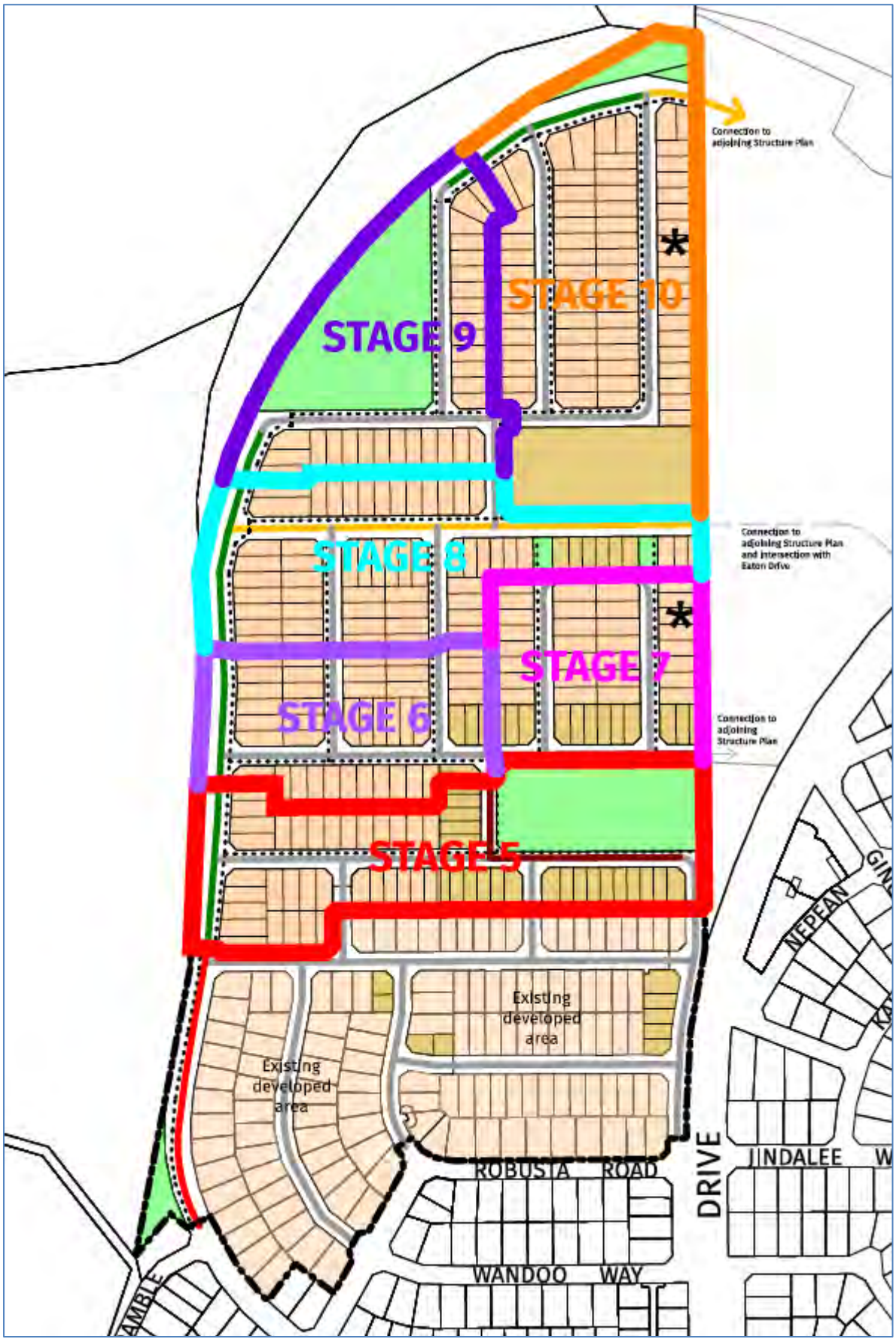


Figure 7 – Indicative Staging Plan

5 CONCLUSION

The proposed modification to the Parkridge Local Structure Plan has been prepared in accordance with the requirements of the *Planning and Development (Local Planning Schemes) Regulations 2015*. Further, the Structure Plan complies with the applicable State and Local Planning Policy Framework as set out in Part One, section 2 of this Report.

This LSP has been prepared to outline a land use and movement network framework for the development of Parkridge Estate, to accommodate low and medium residential housing. The LSP demonstrates that sufficient POS has been proposed.

The LSP seeks to stipulate the key boundaries between land uses, address the key interface considerations and identify the matters that need to be addressed at the detailed subdivision and development stages. This LSP therefore affords a certain degree of flexibility for innovative and creative detailed design responses, if there is compliance with the key elements and principles of the LSP and that the key objectives are realised.

The LSP seeks to extend the life of the Structure Plan for a further 10 years or longer as determined by the Western Australian Planning Commission (WAPC) in accordance with Schedule 2, cl.28(2) of the *Planning and Development (Local Planning Schemes) Regulations 2015*.

Following adoption of the Structure Plan, development and subdivision applications can be considered and approved where they comply with the Structure Plan.

APPENDICES INDEX

APPENDIX NO.	NATURE OF DOCUMENT
A	Certificates of Title
B	Concept Plan
C	Environmental Assessment
D	Local Water Management Strategy
E	Bushfire Management Plan
F	Transport Impact Assessment
G	Servicing and Infrastructure
H	Landscaping Concept Plans

APPENDIX A | CERTIFICATES OF TITLE

WESTERN AUSTRALIA

TITLE NUMBER	
Volume	Folio
4067	**529**

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 9010 ON DEPOSITED PLAN 428930

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

PARKRIDGE GROUP PTY LTD OF 29 STROME ROAD APPLECROSS WA 6153
(AF Q301636) REGISTERED 5/2/2025

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

1. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE/SEWERAGE PURPOSES TO LOCAL AUTHORITY - SEE DEPOSITED PLAN 428930 AS CREATED ON DEPOSITED PLAN 423332
2. P791756 MORTGAGE TO AUSTRALIAN SECURE CAPITAL FUND LTD OF SUITE 6C 33 PARK ROAD MILTON QLD 4064 REGISTERED 20/11/2023.

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. 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:	DP428930
PREVIOUS TITLE:	4058-833
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	SHIRE OF DARDANUP

NOTE 1: P534088 SECTION 138D TLA APPLIES TO CAVEAT P478068

APPENDIX B | Concept Plan

(Appendix ORD: 12.2.2C)

YIELD SUMMARY			
Size	No. Lots	% Total Lots	Avg. Lot Size
235m² - 319m²	6	2.02%	315m²
320m² - 449m²	237	79.80%	405m²
450m² - 499m²	42	14.14%	465m²
500m² - 549m²	5	1.68%	516m²
550m² - 599m²	3	1.01%	561m²
600m² - 699m²	1	0.34%	653m²
700m² - 799m²	2	0.67%	743m²
1 ha - 2 ha	1	0.34%	1.0517ha
Number of Proposed Lots	**297**		
Number of Existing Lots	**131**		
Total Number of Lots	**428**		
Public Open Space			3.0648ha
Regional Open Space			2.2224ha

54422
950

9503

3001

ROS
2.2224ha

POS
1.5153ha

POS
2657m²

POS
345m²

214
1.0517ha
Grouped Housing Site
(47 Dwellings)

POS
1.1593ha

POS
1411m²

25.5m wide Road Reserve

15m wide Road Reserve

18m wide Road Reserve

12.5m wide Road Reserve

14m wide Road Reserve

15m wide RR

6m wide Laneway

DRIVE

SHIRAZ STREET

GUERNSEY STREET

PENINSULA LAKES DRIVE

TUKIDALE STREET

ROBUSTA DRIVE

CAMARGUE STREET

ROBUSTA DRIVE

BOULEVARD

GLENHUON

EATON DRIVE

LEGEND

- Structure Plan Area
- Existing Development
- Existing Cadastre
- Proposed Residential R40
- Proposed Residential R30
- Proposed Residential R20
- Public Open Space
- Regional Open Space

OVERALL CONCEPT SUBDIVISION PLAN
AMENDED STRUCTURE PLAN
PARKRIDGE ESTATE, EATON

Plan No.	22294-29
Date	25/09/25
Drawn	NP
Checked	KS
Revision	E
Scale	1:1500 @ A1 1:3000 @ A3

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NOTE: This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey

Harley Dykstra
PLANNING & SURVEY SOLUTIONS

APPENDIX C | ENVIRONMENTAL ASSESSMENT

(Appendix ORD: 12.2.2C)

accendo AUSTRALIA

ENVIRONMENTAL ASSESSMENT REPORT

LOT 9008 ROBUSTA ROAD, EATON

DECEMBER 2022

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Document Control

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V3	28/11/2022	KMT	KS
Filename	1818_Parkridge Estate EAR_v3		

EXECUTIVE SUMMARY

Parkridge Group Pty Ltd (the proponent) is proposing to subdivide and develop Lot 9008 Robusta Road, Eaton (herein referred to as the subject site). The subject site has a combined area of approximately 32 hectares (ha). It is located 2.5 km north of the Eaton town centre and 8 km east-north- east of Bunbury and is situated adjacent to the Collie River.

A Structure Plan (Harley Dykstra 2022) has been prepared for the subject site to enable urban development with residential cells ranging from R20-40 and R5, also incorporating areas of Regional Open Space.

This report provides a synthesis of a range of information regarding the environmental attributes and values of the subject site. Where environmental values have been identified, suitable management measures have been proposed. In consideration of these management measures, an assessment of the overall environmental impact of the proposed development has been provided.

The environmental attributes and values identified within the site have been outlined in **Section 4** and include:

- Surface elevations range from 10.50 m AHD in the south-eastern corner to 1.30 m AHD along the northern boundary within the Collie River floodplain.
- The subject site has been classified as having a 'moderate to low risk' of ASS occurring within three metres of the natural soil surface.
- The subject area sits within the Leschenault Estuary Catchment and as such is covered by the Leschenault Estuary WQIP.
- The majority of vegetation has been cleared as a result of the historical and current land use (livestock grazing).
- The subject site is mapped as containing a portion of a CC wetland. As identified within the *Wetland Buffer Determination* study (Bioscience 2012) for the subject site, this mapping appears to be incorrect as a site analysis revealed that the wetland function area associated with the CC wetland does not extend into the subject site. Furthermore, an examination of this specific area during the fauna assessment (Harewood 2018) revealed it to be comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduced pasture grasses, which is not consistent with the definition of a CC wetland.
- As a result of the fauna assessment it was determined that the fauna habitat values at the subject site have been severely compromised by the removal of most of the original native vegetation and the degradation of the main remnant patches.
- There is no evidence of WRPs utilising vegetation with the subject site as habitat and overall, habitat quality in areas to be developed are low/very low.
- Some areas of vegetation represent black cockatoo habitat, but the degree of use appears to be low with no breeding or roosting activity detected and only a very limited amount of foraging habitat being present.
- There exist no major constraints relating to fauna, and in particular fauna of conservation significance with respect to the proposed development.

In consideration of the abovementioned key environmental features, the following management measures have been proposed to minimise potential impacts associated with the subdivision of the subject site:

- Prepare and implement an ASS and Dewatering Management Plan if necessary.
- Implement the approved LWMS during subdivision works.

Based on this assessment, Accendo considers that there are no fatal flaws or key environmental values that cannot be accommodated to enable development of the subject site for its intended purpose.

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1 INTRODUCTION

1.1 Background

Parkridge Group Pty Ltd (the proponent) is proposing to subdivide and develop Lot 9008 Robusta Road, Eaton (herein referred to as the subject site). The subject site has an area of approximately 32 hectares (ha). It is located 2.5 km north of the Eaton town centre and 8 km east-north-east of Bunbury and is situated adjacent to the Collie River (refer to **Figure 1** and **2**).

A Structure Plan (Harley Dykstra 2022) has been prepared for the subject site to enable urban development with residential cells ranging from R20-40 and R5, also incorporating areas of Regional Open Space.

This Environment Assessment Report has been prepared to support the proposed subdivision of the subject site. It investigates the existing environment and the opportunities and constraints associated with the development of the site, including recommended management measures to mitigate impacts.

The subject site presents a unique opportunity for residential development within the locality in consideration of its proximity to existing town centres and transport routes.

1.2 Purpose and Scope

This report provides a synthesis of a range of information regarding the environmental attributes and values of the subject site. Where environmental values have been identified, suitable management measures have been proposed. In consideration of these management measures, an assessment of the overall environmental impact of the proposed development has been provided.

In addition to the above, this Environmental Assessment Report also addresses a submission received from the Department of Biodiversity, Conservation and Attractions (DBCA) regarding the Structure Plan.

1.3 Associated Reports

Previous reports produced for the subject site (and adjacent landholdings) include:

- Structure Plan – Parkridge Estate (Calibre 2018a);
- Lot 9004 Eaton Drive, Eaton - Local Water Management Strategy (Calibre 2018b);
- Fauna and Habitat Assessment – Lot 9004 Eaton Drive, Eaton (Harewood 2018);
- Black Cockatoo Habitat Tree Review - Lot 9004 Eaton Drive, Eaton (Harewood 2022);
- Desktop Environmental Assessment Report – Stage 3 - Lot 9004 Peninsula Lakes Drive, Eaton (Accendo 2017);
- Environmental Impact Assessment, Lot 9502 Peninsula Lakes Drive, Eaton (Bioscience 2012).

2 STRUCTURE PLAN

2.1 Description

The Structure Plan has been developed to guide the subdivision and development of 32 ha of undeveloped land within the remaining portion of Parkridge Estate. The Structure Plan for the site is provided in **Appendix A**.

The Structure Plan provides for 1.01 ha of Regional Open Space (ROS) and landscaped common property at the rear of the strata lots.

2.2 Environmental Features of the Structure Plan

The subject site does not have a high level of ecological value. This can be attributed to the historical and current land use which has resulted in clearing of native vegetation for agricultural purposes, e.g. livestock farming.

From an environmental perspective the key influences of the Structure Plan are:

- The Conservation Category (CC) wetland and its associated buffer; and
- Water management.

3 LEGISLATION, POLICY AND GUIDELINES

The following legislation, policy and guidelines have been considered and will guide the required and expected management outcome from Federal, State and local government agencies.

3.1 Commonwealth Legislation

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's central piece of environmental legislation.

The EPBC Act aims to protect Matters of National Environmental Significance. Under the EPBC Act, the Commonwealth Department of the Environment and Energy (DotEE) lists Threatened species, Migratory species and Threatened Ecological Communities (TECs) in certain categories determined by criteria provided within the EPBC Act.

Under the EPBC Act, a significant impact is determined by the sensitivity, value and quality of the environment which is to be impacted and the intensity, duration, magnitude and geographic extent of the impacts (DEWHA 2008). If a proposed action is deemed to have a significant impact, this action should be referred to the Minister.

3.2 Western Australian Legislation

This desktop assessment has been undertaken in consideration of the relevant Western Australian state legislation which includes the following.

Biodiversity and Conservation Act 2016 (BC Act)

The Department of Biodiversity, Conservation and Attractions (DBCA) lists flora and fauna taxa under the provisions of the BC Act as protected according to their need for protection. Flora is given Declared Rare status when their populations are geographically restricted or are threatened by local processes. In addition, under the BC Act, by Notice in the Western Australian Government Gazette of 9 October 1987, all native flora and fauna is protected throughout the State.

Environmental Protection Act 1986 (EP Act)

This EP Act is administered by the Department of Water and Environmental Regulation (DWER) and the DBCA. The EP Act provides for conservation, preservation, protection, enhancement and management of the environment and for matters incidental to or connected with it. The Act establishes head powers to provide mechanisms for the development of Environmental Protection Policies (EPP), the referral and assessment of proposals (Environmental Impact Assessment), the control of pollution and enforcement. The Act also provides for an Environmental Protection Authority (EPA) that is a statutory authority and is the primary provider of independent environmental advice to Government. The EPA is assisted by the EPA Service Unit comprising the Environmental Impact Assessment and Policy Divisions of the DWER.

3.3 State Policy and Guidelines

Shire of Dardanup Biodiversity Policy

The objective of the *Biodiversity Policy* is to preserve significant areas of remnant vegetation, significant wetlands and waterways as well as key biodiversity corridors for future generations.

For the Eaton locality, the following is stated:

- Ensure buffers for ROS in new residential areas are based on ecological requirements of vegetation complexes and separation of wetlands from proposed residences (mosquito management zones). These should be achieved through the structure planning process.
- Ensure existing ROS is reserved for recreation and conservation where there are natural areas.
- Maximize protection of tree stands and understorey in POS, local schools and wider road reserves and road islands.
- Consider providing proponents with incentives to change road layouts to accommodate tree and understorey retention – e.g. Increased densities adjacent to protected natural areas.

Shire of Dardanup Town Planning Scheme No. 3

The general objectives of this Scheme as related to this report include:

- To zone the Scheme Area for the purposes in the Scheme described;
- To secure the amenity, health and convenience of the Scheme Area and the inhabitants;
- To make provisions as to the nature and location of buildings and the size of lots when used for certain purposes;
- The preservation of places of natural beauty, of historic buildings and objects of historical and scientific interest; and
- To make provision for other matters necessary or incidental to town planning and housing.

In relation to this report the Scheme provides for the zoning of 'Local Reserves' which restricts the use of and development on land zoned as a local reserve.

Wetland Management

The EPA administers the *Environmental Protection of Wetlands – Position Statement No. 4* (2004) to outline their principles for the protection of wetlands. The EPA's broad objectives are:

- To protect the environmental values and functions of wetlands in Western Australia.
- To protect, sustain and, where possible, restore the biological diversity of wetland habitats in Western Australia.
- To protect the environmental quality of the wetland ecosystems of Western Australia through sound management in accordance with the concept of 'wise use', as described in the Ramsar Convention, and ecologically sustainable development principles.
- To have as an aspirational goal, no net loss of wetland values and functions.

The identification and delineation of a wetland is described within the *Protocol for Proposing Modifications to the Geomorphic Wetlands Swan Coastal Plain Dataset* (DPaW 2007), whereby three key factors are considered:

- Hydrology – is dynamic and varies annually, seasonally and between wetlands. Long term groundwater data over differing seasons is required to accurately assess wetland hydrology.
- Hydric Soils – are soils formed in response to prevailing inundation or waterlogging, and are a long term wetland determining characteristic.
- Wetland Vegetation – reflects hydrology and hydric soils, in particular, obligate wetland species are considered reliable wetland indicators.

4 BIOPHYSICAL ENVIRONMENT

4.1 Land Use

Historically, the subject site has been used for broad acre agriculture. Accordingly, the subject site is largely devoid of remnant vegetation and consists of paddock grasses. There is a small area on the central western boundary of the site consisting of a stand of trees and a strip of vegetation which runs along the bank of the Collie River and joins into the densely vegetated area to the northwest of the subject site. Currently, the subject site is used for livestock grazing.

4.2 Topography, Soils and Geology

4.2.1 Topography

The subject site is comprised of undulating sand dunes and swampy low-lying areas that are consistent with the geomorphology of the Collie River. Surface elevations range from 10.50 m Australian Height Datum (AHD) in the south-eastern corner to 1.30 m AHD along the northern boundary within the Collie River floodplain.

4.2.2 Geology

The Bunbury-Burekup Sheet of the 1:50,000 Urban Geology Series maps published by the Geological Survey of Western Australia indicates that the subject site comprises two geological units. The Pleistocene Age Bassendean Sand (low rounded dunes) is mapped within the south-east corner of the subject site, while the remainder is underlain by Pleistocene Age Guildford Formation (primarily alluvial sandy clay).

4.2.3 Acid Sulfate Soils

Based on DWER's regional ASS risk mapping, the site has been identified as having a "moderate to low" risk of ASS occurring within 3 m of the natural soil surface (refer to **Figure 3**).

Golder Associates carried out a geotechnical and preliminary ASS investigation across the subject site in 2005. Based upon the results of this investigation it was concluded that the risk of encountering ASS above the action criteria (SCR 0.03%) is high within 3 m of the existing surface.

4.3 Groundwater

Groundwater was also found in 27 of the 35 test pits as part of the geotechnical investigation (Golder Associates, 2005). Groundwater depth ranged between 0.3 and 2.0 m below natural surface (BNS).

In addition, to determine the likely seasonal maximum groundwater levels across the subject site, onsite groundwater level monitoring was undertaken by Calibre between May 2009 and October 2010. The investigation included the installation of 23 monitoring bores across the site, to a depth of approximately 2.1m BNS. Results indicated that groundwater levels generally fall towards the low lying areas of the Collie River floodplain, from east to west with depth to groundwater ranging from above surface to 5.6 m BNS.

4.4 Surface Water

The Collie River is located approximately 330 m west of the subject site. The Collie River discharges south into the Leschenault Estuary and ultimately into the Indian Ocean. The subject site sits within the Leschenault Estuary Catchment and as such is covered by the Leschenault Estuary Water Quality Improvement Plan (WQIP). The Estuary and its tributaries are also a Management Area proclaimed under the *Waterways Conservation Act 1976* and a catchment included in the state government's Regional

Estuary initiative. The subject site discharges west towards the Collie River and ultimately the Leschenault Estuary (Calibre 2018b).

The subject site contains two manmade permanent freshwater dams which provide a water source for grazing stock.

4.5 Wetlands

Wetlands within Western Australia are classified on the basis of landform and water permanence pursuant to the Semeniuk (1995) classification system (refer to **Table 1**).

Table 1. Wetland classifications (Semeniuk 1995).

Water Longevity	Landform				
	Basin	Channel	Flat	Slope	Highland
Permanent Inundation	Lake	River	-	-	-
Seasonal Inundation	Sumpland	Creek	Floodplain	-	-
Intermittent Inundation	Playa	Wadi	Barlkarra	-	-
Seasonal Waterlogging	Dampland	Trough	Palusplain	Paluslope	Palusmont

Areas of wetlands have been mapped previously by Semenuik (1995) across the entire Swan Coastal Plain. This mapping has been converted into a digital dataset that is maintained by the DBCA and is referred to as the '*Geomorphic Wetland of the Swan Coastal Plain*' dataset. This dataset contains information on geomorphic wetland types and assigns management categories that guide the recommended management approach for each wetland area. The wetland management categories and management objectives are listed in **Table 2**.

Table 2. DBCA wetland management categories (Semeniuk 1995).

Category	Description	Management Objectives
Conservation	Wetlands support a high level of ecological attributes and functions.	Highest priority wetlands. Objective is to preserve and protect the existing conservation values of the wetlands through various mechanisms including: • Reservation in national parks, crown reserves and State owned land, • Protection under Environmental Protection Policies, and • Wetland covenanting by landowners. No development or clearing is considered appropriate. These are the most valuable wetlands and any activity that may lead to further loss or degradation is inappropriate.
Resource Enhancement	Wetlands which may have been partially modified but still support substantial ecological attributes and functions	Priority wetlands. Ultimate objective is to manage, restore and protect towards improving their conservation value. These wetlands have the potential to be restored to Conservation category. This can be achieved by restoring wetland function, structure and biodiversity.
Multiple Use	Wetlands with few remaining attributes and functions	Use, development and management should be considered in the context of ecologically sustainable development and best management practice catchment planning through landcare.

The *Geomorphic Wetlands of the Swan Coastal Plain* dataset indicates that the majority of the subject site is mapped as a Multiple Use (MU) wetland. A CC wetland is mapped as marginally intersecting the north-western extent of the subject site (refer to **Figure 4**). However, a *Wetland Buffer Determination* study (Bioscience 2012) undertaken within the subject site determined that the CC wetland mapping is incorrect, as the function area associated with this wetland does not extend into the subject site. Notwithstanding, the area mapped as a CC wetland will be reserved as ROS and will be preserved for conservation purposes.

4.6 Vegetation and Flora

The balance of the subject site is completely cleared of native vegetation, with just a small number of scattered trees of various types. The small areas of remnant native vegetation are predominately comprised of a flooded gum/paperbark woodland in the north, and a grove of peppermint low woodland on higher ground in the south east of the subject site. All the vegetation present can be regarded as being in a 'Degraded' or 'Completely Degraded' condition.

4.6.1 Flora

A search on DBCA's *NatureMap* online indicated that one Declared Rare Flora (DRF) (*Diuris drummondii*) and two Priority Flora (PF) (*Lasiopetalum membranaceum* (Priority 3) and *Caladenia speciosa* (Priority 4)) exist within 2 km radius of the of the subject site. Previous site inspections have not resulted in the identification of any conservation significant flora (Bioscience 2012). Furthermore, given the highly disturbed nature of the subject site and the current land use (livestock grazing), the presence of flora of conservation significance is considered very unlikely.

4.6.2 Vegetation

Regional vegetation has been mapped by Heddle *et al*. (1980) at a scale of 1:250,000 based on major geomorphic units on the Swan Coastal Plain. The subject site traverses the Swan vegetation complex as defined by Heddle *et al*. (1980) which can be described as:

- Fringing woodland of *Eucalyptus rudis – Melaleuca rhaphiophylla* with localised occurrence of low open forest of *Casuarina obesa* and *Melaleuca cuticularis*.

The mapped Heddle *et al.* (1980) vegetation complex can be used to determine vegetation extent and status on the Swan Coastal Plain. The DBCA records show that approximately 13% of the pre- European extent remains across the Swan Coastal Plain. The national objectives and targets for biodiversity conservation in Australia have a target to prevent clearance of ecological communities with an extent below 30% of their pre- European extent remaining. However, the subject site is located within the 'constrained area' of the Perth Metropolitan Region (EPA 2006). Within this area the EPA (2006) provides for the reduction of vegetation complexes to a minimum of 10% of their pre – European extent remaining. The Swan vegetation complex has in excess of 10% of its pre-European extent remaining.

In addition, given that the vegetation structure and species diversity associated with Swan complex is largely absent, the vegetation within the subject site is not representative of this vegetation complex.

In consideration of the above, the vegetation within the subject site is not considered significant as a remnant.

Threatened Ecological Communities

Threatened Ecological Communities (TECs) are defined by the DBCA and are assigned to a category of Priority 1 to Priority 5. While they are not afforded direct statutory protection at a State level their

significance is acknowledged through other State environmental approval processes (i.e. the Environmental Impact Assessment pursuant to Part IV of the EP Act).

Selected TECs are also afforded statutory protection at a Federal level pursuant to the EPBC Act. The EPBC Act provides for the protection of TECs that are listed under section 181 of the Act, and are defined as "Critically Endangered", "Endangered" or "Vulnerable".

A search was undertaken of the DBCA's TEC database and the EPBC Act Protected Matters database and it was found that the *Banksia Woodlands of the Swan Coastal Plain ecological community*, listed under the EPBC Act as a TEC in the 'Endangered' category is 'likely to occur within the area'. The Banksia Woodlands of the Swan Coastal Plain ecological community is a woodland associated with the Swan Coastal Plain of south western, Western Australia. A key diagnostic feature of this TEC is a prominent tree layer of Banksia, with scattered eucalypts and other tree species often present among or emerging above the Banksia canopy. The understorey is a species rich mix of sclerophyllous shrubs, graminoids and forbs (Threatened Species Scientific Committee 2016). Although the ecological community is characterised by high endemism and considerable localised variation in species composition across its range, the absence of Banksia species and lack of vegetation structure, denotes that the TEC does not occur within the subject site.

4.6.3 Regional Ecological Linkages

Ecological linkages can be described as any area of remaining remnant vegetation that can provide a corridor or linkage between larger patches of vegetation, to allow movement of flora, fauna and their genetic material through the landscape.

A Strategy was developed for the EPA to identify regionally significant natural areas in its consideration of the Greater Bunbury Region Scheme. These areas were identified using the reports and studies listed below:

- System reports – System 1 and System 6 (DEC 1976 - 1983);
- Areas of threatened and poorly reserved plant communities: EPA (1994, derived from Gibson *et al*. 1994);
- Areas of threatened ecological communities: as defined by English and Blyth (1997); and
- The Kemerton Buffer Link (EPA 1999).

This resulted in the identification of 16 ecological linkages which are recognised in the Greater Bunbury Region Scheme. The subject site is not located within an ecological linkage which can be attributed to the lack of remnant vegetation.

4.6.4 Environmentally Sensitive Areas

Section 51B of the EP Act allows the Minister to declare an Environmentally Sensitive Area (ESA). Once declared, the exemptions to clear native vegetation under the regulations do not apply in these areas. TECs, areas within 50 m of any Declared Rare Flora and defined wetland areas constitute ESAs. However, a number of other areas of environmental significance are also listed. Current declared ESAs are listed in the *Environmental Protection (Environmentally Sensitive Areas) Notice 2005*.

An ESA marginally intersects the north-western extent of the subject site, which is associated with the CC wetland (refer to **Figure 4**). Under the Structure Plan this area is reserved as ROS and will be preserved for conservation purposes.

4.7 Fauna

4.7.1 Fauna of Conservation Significance

A search of the DBCA Threatened Fauna database was undertaken to establish whether species declared as 'Rare or likely to become extinct' (Schedule 1), 'Birds protected under an international agreement' (Schedule 3) and 'Other Specially protected fauna' (Schedule 4) as listed under the WC Act have been recorded in proximity to the subject site. One species each listed as Schedule one, Priority one and Priority four were recorded within a 1km radius of the subject site. (refer to **Table 3**).

The EPBC Act Protected Matters Search Tool also identified several threatened and migratory species that could potentially occur within or in proximity to the subject site. This included three species classified as Critically Endangered, ten Endangered species, 18 Vulnerable species and 11 Migratory bird species (**Table 3)**.

Table 3. Significant fauna potentially occurring within the subject site as identified by State and Commonwealth database searches.

Species	DPaw Status	EPBC Act Status	Likelihood of Occurrence
Actitis hypoleucos (Common Sandpiper)		Migratory	Unlikely
Anous stolidus (Common Noddy)		Migratory	Unlikely
Anous tenuirostris metanops (Australian Lesser Noddy)		Vulnerable	Unlikely
Apus pacificus (Fork-tailed Swift)		Migratory	Unlikely
Ardenna carneipes (Flesh-footed Shearwater)		Migratory	Unlikely
Botaurus poiciloptilus (Australasian Bittern)		Endangered	Unlikely
Calidris acuminate (Sharp-tailed Sandpiper)		Migratory	Unlikely
Calidris ferruginea (Curlew Sandpiper)		Critically Endangered	Unlikely
Calidris melanotos (Pectoral Sandpiper)		Migratory	Unlikely
Calyptorhynchus banksii subsp. naso (Forest Red-tailed Black-Cockatoo)		Vulnerable	Possible
Calyptorhynchus baudinii (Baudin's Cockatoo)		Endangered	Possible
Calyptorhynchus latirostris (Carnaby's Cockatoo)		Endangered	Possible
Caretta caretta (Loggerhead Turtle)		Endangered	Unlikely
Chelonia mydas (Green Turtle)		Vulnerable	Unlikely
Dasyurus geoffroii (Chuditch, Western Quoll)		Vulnerable	Unlikely
Dermochelys coriacea (Leatherback Turtle)		Endangered	Unlikely
Diomedea amsterdamensis (Amsterdam Albatross)		Endangered	Unlikely
Diomedea dabbenena (Tristan Albatross)		Endangered	Unlikely
Diomedea epomophora (Southern Royal Albatross)		Vulnerable	Unlikely
Diomedea exulans (Wandering Albatross)		Vulnerable	Unlikely
Diomedea sanfordi (Northern Royal Albatross)		Endangered	Unlikely
Geotria australis (Pouched Lampray)	P1		Unlikely
Hydromys chrysogaster (Water-rat)	P4		Unlikely

Species	DPaw Status	EPBC Act Status	Likelihood of Occurrence
Macronectes giganteus (Southern Giant-Petrel)		Endangered	Unlikely
Macronectes halli (Northern Giant Petrel)		Vulnerable	Unlikely
Manta alfredi (Reef Manta Ray)		Migratory	Unlikely
Manta birostris (Manta Ray)		Migratory	Unlikely
Motacilla cinera (Grey Wagtail)		Migratory	Unlikely
Nannatherina balstoni (Baltson's Pygmy Perch)		Vulnerable	Unlikely
Natator depressus (Flatback Turtle)		Vulnerable	Unlikely
Neophoca cinera (Australian Sea-Lion)		Vulnerable	Unlikely
Numenius madagascariensis (Eastern Curlew)		Critically Endangered	Unlikely
Pachyptila turtur subantarctica (Fairy Prion (southern))		Vulnerable	Unlikely
Pandion haliaetus i		Migratory	Unlikely
Pseudocheirus occidentalis (Western Ringtail Possum)	S1	Critically Endangered	Possible
Thalassarche cauta (Tasmanian Shy Albatross)		Vulnerable	Unlikely
Thalassarche cauta cauta (Shy Albatross)		Vulnerable	Unlikely
Thalassarche cauta steadi (White-capped Albatross)		Vulnerable	Unlikely
Thalassarche impavida (Campbell Albatross)		Vulnerable	Unlikely
Thalassarche melanophris (Black-browed Albatross)		Vulnerable	Unlikely
Thalassarche steadi (White-capped Albatross)		Vulnerable	Unlikely
Tringa nebularia (Common Greenshank)		Migratory	Unlikely
Westralunio carteri (Carter's Freshwater Mussel)		Vulnerable	Unlikely

In order to determine the ecological values of the subject site, Harewood undertook a targeted fauna and habitat assessment in September 2018 (refer to **Appendix B**).

Wetland Habitat

Of the abovementioned conservation significant species (excluding black cockatoos and Western Ringtail Possums), many have preferred habitat types associated with the Collie River and foreshore area. Accordingly, a Fauna Habitat Assessment (Harewood 2018) was undertaken to determine the quality and composition of wetland habitat within the subject site.

An examination of the CC wetland area mapped within the subject site revealed it to be comprised of a section of the open/low woodland of flooded gum (*Eucalyptus rudis*), paperback (*Melaleuca rhaphiophylla*) and grassland habitat unit which is 'Completely Degraded' and unlikely to fulfil the criteria of a CC wetland.

The vegetation present is comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduced pasture grasses. The area is currently open to livestock grazing and there is unlikely to be any recruitment of new trees and it can therefore be expected that its quality will further deteriorate over time. The fauna habitat values of the mapped wetland area within the subject site can be considered to be very low. The subject site is not expected to support any wetland species of conservation significance (Harewood 2018).

Black Cockatoos

The black cockatoo (including Baudin's black cockatoo *Calyptorhynchus baudinii*, Carnaby's black cockatoo *Calyptorhynchus latirostris* and the forest red-tailed black cockatoo *Calyptorhynchus banksii naso*) breeding habitat assessment involved the identification of all suitable breeding tree species, including marri, jarrah, flooded gum and any other endemic Corymbia/Eucalyptus species within the subject site, that had a diameter at breast height (DBH) of equal to or over 50 cm (Harewood 2018). The number and size of any hollows present and their suitability for black cockatoos was then recorded. Peppermints, banksia, sheoak and melaleuca tree species were not assessed as they typically do not develop hollows that are used by black cockatoos.

The assessment identified 112 trees within the subject site with a DBH of equal to or over 50 cm. Hollows or possible hollows of some type were identified in 21 of these trees. An updated black cockatoo habitat tree review (Harewood 2022) was undertaken whereby only 13 trees with hollows were identified. Utilising a drone, these hollows were viewed to determine their characteristics. None of the hollows within these trees were considered suitable for black cockatoo breeding purposes given their size and shape (Harewood 2022).

Trees that are known to be or are potentially used as a direct food source (e.g. seeds, flowers, nectar, bark or grubs) by one or more of the species of black cockatoo were recorded within the subject site and include the following:

- Flooded Gum – *Eucalyptus rudis*;
- Marri – *Corymbia calophylla*;
- Jarrah – *Eucalyptus marginata*; and
- Peppermint - *Agonis flexuosa*.

Species such as flooded gum and peppermint while foraged upon on occasions are only likely to contribute a small proportion to any one bird's diet relative to more favoured species such as marri and therefore areas of these species are not generally regarded as representing quality foraging habitat. The only actual evidence of foraging left by black cockatoos was in the form of chewed marri fruits in the central section of the subject site. This evidence was attributed to either the Forest red-tailed black cockatoo or the Baudin's cockatoo. The extent of what would be regarded as quality black cockatoo foraging habitat within the subject site is very small, being comprised of approximately 0.2 ha of marri forest supported to a small degree by a limited number of scattered marri and jarrah trees. Therefore, black cockatoo species are very unlikely to rely on the subject site for its persistence and development within this area is not likely to be considered significant (Harewood 2018).

No evidence of black cockatoos roosting within trees located inside the subject site was observed during the fauna assessment (Harewood 2018).

Western Ringtail Possum (WRP) Assessment

During the fauna assessment, no evidence of WRP being present or utilising the subject site was found during the day or night surveys (Harewood 2018).

The vegetation in the northern portion of the subject site has been mapped by Shedley *et. al*. 2014, as being High Quality habitat suitability (Category Class B) for WRP. However, the low plant species diversity and lack of favoured foraging species present would indicate that the area provides very low quality habitat for WRPs, at best. While WRPs may occur occasionally as transients they would not permanently reside in this vegetation type (Harewood 2018).

The area of remnant vegetation consisting of low woodlands of peppermint adjacent to a small area of marri forest in the centre of the subject site has been mapped as being Medium and High Quality WRP habitat, respectively.

However, the value of this area as WRP habitat is greatly diminished by its small size and isolated nature, with the closest other continuous vegetation being over 300 m away. The absence of WRP observations in these areas during the fauna assessment suggests that the species cannot persist in this remnant or that they have not been able to populate it from other areas due to the distance of separation (Harewood 2018).

5 POTENTIAL IMPACTS AND MANAGEMENT

During the process of undertaking this investigation, a range of specific environmental issues were explored in relation to the subject site and the proposed development. These issues arise from the proposed development, the existing environment of the subject site, its surrounds and the prevailing state and federal environment policy and legislation. The implications associated with the issues in the context of the intended development of the subject site are discussed in this Section.

5.1 Acid Sulfate Soils

The ASS objectives as prescribed by the EPA are to:

- Maintain the integrity, ecological function and environmental values of the soil and landform.
- Ensure that emissions do not adversely affect environmental values or the health, welfare and amenity of people and land uses by meeting statutory requirements and acceptable standards.
- Ensure that rehabilitation achieves an acceptable standard compatible with the intended land use, and consistent with appropriate criteria.

The DWER has published a number of guidelines relating to the identification, reporting and management of contaminated sites and ASS in WA, including the Contaminated Site Management Series report and *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* (DWER 2015).

5.1.1 Potential Impacts

According to existing DWER mapping, the risk of ASS occurring within 3 m of the surface is moderate to low.

In an undisturbed state below the water table, these soils remain benign and non-acidic. However, if these soils are exposed to the atmosphere through drainage, excavation or dewatering, the sulfides may react with oxygen and form sulfuric acid.

While identification of possible ASS hotspots is important, the occurrence of ASS is rarely a 'fatal flaw' issue and in most circumstances can be appropriately addressed at the subdivision/development stages through design or management mechanisms. As a result, if required, detailed ASS investigations would not be necessary until detailed engineering design drawings have been prepared for the subject site.

5.1.2 Environmental Management and Mitigation

It is expected that any deep excavations within the subject site requiring dewatering, such as installing deep sewerage, may trigger the need for a detailed ASS investigation and management plan. Any such investigation is best done after the location and depths of deep excavations are determined, in order to reduce the field work required. This is not expected to be a constraint to the proposed development of the subject site, but may result in a slightly extended approval programme for site works and a relatively minor increase in investigation and reporting fees.

A DWER guideline compliant ASS and Dewatering Management Plan will, if required, then be developed and implemented to manage:

- All proposed dewatering proposed in association with residential development (in accordance with subdivision and servicing layout); and
- Any excavation in actual or potential ASS areas.

The excavation of ASS and dewatering for the project will be managed in accordance with DWER guidelines to result in no adverse impacts to the environment.

5.2 Water Management

The EPA water management objectives include:

- Maintain the quantity of water (surface and ground) so that existing and potential environmental values are protected.
- Ensure that the quality of water emissions (surface and ground) do not adversely affect environmental values or the health, welfare and amenity of people and land uses, and meets statutory requirements and acceptable standards.

5.2.1 Potential Impacts

Development of the subject site is associated with the following potential impacts:

- Groundwater and surface water at the subject site flows west towards the Collie River, which is an environmentally sensitive receptor. Impacts to groundwater and/or surface water quality on site may also impact sensitive receptors downstream.
- The use of subsoil drainage to control pre-development groundwater levels may impact the CC wetland adjacent to the subject site.

5.2.2 Environmental Management and Mitigation

A LWMS has been prepared to support the Structure Plan associated with the subject site. The LWMS details the best management practices approach to water management that will be undertaken for this development, in accordance with *Better Urban Water Management* (WAPC 2008). The LWMS will achieve integrated water management through the following design objectives:

- Effectively manage the risk to human life, property damage and environmental degradation from water contamination, flooding and waterlogging.
- Maintain and if possible, improve water quality (surface and groundwater) within the development in relation to pre-development water quality.
- Reduce potable water consumption within both public and private spaces using practical and cost-effective measures.
- Promote infiltration of surface water on site to minimise the risk of further water quality degradation in the Leschenault Estuary Catchment.
- Implement best management practices in regard to stormwater management, including structural and non-structural controls.
- Incorporate where possible, low maintenance, cost-effective landscaping and stormwater treatment systems.

It is expected that development of the subject site will have a positive impact on groundwater quality through Best Management Practices and the treatment of stormwater prior to infiltration as discussed below:

- The stormwater structural controls will improve infiltrating stormwater water quality through reducing water velocities, biological uptake and increasing infiltration areas.
- Water quality will be improved through minimising and controlling the levels of fertilisers and pesticides applied to the site through appropriate plant selection and operation and maintenance.
- The management of stormwater and nutrients will be in accordance with the Leschenault Estuary WQIP and Better Urban Water Management practices.

Based on the investigations undertaken and the management measures proposed, it is not expected that any changes to groundwater flows, levels or quality will have an adverse impact on the function and environmental values of the subject site.

5.3 Wetlands

The EPA wetland objective is to maintain and where possible enhance the integrity, ecological function and environmental values of wetlands.

5.3.1 Potential Impacts

A portion of the subject site is mapped as containing a MU wetland. MU wetlands have few remaining functions, values and typically their attributes have been considerably degraded such that they provide limited ecological value. On this basis, MU wetlands do not usually preclude development. The impacts to the MU wetlands within the subject site are minimal as these wetlands are in a "Completely Degraded" condition and are considered suitable for development.

A site-specific study (Bioscience 2012) has determined that the CC wetland located adjacent to the subject site does not extend into the subject site. Nonetheless, the area (incorrectly) mapped as a CC wetland within the subject site along with a 50 m buffer, will be excluded from development and retained within ROS. Accordingly, there will be no direct impacts to the CC wetland as result of the proposed development. Indirect potential impacts as a result of the proposed development may include:

- ASS impacts resulting from earthworks or dewatering.
- Changes to hydrology through changes in surface water flows and subsoil drains.

5.3.2 Environmental Management and Mitigation

It is envisaged that by maintaining pre-development surface and groundwater flows to the buffer area, the vegetation will be provided with similar water needs after development, whilst experiencing improved water quality through the use of constructed vegetated bioretention areas (swales) and other suitably designed and best practice water sensitive urban design techniques.

It is important to acknowledge the current surface water flow through the CC wetland, which includes the nutrient run-off from the surrounding paddocks, is not treated. The proposed water management strategy seeks to improve significantly this outcome through incorporating best stormwater quality management practice consistent with Better Urban Water Management principles.

It is anticipated that the above management mechanisms will improve the current condition of the wetland as well as providing suitable waterbird habitat.

5.4 Vegetation and Flora

The EPA flora and vegetation objective is to maintain the abundance, diversity, geographic distribution and productivity of flora at the species and ecosystem levels through the avoidance or management of adverse impacts and through improvement in knowledge.

5.4.1 Potential Impacts

As a result of historical and current anthropogenic disturbances, the vegetation within the subject site is in a 'Degraded' to 'Completely Degraded' condition. It is very unlikely to contain any flora or vegetation of conservation significance and it does not provide any ecological connectivity to surrounding environmental features (i.e. the Collie River).

Consequently, it is anticipated that the proposed development will have very little impact on native vegetation.

5.4.2 Environmental Management and Mitigation

Within the development footprint, there are no vegetation or flora values within the subject site that preclude development or require protection. Accordingly, no specific management measures pertaining to remnant vegetation are deemed necessary.

Any potential impacts will be reduced through the following:

- Retention and replanting of areas ROS in accordance with the Shire of Dardanup's objectives for this area.
- Road reserves will be landscaped, which will involve planting species native to the local area.

5.5 Fauna

The EPA fauna objective is to maintain the abundance, diversity, geographic distribution and productivity of native fauna at the species and ecosystem levels through the avoidance or management of adverse impacts and improvement in knowledge.

5.5.1 Potential Impacts

No evidence of WRPs being present or utilising the subject site has been identified (Harewood 2018). This is likely to be attributed to the composition of the majority of vegetation onsite (flooded gum and paperbark), which represents low quality habitat for WRPs. While WRPs may occur occasionally as transients they would not permanently reside in this vegetation type given the low plant species diversity and a complete lack of some of their favoured foraging species (e.g. peppermint, sheoak).

The value of the peppermint and marri dominated vegetation to WRPs is greatly diminished by the fact that it is a relatively small area (<2 ha) and is isolated, being over 300 metres from the closest other continuous area of vegetation. The absence of WRP observations in this area also suggests that the species cannot persist in this remnant or that they have not been able to populate it from other areas due to the distance of separation (Harewood 2018). Accordingly, there are not expected to be any impacts to WRPs as a result of the proposed development.

The peppermint and marri dominated vegetation unit represents black cockatoo habitat, but the degree of use appears to be low with no breeding or roosting activity detected and only a very limited amount (<2ha) of foraging habitat being present.

Based on the results of the assessment and the scale of the proposed development, likely impacts on WRPs and black cockatoos and/or their preferred habitat are limited (Harewood 2018 and Harewood 2022).

In consideration of their 'Completely Degraded' condition, the fauna habitat values of the CC wetland and MU wetland mapped within the subject site are very low. Accordingly, there are not expected to be any impacts to wetland fauna of conservation significance as a result of the proposed development

5.5.2 Environmental Management and Mitigation

The following management measures have been developed and incorporated to reduce the likelihood of impacts to native fauna:

- Fauna corridors will be created through the revegetation of the ROS.
- Utilise a licensed fauna spotter for all vegetation clearing.

6 CONSULTATION

The proposed Structure Plan was advertised in accordance with the *Planning and Development (Local Planning Schemes) Regulations 2015*. In response to the advertising, 12 submissions (including five public submissions) were received. In the context of environmental issues, the DBCA provided a set of comments which are addressed below in **Table 4**.

Table 4. Response to DBCA's Comments

DBCA	Shire	Accendo Response
The northern portion of Lot 9004 contains native vegetation associated with the adjacent Conservation Category Wetlands (CCW) on the Collie River floodplain.	Noted.	An examination of this specific area during the fauna survey (Harewood 2018) revealed it to be comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduced pasture grasses. It is considered highly degraded and unlikely to fulfil the criteria of a CC wetland. The area is currently open to livestock grazing and there is unlikely to be any recruitment of new trees and it can therefore be expected that its quality will further deteriorate over time. The fauna habitat values of this area can be considered to be very low. It should be noted that other sections of this same vegetation unit located within the subject site, is in identical condition and has been mapped as a MU wetland which is consistent with its highly degraded condition (Harewood 2018). Based on the site-specific survey results (Harewood 2018 and Bioscience 2012), it is considered that the CC wetland does not actually occur within the subject site.
Shelley et at, 2014 mapped the northern Lot 9004 vegetation as being High Quality habitat suitability (Category Class B) for western ringtail possums (WRP) High Quality habitat suitability is important in maintaining the integrity of WRP habitat, which is required to increase the reproductive output of the species and to counter declining populations and losses due to habitat loss and predation.	Noted.	The open woodland of flooded gum and paperback present in the north of the subject site has been mapped by Shelley *et al.* (2014) as being within the "high" habitat suitability class for WRPs. Observations made during the field survey (Harewood 2018) suggest that this area should in fact be rated as having a "very low" habitat suitability (i.e. able to support <0.5 WRPs per ha) at best. Apart from the absence of any WRP observations in this area, this conclusion is justified by the fact the vegetation is comprised of only flooded gum and paperbark, a combination which represents low quality habitat for WRPs. While WRPs may occur occasionally as transients they would not permanently reside in this vegetation type given the low plant species diversity and a complete lack of some of their favoured foraging species (e.g. peppermint, sheoak) (Harewood 2018).

WRP (Schedule 1) is listed as critically endangered species under the Commonwealth of Australia's Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) and Western Australia's Wildlife Conservation Act 1950.	Noted.	Noted. A targeted survey for WRPs was undertaken within the subject site. This included a daytime survey and two-night time survey. No WRPs were identified and no evidence of WRPs utilising the subject site was identified. An assessment of the fauna habitat types within the subject site identified that the habitat quality for WRPs within the development footprint ranged from low to very low. In consideration of the above, there are not anticipated to be any impacts to WRP as a result of the proposed development.
It appears that 2 to 3ha of this high quality WRP habitat will be cleared if the current structure plan is implemented. These areas are also very close, if not overlapping, the environmentally sensitive area associated with the CCW.	The map contained in (Appendix ORD:12.2C) identifies the Conservation Category Wetland (CCW) referred to which is outside of the PESP area and not impacted by the proposal. The vegetated area in the northern part of the site that will be subject to clearing is estimated by staff to be approximately 1.7ha.	Based on the targeted WRP survey, vegetation subject to clearing represents low to very low-quality habitat for WRPs. Furthermore, no evidence of WRPs utilising any of the vegetation within the subject site was identified. In the expert opinion of a highly qualified zoologist, there will be negligible impacts to WRP as a result of the proposed development (Harewood 2018).
The central portion of the structure plan shows that about 1ha of mapped medium quality WRP habitat is to be cleared and the rest retained in Public Open Space (POS).	Noted	The value of the peppermint and marri dominated vegetation to WRPs is greatly diminished by the fact that it encompasses a small area (<2 ha) and is isolated, being over 300m from the closest other continuous area of vegetation. The absence of WRPs in this area also suggests that the species cannot persist in this remnant or that they have not been able to populate it from other areas due to the distance of separation (Harewood 2018). As discussed above, the impacts to WRPs as a result of the proposed development are considered negligible (Harewood 2018).

While the application provided some vegetation classification information, it did not include any flora or fauna survey information.	The structure plan report (Page 10) states that the PESP area has previously been assessed by the EPA during the preparation of the Greater Bunbury Region Scheme, and subsequent amendments to the Local Planning Scheme when the land was re-zoned to 'Development' zone (Amendment 187). It also states that the site has previously been subject to an approved subdivision design that proposed to clear the remnant vegetation, however officers are unclear as to what this is referring to as the most recent subdivision was refused. Notwithstanding, it is recommended that Council requests a modification to the Structure Plan to include the following notation: "At subdivision the applicant/ landowner shall be required to undertake a flora and fauna study to identify the presence of threatened flora and fauna within the site being regarded as being of biodiversity and conservation value."	A Fauna and Habitat Assessment of the subject site was undertaken by a qualified zoologist in September 2018 (Harewood 2018). Based on the results of the assessment it was concluded that there exist no major constraints relating to fauna, and in particular fauna of conservation significance with respect to the proposed development. The Fauna and Habitat Assessment identified the vegetation types within the subject site. Given the historical and current land use (livestock grazing), all the vegetation present can be regarded as being in a Degraded or Completely Degraded condition. Most of the vegetation present is comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduced pasture grasses. Accordingly, it is very unlikely that any flora or vegetation of conservation significance would occur within the subject site. Therefore, undertaking a flora and vegetation survey will provide no further environmental value.

DBCA advises that the proposed clearing should be referred to the Department of Water and Environmental Regulation specifically for consideration under the Environmental Protection Act, Native, Vegetation Clearing regulations.	Council's consideration of the proposal does not remove the responsibility of the landowner to comply with the Environment Protection Act 1986 regarding the clearing of vegetation. The Structure Plan was referred to DWER for comment as required.	A clearing exemption pursuant Schedule 6 of the *Environmental Protection Act 1986* applies to the application area associated with a WAPC subdivision approval.
The proposed structure plan depicts an area of Local Open Space which retains some bushland and a small strip of Regional Open Space (ROS) along the northern and western Lot 9004 boundary. However, it would be desirable to also retain the northern Lot 9004 treed vegetation, to retain the High Quality WRP habitat within Public Open Space. Amongst these areas, the highest priority for protection would be the lines of mature trees immediately inside the northern structure plan boundary, just outside the proposed ROS, associated with the GBRS floodway and flood fringe boundary. This will also retain valuable established trees for the CCW buffer.	It is recommended that Council requests a modification to the Structure Plan to include the following note: "At subdivision the applicant/ landowner shall be required to undertake a flora and fauna study to identify the presence of threatened flora and fauna within the site being regarded as being of biodiversity and conservation value."	This area has been assessed and was determined to be in a Completely Degraded condition. It is predominately comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduced pasture grasses. The area is currently open to livestock grazing and there is unlikely to be any recruitment of new trees and it can therefore be expected that its quality will further deteriorate over time. The fauna habitat values of this area of the CC wetland can be considered to be very low. It should be noted that other sections of this same vegetation unit located within the subject site, is in identical condition and has been mapped as a MU wetland which is consistent with its highly degraded condition (Harewood 2018).
The proponent should consider referral requirements to the Federal Department of the Environment and Energy under the EPBC Act in terms of significant impacts on WRP habitat.	Council's consideration of the proposal does not remove the responsibility of the landowner to comply with the EPBC Act regarding the clearing of vegetation.	Based on a targeted WRP assessment, it was determined that impacts to WRP from the proposed development will be negligible (Harewood 2018). The subject site does not appear to support any WRPs and provides low to very low habitat quality for the species. Accordingly, referral to the DotEE pursuant to the EPBC Act is not considered necessary.

DBCA supports the use of a fauna spotter during clearing and recommends that the fauna spotter is used during all clearing works associated with the development footprint. A wildlife protection management plan could be prepared and implemented to manage threatened species during approved clearing works.	Noted. The flora and fauna study will identify the presence of any native animals within the areas identified for clearing. If determined appropriate DWER may place conditions regarding the requirement for a fauna spotter and/or a wildlife protection management plan on the clearing permit.	Noted.

7 SUMMARY

Accendo was engaged by the proponent to prepare an environmental assessment to support the preparation of a Structure Plan for the subject site. This has included a site-specific fauna assessment to identify and assess the environmental attributes and values within the subject site. The environmental attributes and values identified within the site have been outlined in **Section 4** and include:

- Surface elevations range from 10.50 m AHD in the south-eastern corner to 1.30 m AHD along the northern boundary within the Collie River floodplain.
- The subject site has been classified as having a 'moderate to low risk' of ASS occurring within three metres of the natural soil surface.
- The subject area sits within the Leschenault Estuary Catchment and as such is covered by the Leschenault Estuary WQIP.
- The majority of vegetation has been cleared as a result of the historical and current land use (livestock grazing).
- The subject site is mapped as containing a portion of a CC wetland. As identified within the *Wetland Buffer Determination* study (Bioscience 2012) for the subject site, this mapping appears to be incorrect as a site analysis revealed that the wetland function area associated with the CC wetland does not extend into the subject site. Furthermore, an examination of this specific area during the fauna assessment (Harewood 2018) revealed it to be comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduced pasture grasses, which is not consistent with the definition of a CC wetland.
- As a result of the fauna assessment it was determined that the fauna habitat values at the subject site have been severely compromised by the removal of most of the original native vegetation and the degradation of the main remnant patches.
- There is no evidence of WRPs utilising vegetation with the subject site as habitat and overall, habitat quality in areas to be developed are low/very low.
- Some areas of vegetation represent black cockatoo habitat, but the degree of use appears to be low with no breeding or roosting activity detected and only a very limited amount of foraging habitat being present.
- There exist no major constraints relating to fauna, and in particular fauna of conservation significance with respect to the proposed development.

In consideration of the abovementioned key environmental features, the following management measures have been proposed to minimise potential impacts associated with the subdivision of the subject site:

- Prepare and implement an ASS and Dewatering Management Plan if necessary.
- Implement the approved LWMS during subdivision works.

Based on this assessment, Accendo considers that there are no fatal flaws or key environmental values that cannot be accommodated to enable development of the subject site for its intended purpose.

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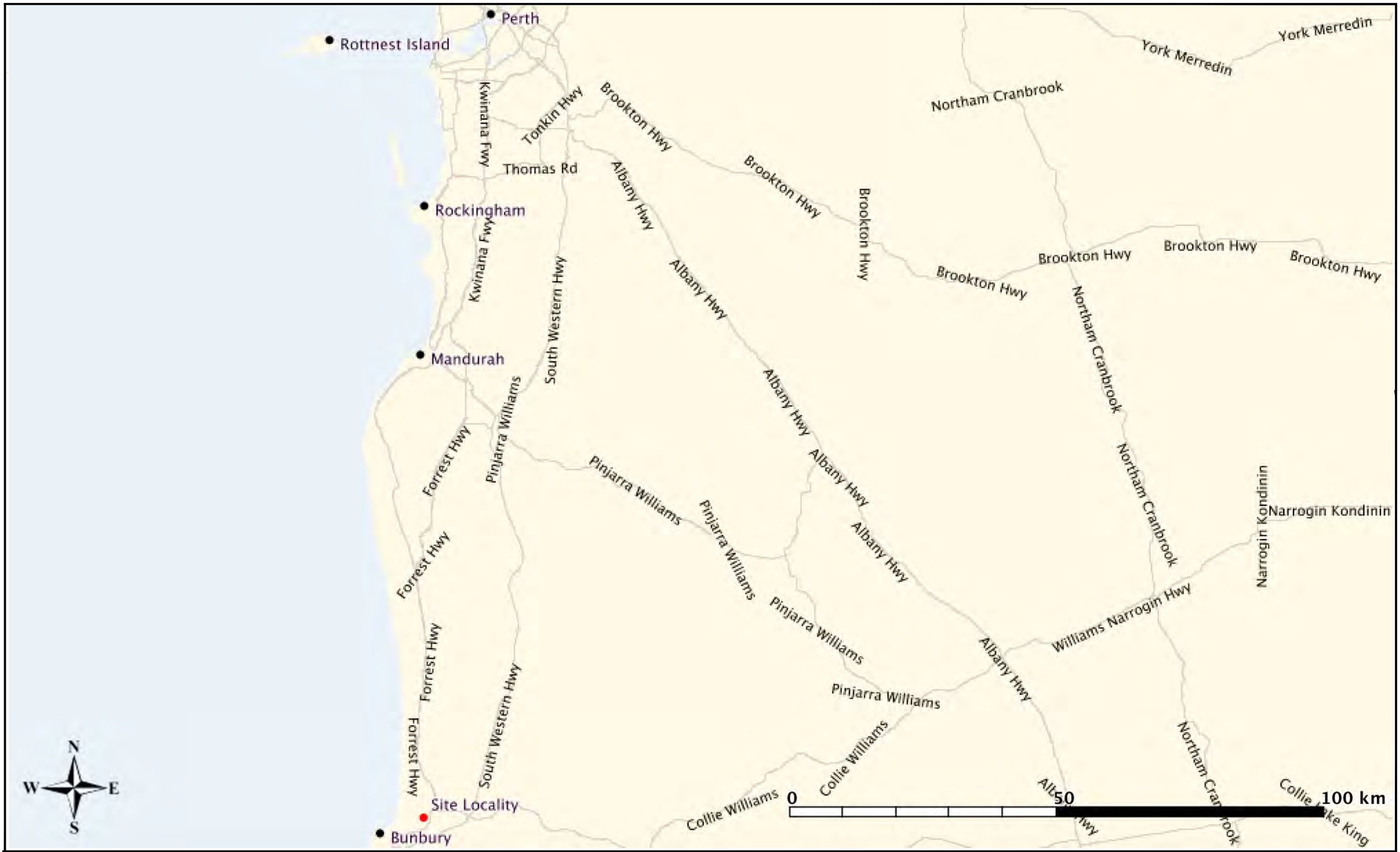
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FIGURES



PROJECT **Lots 9004 & 9503 Eaton Drive, Eaton (Parkridge Estate)**

DRAWING TITLE FIGURE **1** -**Site Locality**

CLIENT **Parkridge Group Pty Ltd**

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Project Number	Drawing Number	Revision
	FIG **1**	A

Designed	KMT	Checked	Date 19.11.2018
Drawn	PN	Approved	Sheet 1 of 1
Local Authority		Shire of Dardanup	



PROJECT **Lots 9004 & 9503 Eaton Drive, Eaton (Parkridge Estate)**

DRAWING TITLE FIGURE **2** -**Extent of Site**

CLIENT **Parkridge Group Pty Ltd**

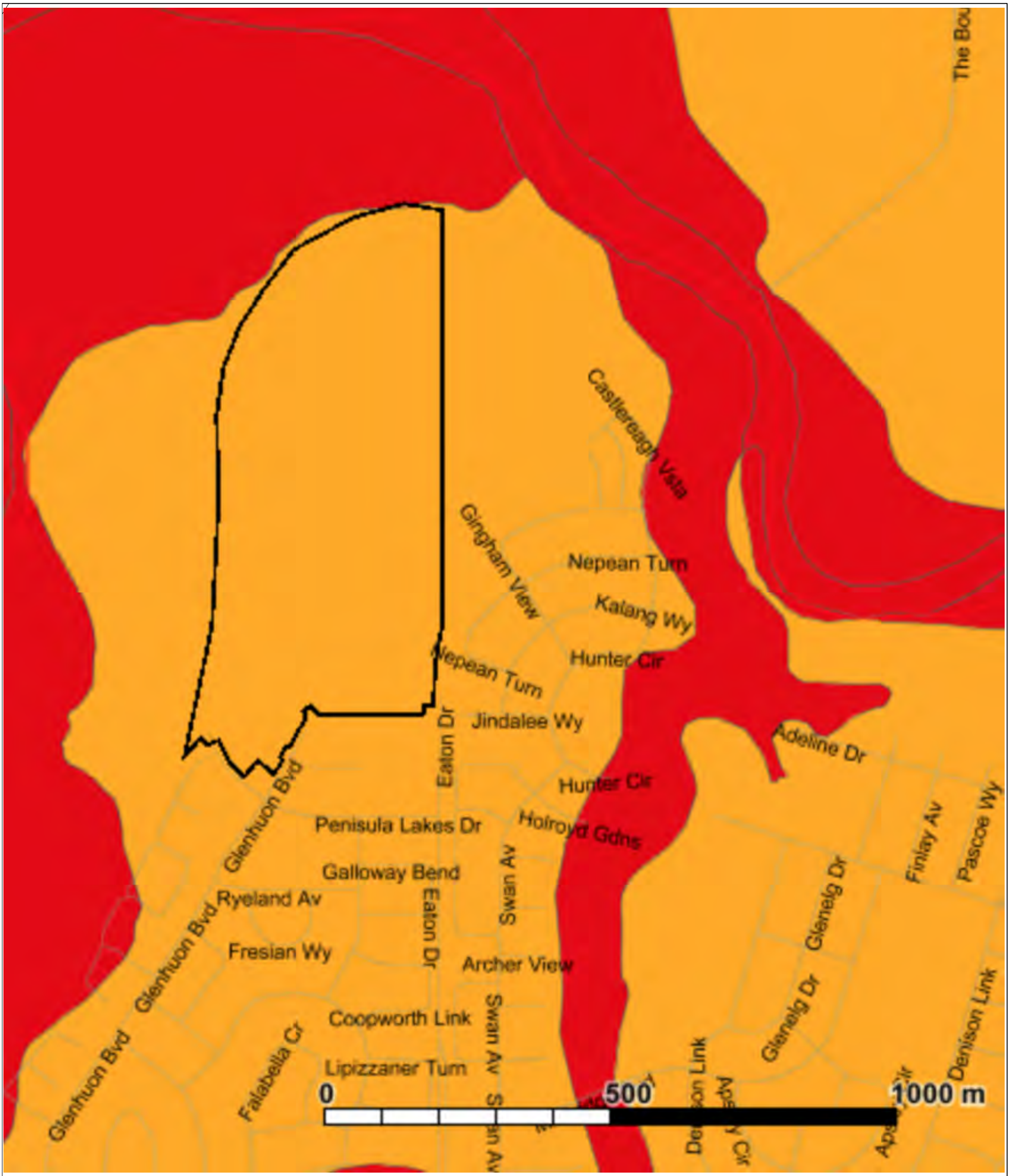
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	FIG **2**	A

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Local Authority		Shire of Dardanup	



Legend

- High to moderate risk of ASS occurring within 3m of natural soil surface. (or deeper)
- Moderate to low risk of ASS occurring within 3m of natural soil surface.

PROJECT Lot **9004 & 9503 Eaton Drive, Eaton (Parkridge Estate)**

DRAWING TITLE FIGURE **3 - Acid Sulphate Soil Mapping**

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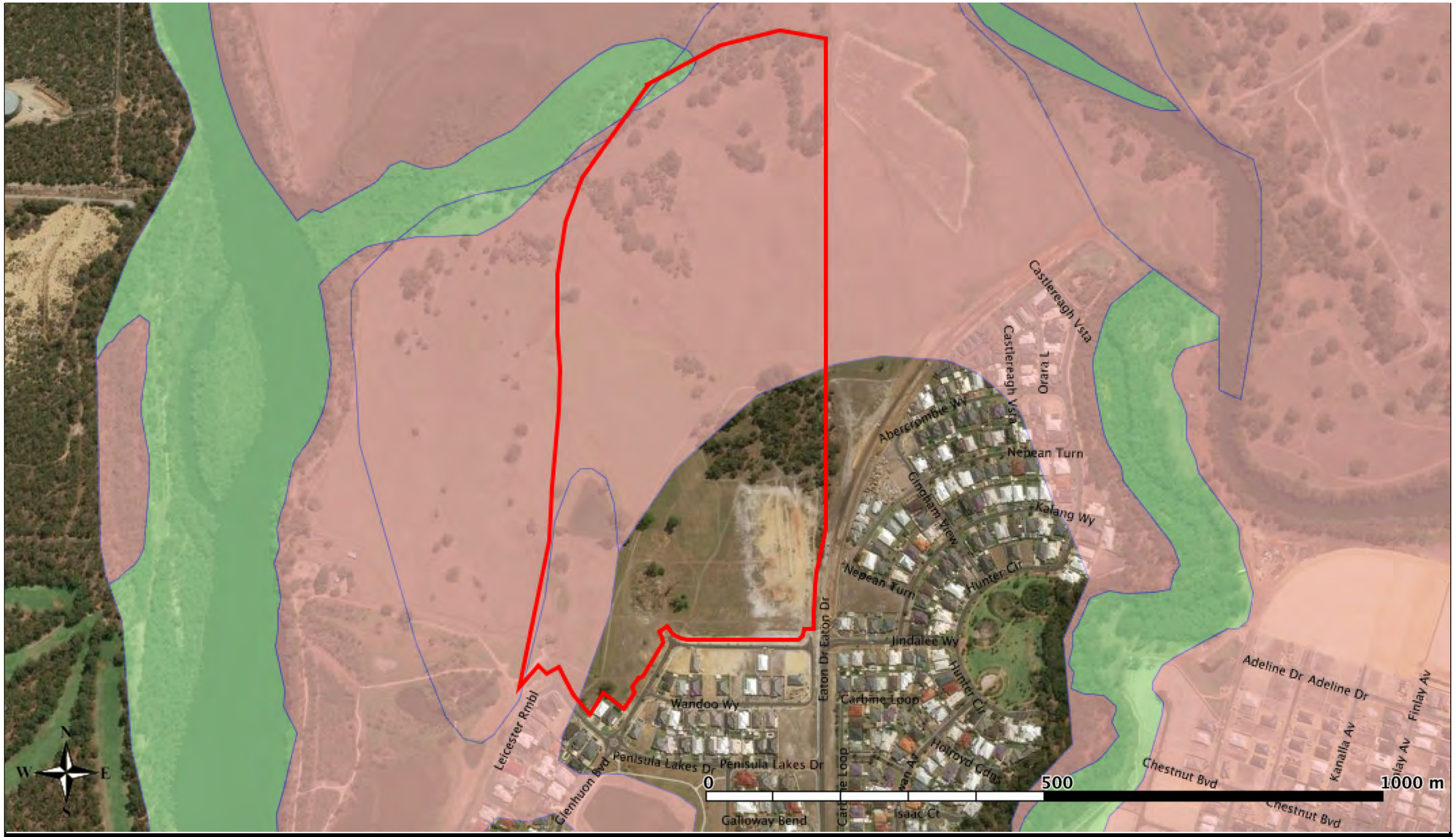
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Project Number	Drawing Number	Revision
	FIG **3**	**A**

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Drawn	PN	Approved	Sheet 1 of 1

Local Authority Shire of Dardanup



PROJECT Lot **9004 & 9503 Eaton Drive, Eaton (Parkridge Estate)**

DRAWING TITLE FIGURE **4 -Mapped Wetlands**

CLIENT **Parkridge Group Pty Ltd**

Legend

- Lot Boundary
- Conservation Category Wetland
- Multiple Use Wetland

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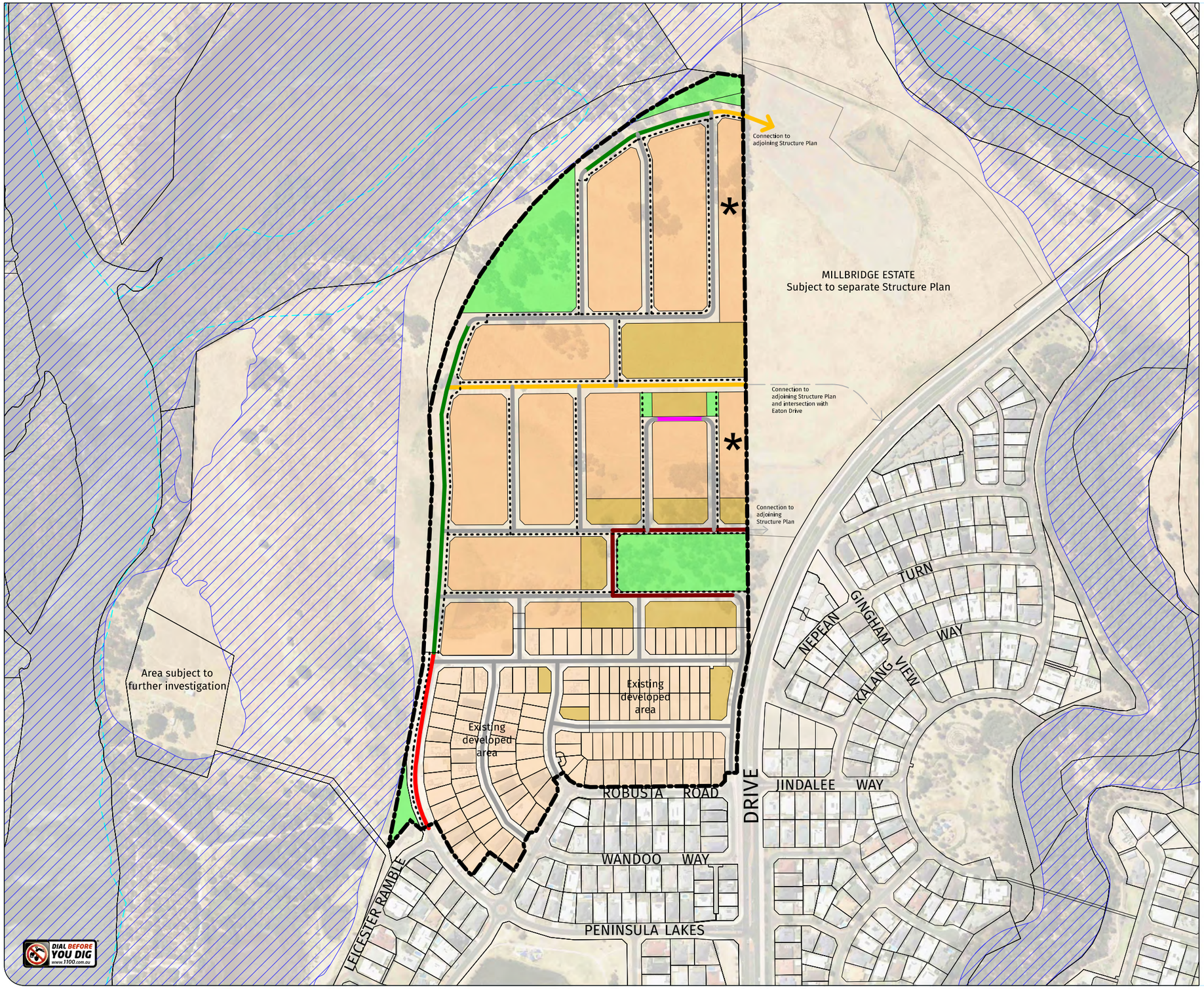
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Project Number	Drawing Number	Revision
	FIG **4**	A

Designed	KMT	Checked	Date 19.11.2018
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Local Authority		Shire of Dardanup	

APPENDIX A. STRUCTURE PLAN



LEGEND

- EXISTING CADASTRE
- STRUCTURE PLAN MODIFICATION BOUNDARY
- PROPOSED CADASTRE
- RESIDENTIAL: R40
- RESIDENTIAL: R30
- RESIDENTIAL: R20
- PUBLIC OPEN SPACE
- MANAGED LOW FUEL ZONE
- * RESIDENTIAL DENSITY TO BE CONSISTENT WITH ADJOINING STRUCTURE PLAN
- PATH NETWORK
- PATH NETWORK & FIRE SERVICE ACCESS ROUTE
- FLOODWAY
- CONSERVATION CATEGORY WETLAND

LOCAL ROADS

- 25.6m Reserve (includes Drainage)
- 21m Reserve
- 18m Reserve
- 15m Reserve
- 12.5m Reserve
- 9m Reserve

Figure 1 - Structure Plan Map

STRUCTURE PLAN MODIFICATION

Robusta Road, Eaton
PARKRIDGE

Plan No.	22294-07
Date	21/08/25
Drawn	NP
Checked	KS
Revision	N
Scale	1:5000@A3

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0 50m 100m 150m

NOTE: This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey

Harley Dykstra
PLANNING & SURVEY SOLUTIONS

APPENDIX B. FAUNA ASSESSMENTS (HAREWOOD)

Fauna and Habitat Assessment



Lot 9004 and Lot 9503 Eaton Drive Eaton

November 2018

V2

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SUMMARY

This report details the results of a targeted fauna and habitat assessment over Lot 9004 and Lot 9503 Eaton Drive, Eaton (subject site). Lot 9004 and Lot 9503 have a combined area of about 34 hectares, most of which is cleared farmland used for or previously used for livestock grazing (Figure 1 and 2)

The scope of works was to carry out a habitat assessment including that of a Conservation Category Wetland, part of which extends into the subject site. A targeted survey for western ringtail possums and black cockatoo habitat was also completed.

The small areas (<4.4 ha) of remnant native vegetation onsite are mainly comprised of a flooded gum/paperbark woodland in the low lying arears in the north of the property and a grove of peppermint low woodland on higher ground in the south east (Figure 3). The balance of the site is totally cleared with just a small number of scattered trees of various types (mainly flooded gum and paperbark). All the vegetation present can be regarded as being in a degraded or highly degraded condition.

Overall fauna habitat values at the subject site have been severely compromised by the removal of most of the original native vegetation and the degradation of the main remnant patches. Most areas lack any natural attributes and are now only utilised by generally common and widespread fauna species with non-specific requirements which allow them to persist in disturbed/highly disturbed habitats. As a consequence, the fauna biodiversity of the subject site is well below levels present prior to historical and ongoing disturbances taking place.

The assessment of part of a Conservation Category Wetland (Figure 4) which extends into the subject site suggests that it should be considered for re-classification as a Multiple Use Wetland given it is highly degraded and of an identical character to adjoining areas that are mapped as such.

No evidence of western ringtail possum being present or utilising the subject site was found during the day or night surveys. Given the relatively small extent of the remnant vegetation remaining on site (~4.4 ha excluding scattered trees) and the fact that it was relatively easy to survey for evidence of the species, it is the Authors opinion that at the time of the surveys western ringtail possums were not present within the subject site. The lack of use of the area by this species can be attributed to the low quality habitat present in some areas and the small extent and isolation of other remnant patches.

The habitat tree assessment identified 112 trees within the subject site with a DBH of ≥50cm. Twenty one of these trees were observed to contain hollows or possible hollows of some type with four being assessed at the time to possibly have hollows suitable for black cockatoos to use for nesting (i.e. large enough entrance into a suitably sized and orientated branch/truck). No actual evidence (e.g. chew marks) of any hollows being used by black cockatoos for nesting (currently or previously) was seen. Common brushtail possums were

observed in close proximity to some of these hollow trees during the nocturnal surveys and these animals may be occupying at least some of the potential hollows recorded.

The extent of what would be regarded as quality black cockatoo foraging habitat within the subject site is very small, being comprised of about 0.2 ha of marri forest supported to a small degree by a limited number of scattered marri and jarrah trees.

No existing roosting trees (trees used at night by black cockatoos to rest) were positively identified during the survey.

The results of the assessment suggest that if the proposed development were to be referred to the Department of the Environment and Energy (DotEE) for review under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) that it would be regarded as "not a controlled action" given impacts on listed species or their habitat are not likely to be significant.

It is therefore concluded that there exists no major constraints relating to fauna, and in particular fauna of conservation significance with respect to the proposed development.

It is recommended that a fauna relocation program be implemented prior to and during clearing works to ensure direct impact on fauna (e.g. common brushtail possums) most likely to be encountered, are minimised.

1. INTRODUCTION

This report details the results of a targeted fauna and habitat assessment over Lot 9004 and Lot 9503 Eaton Drive, Eaton (subject site). The subject site is situated about nine kilometres east of Bunbury in the south west of Western Australia and is centred at approximately 33.296748°S and 115.727755°E. Lot 9004 and Lot 9503 have a combined area of about 34 hectares, most of which is cleared farmland used for or previously used for livestock grazing (Figure 1 and 2).

2. SCOPE OF WORKS

The scope of works, as defined by Accendo Australia, was to

- Carry out a wetland habitat assessment of the native vegetation associated with a nearby Conservation Category Wetland;
- Carry out a preliminary survey of western ringtail possums (WRP)(*Pseudocheirus occidentalis*) with the aim of obtaining an estimate of the distribution, abundance and habitat extent of the species within the subject site;
- Carry out a black cockatoo habitat assessment with the aim of determining the status, extent and quality of habitat within the subject site; and
- Prepare a report summarising all results.

Note: For the purposes of this report the term black cockatoo is in reference to Baudin's black cockatoo *Calyptorhynchus baudinii*, Carnaby's black cockatoo *Calyptorhynchus latirostris* and the forest red-tailed black cockatoo *Calyptorhynchus banksii naso*.

3. METHODS

Daytime field survey work at the site was carried out on the 9 and 10 September 2018. The nocturnal WRP surveys were carried out on the 29 and 31 September 2018. All survey work and reporting has been completed by Greg Harewood (Zoologist).

3.1 HABITAT ASSESSMENT

3.1.1 Fauna Habitat Assessment

The vegetation communities, soils and landforms identified during the site reconnaissance survey have been used as the basis for a classification of areas into broad fauna habitat types.

3.1.2 Wetland Habitat Assessment

The northern portion of Lot 9004 contains native vegetation mapped as part of a Conservation Category Wetland (CCW) which extends westwards outside of the subject site. The onsite wetland vegetation making up part of this habitat was examined to determine its quality and composition in relation to the overall CCW classification.

3.2 WESTERN RINGTAIL POSSUM ASSESSMENT

To determine if western ringtail possums were utilising the subject site the following was carried out:

- Daytime survey of the site along closed spaced traverses searching for dreys, obvious tree hollows (and other potential daytime refuge habitat), scats and individual WRPs. The day time survey was carried out using a GPS equipped PDA for guidance and as a data recorder;

- Two night time surveys were undertaken to provide information on the approximate distribution and abundance of WRPs. The nocturnal counts involved the systematic searching of potential WRP habitats within the subject site along close spaced transects, on foot using a head torch. The nocturnal counts were carried out using a GPS equipped PDA for guidance and as a data recorder; and

- An estimation of the amount and quality of WRP habitat present within the subject site based on field observations and available air photography has also been made. This information has been compared to mapping and classifications of habitat suitability provided by Shelley *et al*. (2014).

3.3 BLACK COCKATOO HABITAT ASSESSMENT

The following methods were employed to comply with the defined scope of works and are based on guidelines published by the federal DotEE (Commonwealth of Australia 2012) which states that surveys for Carnaby's, Baudin's and forest red-tailed black cockatoo habitat should:

- be done by a suitably qualified person with experience in vegetation or cockatoo surveys, depending on the type of survey being undertaken;

- maximise the chance of detecting the species' habitat and/or signs of use;

- determine the context of the site within the broader landscape—for example, the amount and quality of habitat nearby and in the local region (for example, within 10 km);

- account for uncertainty and error (false presence and absences); and

- include collation of existing data on known locations of breeding and feeding birds and night roost locations.

Habitat used by black cockatoos have been placed into three categories by the DotE (Commonwealth of Australia 2012) these being:

- Breeding Habitat;
- Foraging Habitat; and
- Night Roosting Habitat.

So as to comply with the requested scope of works and in line with the published guidelines the following was carried out.

3.3.1 Black Cockatoo Breeding Habitat

The black cockatoo breeding habitat assessment involved the identification of all suitable breeding tree species within the subject site that had a diametre at breast height (DBH) of equal to or over 50cm. The DBH of each tree was estimated using a pre-made 50 cm "caliper".

The location of each tree identified as being over the threshold DBH was recorded with a GPS and details on tree species, number and size of hollows (if any) noted. Trees observed to contain hollows (of any size/type) were marked with "H" using spray paint for easy future reference.

Target tree species included marri, jarrah and flooded gum or any other endemic *Corymbia/Eucalyptus* species of a suitable size that was present. Peppermints, *banksia*, sheoak and *melaleuca* tree species (for example) were not assessed as they typically do not develop hollows that are used by black cockatoos.

For the purposes of this study a tree containing a potential cockatoo nest hollow was defined as:

Generally, any tree which is alive or dead that contains one or more visible hollows (cavities within the trunk or branches) or possible hollows considered potentially suitable for occupation by black cockatoos for the purpose of nesting/breeding. Hollows or possible hollows that had an entrance greater than about 10cm in diameter and would allow the entry of a black cockatoo into a suitably orientated and sized branch/trunk, were recorded as "potential nest hollows".

Identified hollows were examined using binoculars for evidence of actual use by black cockatoos (e.g. chewing around hollow entrance, scarring and scratch marks on trunks and branches).

A review of available literature was carried out to determine the location/extent of any known/likely black cockatoo breeding habitat areas in the vicinity of the subject site.

3.3.2 Black Cockatoo Foraging Habitat

The location and nature of black cockatoo foraging evidence (e.g. chewed fruits around the base of trees) observed during the field survey was recorded. The nature and extent of potential foraging habitat present was also documented irrespective of the presence of any actual foraging evidence.

A review of available literature was also carried out to determine the location/extent of any known/likely black cockatoo foraging habitat areas in the vicinity of the subject site.

3.3.3 Black Cockatoo Roosting Habitat

Direct and indirect evidence of black cockatoos roosting within trees was with the subject site was noted if observed (e.g. branch clippings, droppings or moulted feathers). Two dusk surveys were also carried out immediately prior to the nocturnal WRP surveys

A review of available literature was also carried out to determine the location/extent of any known/likely black cockatoo roosting habitat areas in the vicinity of the subject site.

3.4 OPPORTUNISTIC FAUNA OBSERVATIONS

Opportunistic observations of fauna species were made during all field survey work which primarily involved a series of transects across the subject site during the day while searching microhabitats such as logs, rocks, leaf litter and observations of bird species with binoculars. Secondary evidence of a species presence such as tracks, scats, skeletal remains, foraging evidence or calls were also noted if observed/heard.

4. SURVEY CONSTRAINTS

No seasonal sampling has been carried out as part of this fauna assessment. The conclusions presented are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the subject site at the time of the field assessments. It should also be recognised that site conditions can change with time.

During the black cockatoo habitat survey a search for trees containing hollows was completed. It should be noted that identifying hollows suitable for fauna species from ground level has limitations. Generally the full characteristics of any hollow seen are not fully evident (e.g. internal dimensions). It is also difficult to locate all hollows within all trees as some are not observable from ground level.

The location of observations was recorded using a handheld GPS. The accuracy of the GPS cannot be guaranteed above a level of about 5 to 10 metres, though it should be noted that in some circumstance the accuracy can increase or decrease beyond this range.

5. RESULTS

5.1 HABITAT ASSESSMENT

5.1.1 Fauna Habitat Assessment

The subject site is situated on the western margin of the Swan Coastal Plain and mainly overlaps a low-lying section of the Guildford Formation which is characterised by alluvial sandy clays. The higher ground in the south east section of the subject site represents a subdued section of the Bassendean Dune System which consists of a relatively thin layer of leached, grey sands. The general area has largely been cleared of vegetation in the past, primarily for livestock grazing and more recently for residential developments.

The small areas of remnant native vegetation onsite are mainly comprised of a flooded gum/paperbark woodland in the low lying arears in the north of the property and a grove of peppermint low woodland on higher ground in the south east. The balance of the site is totally cleared with just a small number of scattered trees of various types (mainly flooded gum and paperbark). All the vegetation present can be regarded as being in a degraded or highly degraded condition.

Descriptions and examples images of the main fauna habitats/dominant vegetation present within the subject site are provided in Table 1. The location and extent of the identified habitat units is shown in Figure 3.

Table 1: Main Fauna Habitats within the Subject Site

Unit	Fauna Habitat Description	Example Image
1	Cleared paddocks comprised of grassland introduced pasture species with occasional sedges and widely scattered remnant trees (flooded gum (*Eucalyptus rudis),* peppermint *(Agonis flexuosa),* jarrah *(Eucalyptus marginata), marri (*Corymbia calophylla*)* and paperback (*Melaleuca rhaphiophylla*). Area = ~ 29.1 ha (~86%)	

Unit	Fauna Habitat Description	Example Image
2	Open woodland of flooded gum (*Eucalyptus rudis*) over low woodland of paperback (*Melaleuca rhaphiophylla*) over a grassland of introduced pasture species. Area = ~ 2.7 ha (~8%)	
3	Low woodland/low open woodland of peppermint (*Agonis flexuosa*) with emergent jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) over a grassland of introduced pasture species. Area = ~ 1.5 ha (~4%)	
4	Tall open forest of marri (*Corymbia calophylla*) over grassland of introduced pasture species. Area = ~ 0.2 ha (~1%)	

Unit	Fauna Habitat Description	Example Image
5	Manmade permanent freshwater dam with occasional fringing sedges, flooded gum (*Eucalyptus rudis*) and paperback (*Melaleuca rhaphiophylla*). Area = ~ 0.5 ha (~1%)	

Overall fauna habitat values at the subject site have been severely compromised by the removal of most of the original native vegetation and the degradation of the main remnant patches. Most areas lack any natural attributes and are now only utilised by generally common and widespread fauna species with non-specific requirements which allow them to persist in disturbed/highly disturbed habitats. As a consequence the fauna biodiversity of the subject site is well below levels present prior to historical and ongoing disturbances taking place.

5.1.2 Wetland Habitat Assessment

Figure 4 shows the relative extent of mapped wetland classification units within the subject site. As can be seen in Figure 4 a small section (~2,000 m^2) of a Conservation Category Wetland is mapped as extending into the subject site. An examination of this specific area during the field survey revealed it to be comprised of a section of the open/low woodland of flooded gum (*Eucalyptus rudis*), paperback (*Melaleuca rhaphiophylla*) and grassland habitat unit which is clearly highly degraded and unlikely to fulfil the criteria of a Conservation Category Wetland. An example image is provided in Plate 1 below.

Plate 1: Example image of the Conservation Category Wetland within the Subject Site



The vegetation present is comprised of only two native species (*Eucalyptus rudis* and *Melaleuca rhaphiophylla*) over introduce pasture grasses. The area is currently open to livestock grazing and there is unlikely to be any recruitment of new trees and it can therefore be expected that its quality will further deteriorate over time. The fauna habitat values of this area of the CCW can be considered to be very low. It should be noted that other sections of this same vegetation unit located within the subject site, is in identical condition and has been mapped as a Multiple Use Wetland which is consistent with its highly degraded condition.

That section of the CCW that occurs outside of the subject site to the west is significantly different in its character and is in a much higher level of condition. An example image is provided below.

Plate 2: Example image of the Conservation Category Wetland outside of the Subject Site



This area of the CCW is likely to have relatively good fauna habitat values given most of the original vegetation structure and composition still persists.

5.2 WESTERN RINGTAIL POSSUM ASSESSMENT

The locations of various possum observations made during the site surveys are shown in Figure 5.

No evidence of western ringtail possum being present or utilising the subject site was found during the day or night surveys. Given the relatively small extent of the remnant vegetation remaining on site (~4.4 ha excluding scattered trees) and the fact that it was relatively easy to survey for evidence of the species it is the Author's opinion that at the time of the surveys WRP were not present within the subject site.

Eight common brushtail possums (*Trichosurus vulpecula*) were observed on the first night survey and seven on the second night. This distribution of observations suggest that nine individual possums were involved.

The open woodland of flooded gum and paperback present in the north of the subject site has been mapped by Shelley *et al*. (2014) as being within the "high" habitat suitability class for WRPs (i.e. able to support 5-10 WRPs per ha). Observations made during the field survey suggest that in reality this area should in fact be rated as having a "very low" habitat suitability (i.e. able to support <0.5 WRPs per ha) at best. Apart from the lack of WRP observations in this area, this conclusion is justified by the fact the vegetation is comprised of only flooded gum and paperbark, a combination which represents low quality habitat for WRPs. While WRPs may occur occasionally as transients they would not permanently reside in this vegetation type given the low plant species diversity and a complete lack of some of their favoured foraging species (e.g. peppermint, sheoak).

The other main area of vegetation within the subject site is dominated by a low open woodland of peppermint. This area has been mapped by Shelley *et al.* (2014) as being within the "medium" habitat suitability class for WRPs (i.e. able to support 2-5 WRPs per ha). This classification is probably justified given the dominance of peppermint, a food source often favoured by WRPs. The small area of marri forest which adjoins the peppermint has been mapped as being within the "high" habitat suitability class for WRPs (i.e. able to support 5-10 WRPs per ha). This vegetation unit is however unlikely to have the capacity to support this density of WRPs and should in fact be mapped as having the same or slightly less value as the adjoining peppermint woodland given a lack of midstorey species (including peppermint) which WRPs generally favour.

The value of the peppermint and marri dominated vegetation to WRPs is however greatly diminished by the fact that they cover a relatively small area (<2 ha) and are isolated, being over 300 metres from the closest other continuous area of vegetation. The lack of WRP observations in these areas also suggests that the species cannot persist in this remnant or that they have not been able to populate it from other areas due to the distance of separation.

5.3 BLACK COCKATOO HABITAT ASSESSMENT

5.3.1 Black Cockatoo Breeding Habitat

Trees considered potentially suitable for black cockatoos to use as nesting habitat (using DotEE criteria – Commonwealth of Australia 2012, but ultimately subject to a suitable hollow being present or developing and a range of other factors) which were found within the subject site comprised the following species:

- Flooded Gum – *Eucalyptus rudis*
- Marri – *Corymbia calophylla;*

- Jarrah - *Eucalyptus marginata*; and
- Dead unidentified species.

It should be noted that the likelihood of particular tree species developing hollows suitable for black cockatoos to use for breeding varies considerably. On the Swan Coastal Plain tuart is most commonly used by Carnaby's black cockatoos for breeding (Johnstone & Kirkby 2011). Available data also suggests that jarrah (*Eucalyptus marginata*) rarely produces suitable hollows. Kirkby (2009) reports that from a database of 109 confirmed black cockatoo nest trees throughout an area of jarrah forest only six were located in jarrah trees.

A summary of the potential black cockatoo habitat trees observed within the subject site is provided in Table 2 below and their location shown in Figure 6.

The assessment identified 112 trees within the subject site with a DBH of ≥50cm. Twenty one of these trees were observed to contain hollows or possible hollows of some type with four being assessed at the time to possibly have hollows suitable for black cockatoos to use for nesting (i.e. large enough entrance into a suitably sized and orientated branch/truck).

No actual evidence (e.g. chew marks) of any hollows being used by black cockatoos for nesting (currently or previously) was seen. Common brushtail possums were observed in close proximity to some of these hollow trees during the nocturnal surveys and these animals may be occupying at least some of the potential hollows recorded.

Table 2: Summary of Potential Black Cockatoo Habitat Trees (DBH ≥50cm) within the Subject Site

Tree species	Total Number of Habitat Trees Recorded	Number of Trees with No Hollows Observed	Number of Trees with Hollows Considered Unsuitable for Nesting Black Cockatoos	Number of Trees with Hollows Considered Possibly Suitable for Nesting Black Cockatoos
Flooded Gum	73	65	8	0
Marri	22	22	0	0
Jarrah	8	4	4	0
Dead Unidentified Eucalyptus	9	0	5	4
Total	**117**	**91**	**17**	**4**

Additional details on each habitat tree observed can be found in Appendix D.

A review of publicly available data showed no previous black cockatoo breeding records in or near the subject site (DoP 2011). The closest breeding records shown in the DoP document are located 20 km south east of the subject site in Dalyellup.

Based on available mapping there is about 5,300 ha of remnant native vegetation within 10 kilometres of the subject site. Some of this vegetation is also likely to contain "potential" breeding habitat as defined by DotEE.

5.3.2 Black Cockatoo Foraging Habitat

Following is a list of the main flora species recorded within the subject site survey that are known to be or are potentially used as a direct food source (e.g. seeds, flowers, nectar, bark or grubs) by one or more species of black cockatoo:

- Flooded Gum – *Eucalyptus rudis*
- Marri – *Corymbia calophylla;*
- Jarrah - *Eucalyptus marginata*; and
- Peppermint – *Agonis flexuosa*.

It should be noted that some of the above-mentioned species (e.g., flooded gum and peppermint) while foraged upon on occasions are only likely to contribute a small proportion to any one birds diet relative to more favoured plant species such as marri. Areas of flooded gum and peppermint are therefore not generally regarded as representing quality foraging habitat. In addition, some tree species are also only represented by a small number of specimens (i.e. jarrah) and therefore do not contribute to the overall foraging resource to a significant degree.

The only actual evidence of foraging left by black cockatoos was in the form of chewed marri fruits at a few locations in the area of marri located in the central section of the subject site. This evidence was attributed to the forest red-tailed black-cockatoo or Baudin's black-cockatoo depending on the nature of the marks left on the fruit debris in each instance, examples of which is provided in Table 3.

The extent of what would be regarded as quality black cockatoo foraging habitat within the subject site is very small being comprised of about 0.2 ha of marri forest supported to a small degree by a limited number of scattered marri and jarrah trees.

Table 3: Foraging Evidence Examples

Foraging Evidence Description	Example Image
Marri Fruits – foraging activity attributed to the forest red-tailed black-cockatoo.	
Marri fruits – foraging activity attributed to Baudin's black cockatoo.	

Based on available mapping there is about 5,300 ha of remnant native vegetation within 10 kilometres of the subject site. Much of this is likely to also represent black cockatoo foraging habitat of some type.

5.3.3 Black Cockatoo Roosting Habitat

No evidence of black cockatoos roosting within trees located inside the subject site was observed during the survey period.

A review of the 2017 Great Cocky Count database shows no documented roost sites within the subject site, the closest active roost (2017) being about 3 km south. This site was in use by 20 white-tailed black cockatoos during the 2017 Great Cocky Count. Another nine documented roost sites (but not necessarily in current use) occur within 10 km of the subject site.

5.4 OPPORTUNISTIC FAUNA OBSERVATIONS

Opportunistic fauna observations are listed in Appendix B. A total of 37 native fauna species were observed (or positively identified from foraging evidence, scats, tracks,

skeletons or calls) within the subject site during the course of site visits. Five introduced species were also confirmed as being present. Most of the fauna species recorded are common, widespread bird species.

Evidence of two listed threatened black cockatoo species was observed (forest red-tailed black cockatoo and Baudin's black cockatoo – foraging evidence (chewed marri fruits) (see section 5.2.4.2). No evidence of any listed migratory or DBCA priority fauna species using the area was found.

6. CONCLUSION

The fauna assessment within the subject site was undertaken for the purposes of delineating and characterising the fauna and wetland habitats present and to identify potential impacts of the proposed development. Targeted searches for western ringtail possums and black cockatoo individuals and their habitat were also carried out.

An assessment of part of a Conservation Category Wetland which extends into the subject site suggests that it should be considered for re-classification as a Multiple Use Wetland given it is highly degraded and of an identical character to adjoining areas that are mapped as such.

Based on the results of the assessment and the scale of the proposed development, likely impacts on western ringtail possums and black cockatoos and/or their preferred habitat are considered to be non-existent/negligible.

Western ringtail possums appear not to be utilising vegetation with the subject site as habitat and overall, habitat quality in areas to be developed are low/very low.

Some areas of vegetation represent black cockatoo habitat, but the degree of use appears to be low with no breeding or roosting activity detected and only a very limited amount of quality foraging habitat being present.

The results of the assessment suggest that if the proposed development were to be referred to the DotEE for review under the *EPBC Act* that it would be regarded as "not a controlled action" given impacts on listed species or their habitat are not likely to be significant.

It is therefore concluded that there exists no major constraints relating to fauna, and in particular fauna of conservation significance with respect to the proposed development.

It is recommended that a fauna relocation program be implemented prior to and during clearing works to ensure direct impact on fauna (e.g. common brushtail possums) most likely to be encountered, are minimised.

7. REFERENCES

Commonwealth of Australia (2012). *EPBC Act* Referral guidelines for three threatened black cockatoo species: Carnaby's cockatoo (endangered) *Calyptorhynchus latirostris*, Baudin's cockatoo (vulnerable) *Calyptorhynchus baudinii*, Forest red-tailed black cockatoo (vulnerable) *Calyptorhynchus banksii naso*.

Department of Planning (DoP) (2011). 'Greater Bunbury Region Scheme (GBRS) - potential habitat for the Carnaby's Black Cockatoo which may require further assessment". Department of Planning: Mapping and GeoSpatial Branch January 2011.

Johnstone, R. E. & Kirkby, T. (2011). Carnaby's Cockatoo (*Calyptorhynchus latirostris*), Baudin's Cockatoo (*Calyptorhynchus baudinii*) and the Forest Red-tailed Black Cockatoo (*Calyptorhynchus banksii naso*) on the Swan Coastal Plain (Lancelin–Dunsborough), Western Australia. Studies on distribution, status, breeding, food, movements and historical changes. Report for the Department of Planning, Western Australia.

Kirkby, T. (2009). Results of Black Cockatoo Survey at Lot 2 Dawesville. Unpublished report for WA Limestone.

Shedley E. and Williams K. (2014). An assessment of habitat for western ringtail possum (*Pseudocheirus occidentalis*) on the southern Swan Coastal Plain. Unpublished report for the Department of Parks and Wildlife, Bunbury, Western Australia.

FIGURES



Legend

Subject Site

0 1 2 3 4 5
Kilometres

Fauna Assessment

Lot 9004 and Lot 9503
Eaton Drive - Eaton

Subject Site & Surrounds

Drawn: G Harewood
Date: Oct 2018
Scale: 1:50,000
Projection/Coordinate System: UTM/MGA Zone 50
Figure: 1



Legend

Subject Site

0 50 100 150 200

Metres

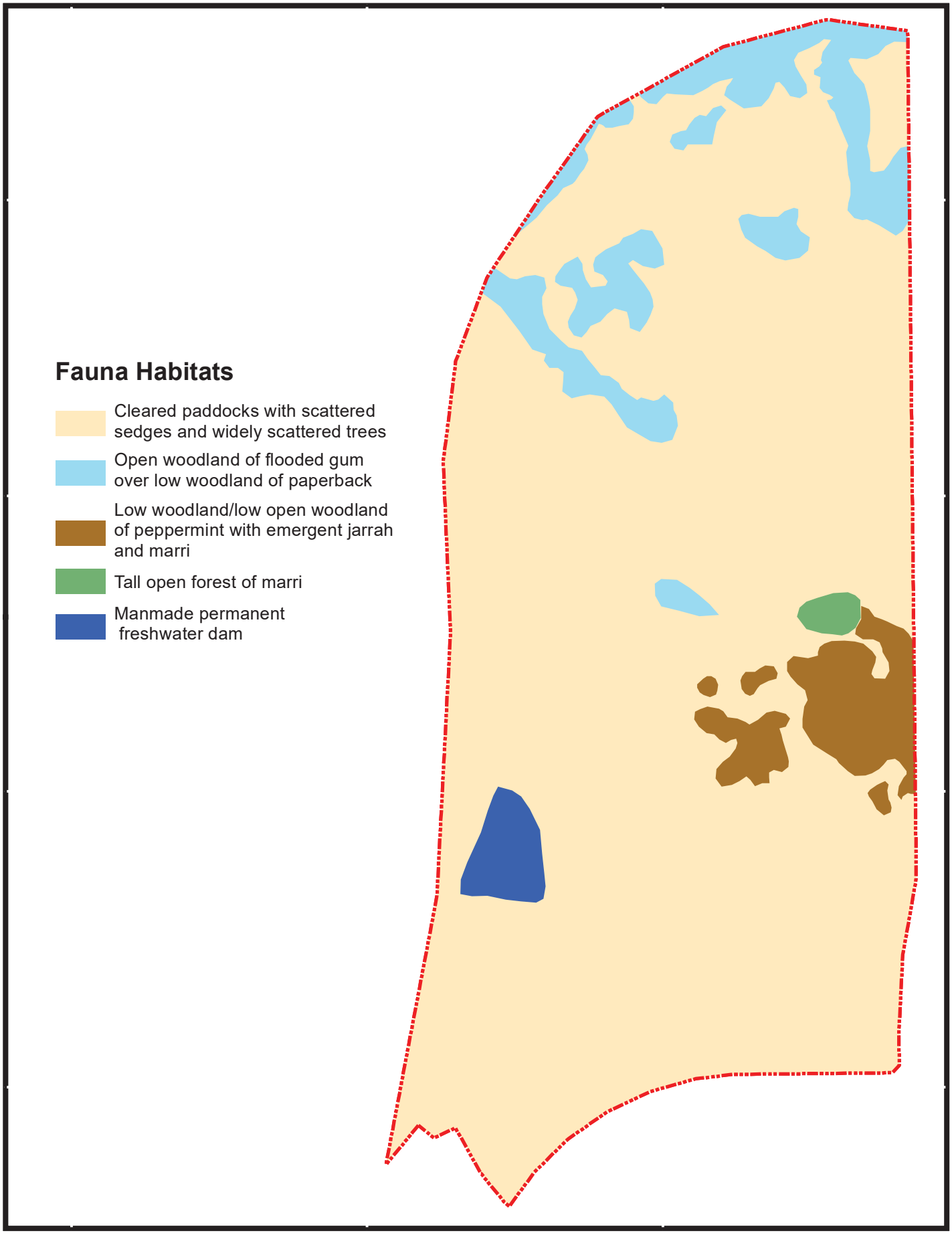


Lot 9004 and Lot 9503
Eaton Drive - Eaton

Air Photo

Drawn: G. Harewood
Date: Nov 2018
Scale: 1:4,275
Projection/Coordinate System: UTM/MGA Zone 50

Figure: 2



Legend

Subject Site

N

0 50 100 150 200

Metres



Drawn: G. Harewood

Date: Nov 2018

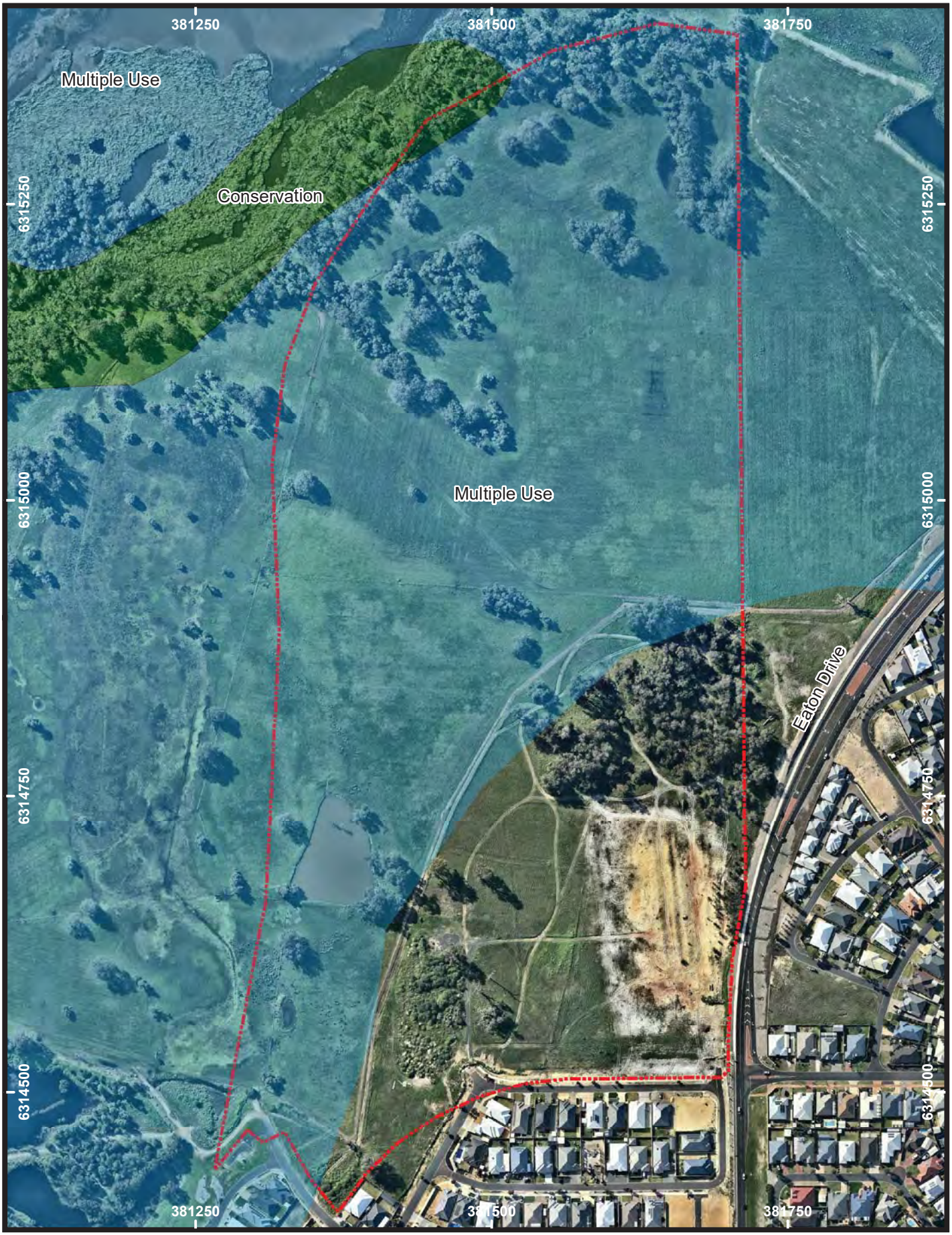
Scale: 1:4,275

Projection/Coordinate System: UTM/MGA Zone 50

Lot 9004 and Lot 9503
Eaton Drive - Eaton

Fauna Habitats

Figure: 3



Legend

Subject Site

0 50 100 150 200

Metres

Fauna Assessment

Drawn: G. Harewood

Date: Nov 2018

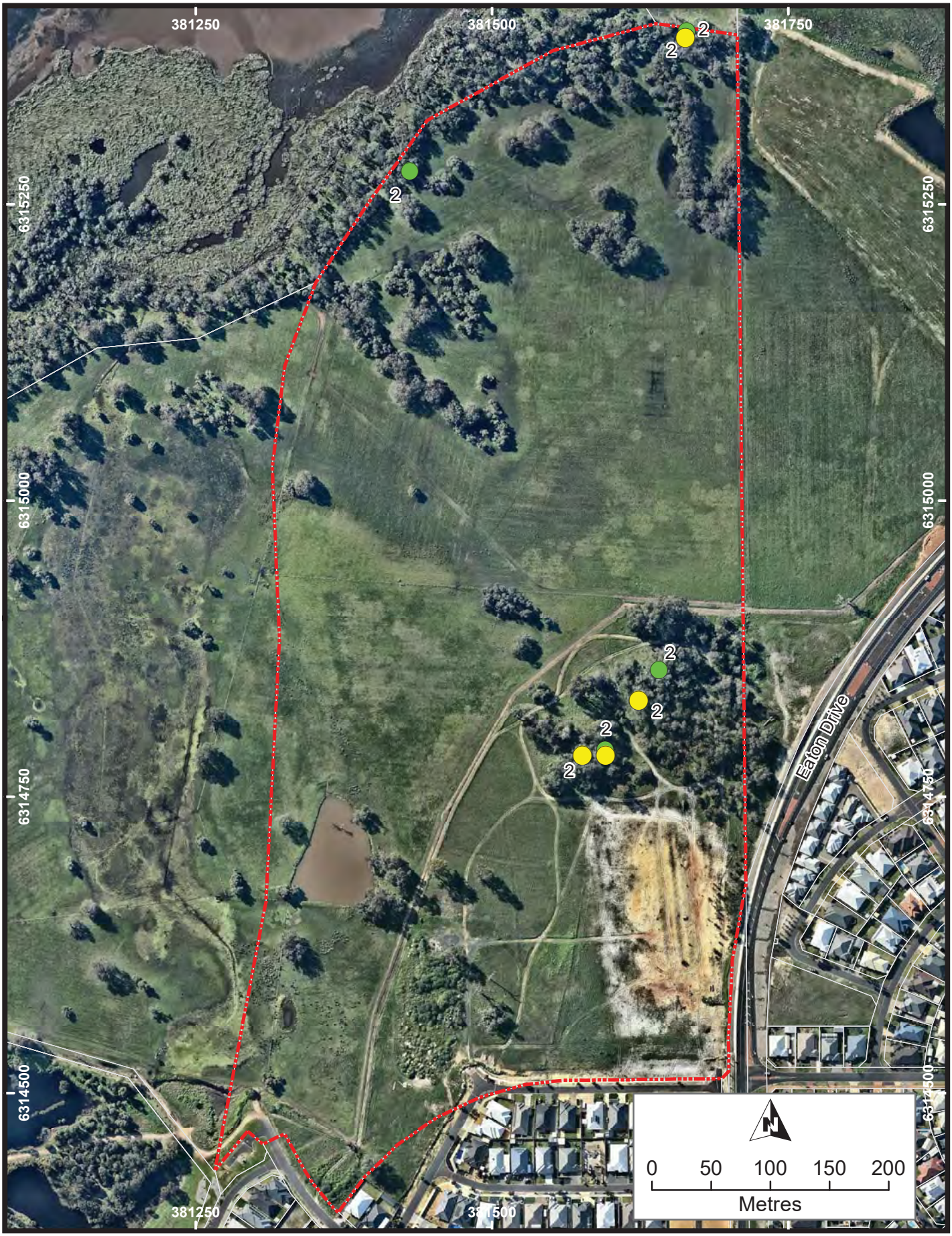
Scale: 1:4,275

Projection/Coordinate System: UTM/MGA Zone 50

Lot 9004 and Lot 9503
Eaton Drive - Eaton

Wetland Classifications

Figure: 4



Legend

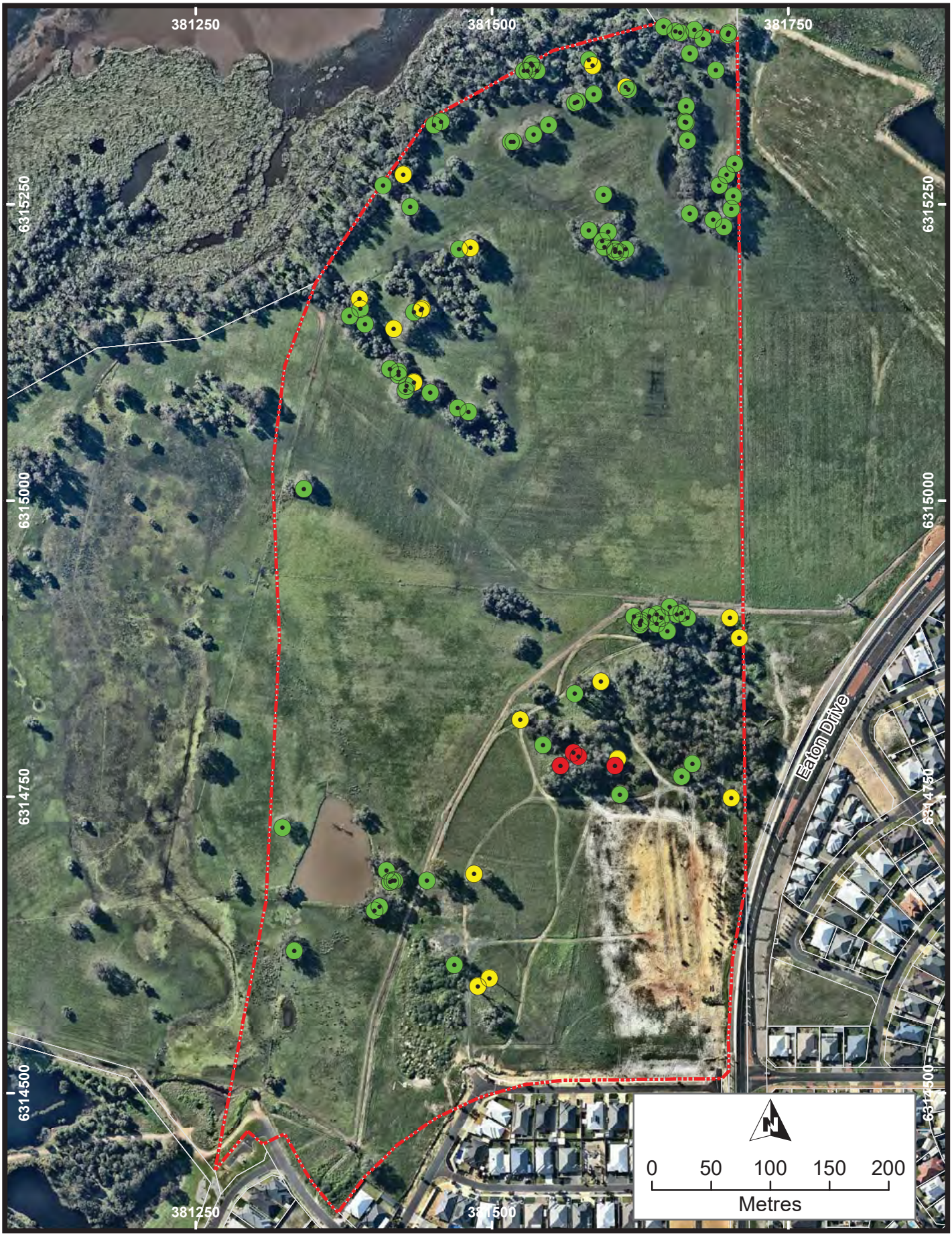
- Subject Site
- Night 1 - Common Brushtail Possum (8)
- Night 2 - Common Brushtail Possum (7)



Lot 9004 and Lot 9503
Eaton Drive - Eaton

Possum Observations

Drawn: G. Harewood	
Date: Nov 2018	
Scale: 1:4,275	
Projection/Coordinate System: UTM/MGA Zone 50	Figure: 5



Legend

- Subject Site
- Habitat Tree - One or more hollows possibly suitable for black cockatoos
- Habitat Tree - One or more hollows unsuitable for black cockatoos
- Habitat Tree - No hollows seen

Fauna Assessment

Lot 9004 and Lot 9503
Eaton Drive - Eaton

Habitat Trees (DBH >50cm)

Drawn: G. Harewood
Date: Nov 2018
Scale: 1:4,275
Projection/Coordinate System: UTM/MGA Zone 50

Figure: 6

APPENDIX A

BLACK COCKATOO HABITAT TREE DETAILS

Habitat Trees
DBH >50cm
Datum - GDA94
Entrance Size Ranges - Small = >5cm, Medium = 5 to 10cm, Large = >10cm

Waypoint Number	Zone	mE	mN	Tree Species	Tree Height (m)	DBH (cm)	Number of Hollows	Estimated Hollow Entrance Size	Occupancy	Chew Marks	Potential Cockatoo Nest Hollow	Comments
wpt001	50H	381709	6314884	Dead Unknown	15-20	>50	2+	Small & Medium	No signs	No signs	No	Internal dimensions of hollows unknown
wpt002	50H	381701	6314901	Dead Unknown	15-20	>50	2+	Small	No signs	No signs	No	Internal dimensions of hollows unknown
wpt003	50H	381665	6314901	Marri	15-20	>50	0					
wpt004	50H	381660	6314905	Marri	20+	>50	0					
wpt005	50H	381656	6314904	Marri	20+	>50	0					
wpt006	50H	381650	6314910	Marri	20+	>50	0					
wpt007	50H	381643	6314901	Marri	20+	>50	0					
wpt008	50H	381639	6314904	Marri	20+	>50	0					
wpt009	50H	381620	6314902	Marri	15-20	>50	0					
wpt010	50H	381626	6314899	Marri	20+	>50	0					
wpt011	50H	381625	6314897	Marri	20+	>50	0					
wpt012	50H	381625	6314895	Marri	20+	>50	0					
wpt013	50H	381639	6314896	Marri	20+	>50	0					
wpt014	50H	381633	6314902	Marri	15-20	>50	0					
wpt015	50H	381648	6314890	Marri	20+	>50	0					
wpt016	50H	381592	6314847	Jarrah	15-20	>50	2+	Small, Medium & Large	No signs	No signs	No	Internal dimensions of hollows unknown
wpt017	50H	381570	6314837	Marri	20+	>50	0					
wpt018	50H	381524	6314815	Jarrah	20+	>50	2+	Small	No signs	No signs	No	Internal dimensions of hollows unknown
wpt019	50H	381543	6314794	Marri	15-20	>50	0					
wpt020	50H	381558	6314776	Dead Unknown	10-15	>50	2+	Medium & Large (Cockatoo)	No signs	No signs	Yes	Internal dimensions of hollows unknown
wpt021	50H	381573	6314784	Dead Unknown	10-15	>50	2+	Medium & Large (Cockatoo)	No signs	No signs	Yes	Internal dimensions of hollows unknown
wpt022	50H	381569	6314787	Dead Unknown	15-20	>50	2+	Medium & Large (Cockatoo)	No signs	No signs	Yes	Internal dimensions of hollows unknown
wpt023	50H	381604	6314776	Dead Unknown	10-15	>50	2+	Medium & Large (Cockatoo)	No signs	No signs	Yes	Internal dimensions of hollows unknown
wpt024	50H	381606	6314782	Dead Unknown	5-10	>50	2+	Medium & Large	No signs	No signs	No	Internal dimensions of hollows unknown
wpt025	50H	381608	6314752	Jarrah	10-15	>50	0					
wpt026	50H	381660	6314767	Jarrah	10-15	>50	0					
wpt027	50H	381669	6314778	Jarrah	15-20	>50	0					
wpt028	50H	381702	6314749	Dead Unknown	10-15	>50	2+	Small & Medium	No signs	No signs	No	Internal dimensions of hollows unknown
wpt029	50H	381488	6314590	Dead Jarrah	15-20	>50	2+	Small, Medium & Large	No signs	No signs	No	Tree Martins nesting
wpt030	50H	381498	6314597	Dead Unknown	15-20	>50	2+	Small, Medium & Large	No signs	No signs	No	Kestrel nesting ?
wpt031	50H	381468	6314608	Marri	15-20	>50	0					
wpt032	50H	381485	6314685	Jarrah	15-20	>50	2+	Small, Medium & Large	No signs	No signs	No	Internal dimensions of hollows unknown
wpt033	50H	381445	6314679	Jarrah	20+	>50	0					
wpt034	50H	381414	6314678	Marri	15-20	>50	0					
wpt035	50H	381418	6314679	Marri	15-20	>50	0					
wpt036	50H	381416	6314679	Marri	15-20	>50	0					
wpt037	50H	381411	6314688	Marri	15-20	>50	0					
wpt038	50H	381401	6314654	Flooded Gum	15-20	>50	0					

Waypoint Number	Zone	mE	mN	Tree Species	Tree Height (m)	DBH (cm)	Number of Hollows	Estimated Hollow Entrance Size	Occupancy	Chew Marks	Potential Cockatoo Nest Hollow	Comments
wpt039	50H	381405	6314657	Flooded Gum	15-20	>50	0					
wpt040	50H	381333	6314620	Flooded Gum	15-20	>50	0					
wpt041	50H	381323	6314724	Marri	15-20	>50	0					
wpt042	50H	381341	6315010	Flooded Gum	15-20	>50	0					
wpt043	50H	381480	6315075	Flooded Gum	15-20	>50	0					
wpt044	50H	381471	6315078	Flooded Gum	15-20	>50	0					
wpt045	50H	381448	6315091	Flooded Gum	15-20	>50	0					
wpt046	50H	381434	6315100	Flooded Gum	15-20	>50	2+	Small & Medium	No signs	No signs	No	Internal dimensions of hollows unknown
wpt047	50H	381427	6315093	Flooded Gum	15-20	>50	0					
wpt048	50H	381428	6315097	Flooded Gum	15-20	>50	0					
wpt049	50H	381421	6315106	Flooded Gum	15-20	>50	0					
wpt050	50H	381421	6315109	Flooded Gum	15-20	>50	0					
wpt051	50H	381414	6315111	Flooded Gum	15-20	>50	0					
wpt052	50H	381393	6315149	Flooded Gum	15-20	>50	0					
wpt053	50H	381380	6315156	Flooded Gum	15-20	>50	0					
wpt054	50H	381389	6315162	Flooded Gum	15-20	>50	0					
wpt055	50H	381388	6315170	Flooded Gum	15-20	>50	2+	Small	No signs	No signs	No	Internal dimensions of hollows unknown
wpt056	50H	381417	6315145	Flooded Gum	15-20	>50	2+	Small	No signs	No signs	No	Internal dimensions of hollows unknown
wpt057	50H	381434	6315159	Flooded Gum	15-20	>50	0					
wpt058	50H	381440	6315161	Flooded Gum	15-20	>50	0					
wpt059	50H	381441	6315162	Flooded Gum	15-20	>50	2+	Small	No signs	No signs	No	Internal dimensions of hollows unknown
wpt060	50H	381472	6315212	Flooded Gum	15-20	>50	0					
wpt061	50H	381482	6315213	Flooded Gum	15-20	>50	2+	Small & Medium	No signs	No signs	No	Internal dimensions of hollows unknown
wpt062	50H	381431	6315248	Flooded Gum	15-20	>50	0					
wpt063	50H	381408	6315266	Flooded Gum	15-20	>50	0					
wpt064	50H	381425	6315275	Flooded Gum	15-20	>50	2+	Small, Medium & Large	No signs	No signs	No	Large hollows too low - Internal dimensions of hollows unknown
wpt065	50H	381451	6315317	Flooded Gum	15-20	>50	0					
wpt066	50H	381457	6315320	Flooded Gum	15-20	>50	0					
wpt067	50H	381516	6315303	Flooded Gum	15-20	>50	0					
wpt068	50H	381518	6315303	Flooded Gum	15-20	>50	0					
wpt069	50H	381535	6315309	Flooded Gum	15-20	>50	0					
wpt070	50H	381548	6315317	Flooded Gum	15-20	>50	0					
wpt071	50H	381572	6315337	Flooded Gum	15-20	>50	0					
wpt072	50H	381570	6315336	Flooded Gum	15-20	>50	0					
wpt073	50H	381586	6315343	Flooded Gum	15-20	>50	0					
wpt074	50H	381527	6315363	Flooded Gum	15-20	>50	0					
wpt075	50H	381530	6315363	Flooded Gum	15-20	>50	0					
wpt076	50H	381534	6315367	Flooded Gum	15-20	>50	0					
wpt077	50H	381533	6315369	Flooded Gum	15-20	>50	0					
wpt078	50H	381538	6315363	Flooded Gum	15-20	>50	0					
wpt079	50H	381582	6315372	Flooded Gum	15-20	>50	0					
wpt080	50H	381585	6315367	Flooded Gum	15-20	>50	1	Small	No signs	No signs	No	Internal dimensions of hollows unknown

Waypoint Number	Zone	mE	mN	Tree Species	Tree Height (m)	DBH (cm)	Number of Hollows	Estimated Hollow Entrance Size	Occupancy	Chew Marks	Potential Cockatoo Nest Hollow	Comments
wpt081	50H	381613	6315349	Flooded Gum	15-20	>50	2+	Small	No signs	No signs	No	Internal dimensions of hollows unknown
wpt082	50H	381615	6315347	Flooded Gum	15-20	>50	0					
wpt083	50H	381645	6315400	Flooded Gum	15-20	>50	0					
wpt084	50H	381655	6315396	Flooded Gum	15-20	>50	0					
wpt085	50H	381659	6315395	Flooded Gum	15-20	>50	0					
wpt086	50H	381671	6315397	Flooded Gum	15-20	>50	0					
wpt087	50H	381678	6315390	Flooded Gum	15-20	>50	0					
wpt088	50H	381699	6315393	Flooded Gum	15-20	>50	0					
wpt089	50H	381700	6315395	Marri	15-20	>50	0					
wpt090	50H	381689	6315363	Flooded Gum	15-20	>50	0					
wpt091	50H	381667	6315377	Flooded Gum	15-20	>50	0					
wpt092	50H	381664	6315333	Flooded Gum	15-20	>50	0					
wpt093	50H	381663	6315320	Flooded Gum	15-20	>50	0					
wpt094	50H	381664	6315319	Flooded Gum	15-20	>50	0					
wpt095	50H	381665	6315304	Flooded Gum	15-20	>50	0					
wpt096	50H	381705	6315284	Flooded Gum	15-20	>50	0					
wpt097	50H	381698	6315275	Flooded Gum	15-20	>50	0					
wpt098	50H	381692	6315266	Flooded Gum	15-20	>50	0					
wpt099	50H	381704	6315257	Flooded Gum	15-20	>50	0					
wpt100	50H	381702	6315246	Flooded Gum	15-20	>50	0					
wpt101	50H	381696	6315231	Flooded Gum	15-20	>50	0					
wpt102	50H	381687	6315237	Flooded Gum	15-20	>50	0					
wpt103	50H	381667	6315242	Flooded Gum	15-20	>50	0					
wpt104	50H	381594	6315258	Flooded Gum	15-20	>50	0					
wpt105	50H	381582	6315228	Flooded Gum	15-20	>50	0					
wpt106	50H	381598	6315227	Flooded Gum	15-20	>50	0					
wpt107	50H	381593	6315219	Flooded Gum	15-20	>50	0					
wpt108	50H	381595	6315214	Flooded Gum	15-20	>50	0					
wpt109	50H	381604	6315210	Flooded Gum	15-20	>50	0					
wpt110	50H	381604	6315212	Flooded Gum	15-20	>50	0					
wpt111	50H	381608	6315209	Flooded Gum	15-20	>50	0					
wpt112	50H	381613	6315212	Flooded Gum	15-20	>50	0					

APPENDIX B

LIST OF FAUNA OBSERVED

List of Fauna Observed

LOT 9004 9503 EATON DRIVE - EATON

Compiled by Greg Harewood - Nov 2018

Class **Family** *Species*	Common Name	Conservation Status
Reptilia		
Scincidae Skinks		
Cryptoblepharus buchananii	Fence Skink	
Tiliqua rugosa	Bobtail	
Aves		
Anatidae Geese, Swans, Ducks		
Anas gracilis	Grey Teal	LC
Anas superciliosa	Pacific Black Duck	LC
Aythya australis	Hardhead	Bh LC
Chenonetta jubata	Australian Wood Duck	LC
Tadorna tadornoides	Australian Shelduck	LC
Podicipedidae Grebes		
Tachybaptus novaehollandiae	Australasian Grebe	LC
Ardeidae Herons, Egrets, Bitterns		
Ardea ibis	Cattle Egret	CA JA
Ardea novaehollandiae	White-faced Heron	LC
Threskiornithidae Iibises, Spoonbills		
Threskiornis molucca	Australian White Ibis	LC
Threskiornis spinicollis	Straw-necked Ibis	LC

WC Act Status - S1 to S7, EPBC Act Status - EN = Endangered, VU = Vulnerable, EX = Extinct, DBCA Priority Status - P1 to P4, Int. Agmts - CA = CAMBA, JA = JAMBA, RK = ROKAMBA, Bush Forever Decreaser Species - Bh = habitat specialists, Bp = wide ranging species, Be = extinct in Perth Coastal Plain Region. IUCN Red List Category Definitions LC = Least Concern - see Appendix A and http://www.iucnredlist.org/technical-documents/categories-and-criteria/2001-categories-criteria for others.

Class **Family** *Species*	Common Name	Conservation Status
Accipitridae Kites, Goshawks, Eagles, Harriers		
Haliastur sphenurus	Whistling Kite	Bp LC
Falconidae Falcons		
Falco cenchroides	Australian Kestrel	LC
Rallidae Rails, Crakes, Swamphens, Coots		
Fulica atra	Eurasian Coot	LC
Columbidae Pigeons, Doves		
Ocyphaps lophotes	Crested Pigeon	LC
Streptopelia senegalensis	Laughing Turtle-Dove	Introduced
Psittacidae Parrots		
Cacatua roseicapilla	Galah	LC
Cacatua sanguinea	Little Corella	Introduced
Calyptorhynchus banksii naso	Forest Red-tailed Black-Cockatoo	S3 VU Bp LC
Calyptorhynchus baudinii	Baudin's Black Cockatoo	S2 EN Bp EN A3cde
Platycercus spurius	Red-capped Parrot	LC
Platycercus zonarius	Australian Ringneck	LC
Halcyonidae Tree Kingfishers		
Dacelo novaeguineae	Laughing Kookaburra	Introduced
Acanthizidae Thornbills, Geryones, Fieldwrens & Whitefaces		
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	Bh LC
Gerygone fusca	Western Gerygone	LC
Smicrornis brevirostris	Weebill	Bh LC

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Class **Family** *Species*	Common Name	Conservation Status
Pardalotidae Pardalotes		
Pardalotus striatus	Striated Pardalote	LC
Meliphagidae Honeyeaters, Chats		
Anthochaera carunculata	Red Wattlebird	LC
Dicruridae Monarchs, Magpie Lark, Flycatchers, Fantails, Drongo		
Grallina cyanoleuca	Magpie-lark	LC
Rhipidura fuliginosa	Grey Fantail	LC
Rhipidura leucophrys	Willie Wagtail	LC
Campephagidae Cuckoo-shrikes, Trillers		
Coracina novaehollandiae	Black-faced Cuckoo-shrike	LC
Cracticidae Currawongs, Magpies & Butcherbirds		
Cracticus tibicen	Australian Magpie	LC
Cracticus torquatus	Grey Butcherbird	LC
Corvidae Ravens, Crows		
Corvus coronoides	Australian Raven	LC
Hirundinidae Swallows, Martins		
Hirundo nigricans	Tree Martin	LC
Mammalia		
Phalangeridae Brushtail Possums, Cuscuses		
Trichosurus vulpecula vulpecula	Common Brushtail Possum	LC
Macropodidae Kangaroos, Wallabies		
Macropus fuliginosus	Western Grey Kangaroo	LC

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Class **Family** *Species*	Common Name	Conservation Status
Canidae Dogs, Foxes		
Vulpes vulpes	Red Fox	Introduced
Bovidae Horned Ruminants		
Bos taurus	European Cattle	Introduced
Leporidae Rabbits, Hares		
Oryctolagus cuniculus	Rabbit	Introduced

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The conclusions are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of preparing the report. Also it should be recognised that site conditions, can change with time.

Within the limitations imposed by the scope of services, the field assessment and preparation of this report have been undertaken and performed in a professional manner, in accordance with generally accepted practices and using a degree of skill and care ordinarily exercised by reputable environmental consultants under similar circumstances. No other warranty, expressed or implied, is made.

In preparing the report, the Author has relied upon data, surveys, analyses, designs, plans and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise stated in the report, the Author has not verified the accuracy of completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. The Author will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to the Author.

The report has been prepared for the benefit of the Client and no other party. The Author assumes no responsibility and will not be liable to any other person or organisation for or in relation to any matter dealt with or conclusions expressed in the report, or for any loss or damage suffered by any other person or organisation arising from matters dealt with or conclusions expressed in the report (including without limitation matters arising from any negligent act or omission of the Author or for any loss or damage suffered by any other party relying upon the matters dealt with or conclusions expressed in the report). Other parties should not rely upon the report or the accuracy or completeness of any conclusions and should make their own enquiries and obtain independent advice in relation to such matters.

The Author will not be liable to update or revise the report to take into account any events or emergent circumstances or facts occurring or becoming apparent after the date of the report.

Black Cockatoo Habitat Tree Review



Lot 9004 and Lot 9503 Eaton Drive Eaton

November 2022
Version 1

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1. INTRODUCTION

This report details the results of a black cockatoo habitat tree review carried out over Lot 9004 and Lot 9503 Eaton Drive, Eaton (subject site). The subject site is situated about nine kilometres east of Bunbury in the south west of Western Australia. Lot 9004 and Lot 9503 have a combined area of about 34 hectares, most of which is cleared farmland used for or previously used for livestock grazing.

As part of an overall environmental assessment a black cockatoo breeding habitat survey was undertaken by Greg Harewood in 2018 (Harewood 2018). One hundred and twelve habitat trees (i.e. trees with a diameter at breast height ≥50cm) were identified within the subject site. Twenty one of these trees were observed to contain hollows or possible hollows of some type with four being assessed at the time to possibly have hollows suitable for black cockatoos to use for nesting (i.e. large enough entrance into a suitably sized and orientated branch/truck). No actual evidence (e.g. chew marks) of any hollows being used by black cockatoos for nesting (currently or previously) was seen.

To obtain up to date information on the current status of the previously identified habitat trees, the Shire of Dardanup have requested a review of the trees be undertaken. The results of this survey work are presented here.

2. SCOPE OF WORKS

The scope of works was to reinspect the 21 habitat trees containing potential hollows so as to obtain current information on their potential suitability as actual black cockatoo breeding trees.

3. METHODS

The review was carried out by Greg Harewood (Zoologist) on the 22 November 2022. The assessment involved the inspection of 21 trees previously identified as containing hollows or apparent hollows.

The assessment of hollow suitability was initially carried out from ground level, however trees assessed as containing large hollows suspected of being possibly suitable for black cockatoos were also examine and photograph at close range using a drone (DJI Mavic Mini) or a pole mounted “GoPro” camera. The photographs obtained were subsequently examined to assist in determining suitability and to aid in identifying any signs of current or previous use by black cockatoos.

Identified hollows have initially been placed into one of three categories based on the type of hollow entry:

- Chimney: the hollow entry faces directly upwards in the end of the main trunk;
- Spout: hollow entry which is at the end of a broken branch; or
- Side: the entry is directly into the side of the trunk or a branch with no protrusions.

For the purpose of this review, hollows have then been placed into one of five categories based on the observable characteristics of each hollow. The categories used were:

- Confirmed Hollow: Black cockatoos observed utilising the hollow for breeding purposes;
- Chewed Hollow: The hollow shows signs of chewing ("chipping" around or near entrance and/or internally) attributed to black cockatoo activity (in most cases indicating nesting activity, but in some cases possibly marks left by black cockatoos investigating ("prospecting") hollows);
- Unused Hollow: The hollow appears to be of a suitable size for black cockatoos to use for nesting, but no conclusive evidence of this activity seen. It should be noted that chew marks/chipping are not always evident or present on some hollows that have been used for nesting. Hollows classified as "unused" may therefore have been used for nesting but cannot be specifically classified as such. Alternatively, some "unused" hollows may not be suitable for black cockatoos as a range of characteristics, not all of which can be seen or measured, ultimately determined if a hollow will ever actually be used;
- Unsuitable Hollow: The hollow has been assessed, based on information obtained, as being unlikely to be suitable for black cockatoos (generally because of the entrance appearing to be too small or because the actual hollow or accommodating branch/tree trunk appears to be too small or as having an unfavourable orientation);
- No Hollow: A possible hollow was found upon closer inspection not to be present.
- Fallen Tree/No Tree: The tree has fallen over or been removed since the original survey.

4. SURVEY CONSTRAINTS

No seasonal sampling has been carried out as part of this fauna assessment. The conclusions presented are based upon field data and the environmental monitoring and/or testing carried out over a limited period of time and are therefore merely indicative of the environmental condition of the site at the time of the field assessments. It should also be recognised that site conditions can change with time.

5. RESULTS

A summary of the black cockatoo "habitat trees" assessed is provided in Table 1 below. The location of the trees inspected are shown in Figure 1.

Photographs and additional details of eight trees suspected of possibly containing larger hollows and assessed in more detail can be found in Appendix A.

Table 1: Summary of Habitat Trees Inspected

Tree Id	Number of Hollows	Reviewed Status	Justification
Wpt001	N/A	No tree	2018 assessment identified a dead habitat tree with possible small/medium sized hollows, none suitable for black cockatoos. Appears to have been removed, possibly for firewood.
Wpt002	2+	No suitable hollows.	2018 assessment identified a dead habitat tree with possible small sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review.
Wpt016	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium/large sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review.
Wpt018	2+	No suitable hollows.	2018 assessment identified a dead habitat tree with possible small sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review.
Wpt020	2+	No suitable hollows.	2018 assessment identified a dead habitat tree with small/medium/large sized hollows, some possibly suitable for black cockatoos. 2022 review suggests hollows are not suitable and status therefore changed to "No suitable hollows".

Tree Id	Number of Hollows	Reviewed Status	Justification
Wpt021	2+	No suitable hollows.	2018 assessment identified a dead habitat tree with small/medium/large sized hollows, some possibly suitable for black cockatoos. 2022 review suggests hollows are not suitable and status therefore changed to “No suitable hollows”.
Wpt022	2+	No suitable hollows.	2018 assessment identified a dead habitat tree with small/medium/large sized hollows, some possibly suitable for black cockatoos. 2022 review suggests hollows are not suitable and status therefore changed to “No suitable hollows”.
Wpt023	2+	No hollows.	2018 assessment identified a dead habitat tree with small/medium/large sized hollows, some possibly suitable for black cockatoos. 2022 review suggests hollows are not actually present and status therefore changed to “No hollows”.
Wpt024	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium/large sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review.
Wpt028	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium sized hollows, none suitable for black cockatoos. Additional large shallow hollow identified, but unsuitable for black cokatoos. No change in this status considered warranted based on 2022 review
Wpt029	N/A	No tree	2018 assessment identified a dead habitat tree with small/medium/large sized hollows, none suitable for black cockatoos. Appears to have been removed during subdivision development.
Wpt030	N/A	No tree	2018 assessment identified a dead habitat tree with small/medium/large sized hollows, none suitable for black cockatoos. Appears to have been removed, possibly for firewood.
Wpt032	N/A	No tree	2018 assessment identified a jarrah habitat tree with small/medium/large sized hollows, none suitable for black cockatoos. Appears to have been removed, possibly for firewood.
Wpt046	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review
Wpt055	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review

Tree Id	Number of Hollows	Reviewed Status	Justification
Wpt056	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review
Wpt059	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review
Wpt061	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review
Wpt064	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium/large sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review.
Wpt080	1	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review
Wpt081	2+	No suitable hollows.	2018 assessment identified a habitat tree with possible small/medium sized hollows, none suitable for black cockatoos. No change in this status considered warranted based on 2022 review

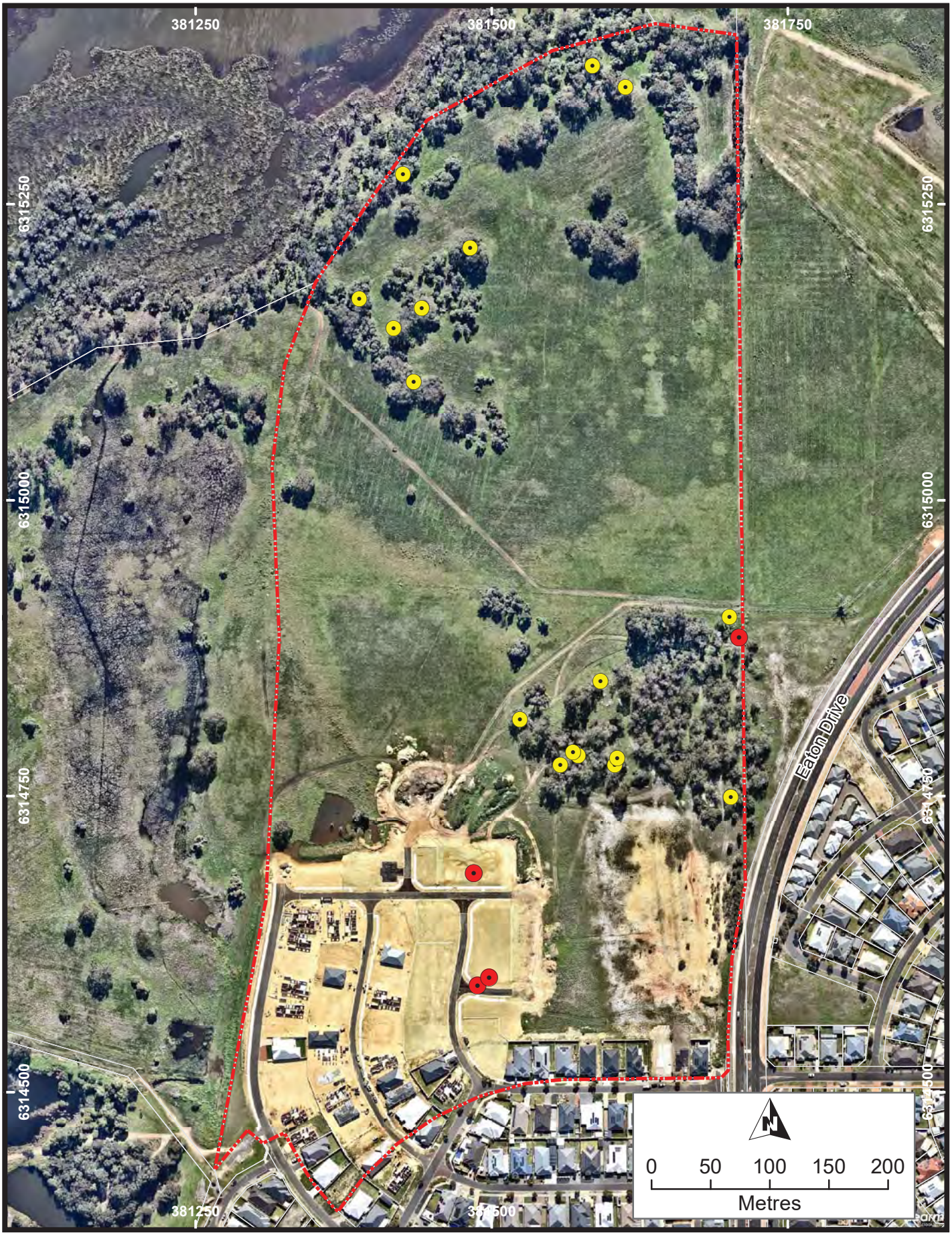
6. CONCLUSION

The assessment reported on here was undertaken to provide up to date information on the likely suitability of hollows for black cockatoos within 21 previously identified habitat trees.

Four of the 21 trees were found to no longer be present. Three of these trees appear to have been removed as part of ongoing subdivision activities. The fourth tree appears to have been removed for firewood.

Four habitat trees previously assessed as potentially containing hollows suitable for black cockatoos have been re-assessed as not containing suitable hollows a conclusion generally based on the fact that the possible hollows were found to be too small internally or non-existent when examined/photographed with a drone.

The status of the remaining 13 habitat trees was assessed as having not changed since the previous assessment in 2018 given that upon re-inspection none contained hollows suitable for black cockatoos to use for nesting purposes. In most cases these hollows appear to be too small or shallow with inadequate internal dimensions.



Legend

Subject Site

Habitat Tree - One or more hollows unsuitable for black cockatoos

Previously identified Habitat Tree no longer present

Fauna Assessment

Drawn: G. Harewood

Date: Nov 2022

Scale: 1:4,275

Projection/Coordinate System: UTM/MGA Zone 50

Lot 9004 and Lot 9503
Eaton Drive - Eaton

Habitat Trees (DBH >50cm) Reviewed 2022

Figure: 1

7. REFERENCES

Harewood, G. (2018). Fauna and Habitat Assessment - Lot 9004 and Lot 9503, Eaton Drive, Eaton. Unpublished report prepared for Accendo Australia.

APPENDIX A

Habitat Tree Details
(trees with possible larger hollows only)

ID	Coordinates (MGA 94/Z50)	381592 mE	6314846 mN	Tree Species	Dead (Jarrah)	Review Date	22/11/2022
16	**Comments**	Recently dead jarrah tree with a number of potential hollows in branches and trunk. When examined with a drone the various hollows appeared to be either too small internally and/or wrong orientation or non-existent. This is consistent with the original classification (Harewood 2018) where no hollows suitable for black cockatoos were identified. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable/No Hollows.







ID	Coordinates (MGA 94/Z50)	381557 mE	6314775 mN	Tree Species	Dead (unknown)	Review Date	22/11/2022
20	**Comments**	Dead tree with a number of potential hollows in branches. When examined with a drone the various hollows appeared to be either too small internally or non-existent. The original classification (Harewood 2018) has therefore been changed from potential hollows suitable for black cockatoos to no suitable hollows. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable/No Hollows.









ID	Coordinates (MGA 94/Z50)	381573 mE	6314784 mN	Tree Species	Dead (unknown)	Review Date	22/11/2022
21	**Comments**	Dead tree with a number of potential hollows in branches and main trunk. When examined with a drone the various hollows appeared to be too small internally. The original classification (Harewood 2018) has therefore been changed from potential hollows suitable for black cockatoos to no suitable hollows. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable Hollows.









ID	Coordinates (MGA 94/Z50)	381568 mE	6314786 mN	Tree Species	Dead (unknown)	Review Date	22/11/2022
22	**Comments**	Dead tree with a number of potential hollows in branches and main trunk. When examined with a drone the various hollows appeared to be too small internally or non-existent. The original classification (Harewood 2018) has therefore been changed from potential hollows suitable for black cockatoos to no suitable hollows. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable/No Hollows.

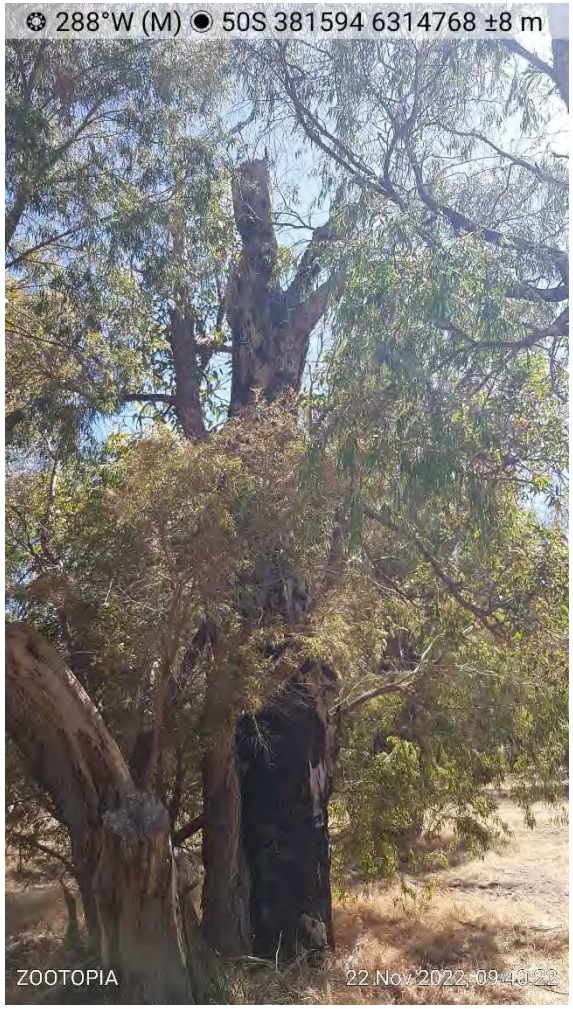








ID	Coordinates (MGA 94/Z50)	381604 mE	6314776 mN	Tree Species	Dead (unknown)	Review Date	22/11/2022
23	**Comments**	Dead tree with a number of potential hollows in branches and main trunk. When examined with a drone the various hollows appeared to be non-existent. The original classification (Harewood 2018) has therefore been changed from potential hollows suitable for black cockatoos to no suitable hollows. No conclusive evidence of use by other fauna evident.				**Revised Classification**	No Hollows.





ID	Coordinates (MGA 94/Z50)	381606 mE	6314781 mN	Tree Species	Dead (unknown)	Review Date	22/11/2022
24	**Comments**	Dead tree with a number of potential hollows in branches and main trunk. When examined with a drone the various hollows appeared to be too small internally or non-existent. This is consistent with the original classification (Harewood 2018) where no hollows suitable for black cockatoos were identified. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable/No Hollows.

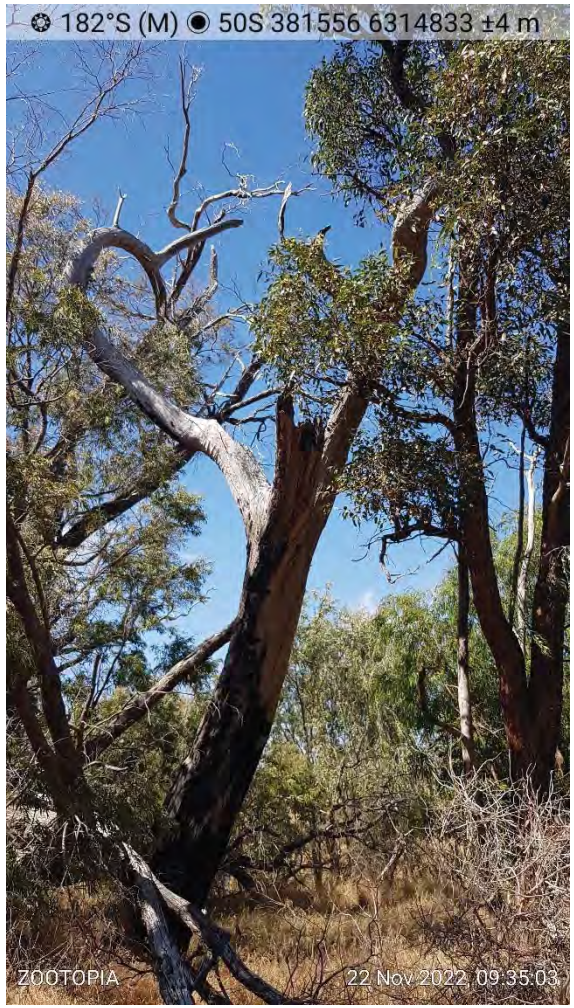








ID	Coordinates (MGA 94/Z50)	381702 mE	6314749 mN	Tree Species	Dead (unknown)	Review Date	22/11/2022
28	**Comments**	Dead tree with a number of potential hollows in branches and trunk. When examined with a drone the single large hollow was found to be relatively shallow and has been assessed as unsuitable for black cockatoos. This is consistent with the original classification (Harewood 2018) where no hollows suitable for black cockatoos were identified. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable Hollow.





ID	Coordinates (MGA 94/Z50)	381424 mE	6315275 mN	Tree Species	Flooded Gum	Review Date	22/11/2022
64	**Comments**	Flooded gum with very large side entry type hollow located low on main trunk. This hollow was examined using a pole mounted camera. The pictures obtained show that the hollow unsuitable for black cockatoos as it has no base and continues downwards to another opening in the main truck at about ground level. This is consistent with the original classification (Harewood 2018) where no hollows suitable for black cockatoos were identified. No conclusive evidence of use by other fauna evident.				**Revised Classification**	Unsuitable Hollow.





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APPENDIX D | LOCAL WATER MANAGEMENT PLAN

Robusta Road, Eaton

REVISED LOCAL WATER MANAGEMENT STRATEGY

B22049
V4 September 2025

DOCUMENT QUALITY CONTROL

Project Reference		B22049
Ver No.	Purpose	Date
V1	Client Review	May 2023
V2	Submission for approval	May 2023
V3	Submission for approval – revised layout	February 2025
V4	Submission for approval – revised layout	September 2025

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1 EXECUTIVE SUMMARY

The Robusta Road Revised Local Water Management Strategy (LWMS) has been developed to accompany the updating of the Structure Planning for the subject land. It provides an update to the approved Lot 9004 Eaton Drive Local Water Management Strategy and highlights how water is to be managed in response to the revised layout (Revision N).

The current subject land layout is shown in Figure 2. It is located west of Eaton Drive and east of Collie River. A location plan for the site is provided in Figure 1. This updated LWMS also considered the larger foreshore area that was analysed as part of the original structure planning and approved LWMS. This is identified as the original investigation area in Figure 1.

The majority of the undeveloped subject land is cleared and seeded with grass and pasture species with minimal to sparse tree and understorey species. The landform of the site consists of undulating sand dunes with a low lying swampy area in the centre of the site within the Collie River floodplain. A high point exists in the original structure planning area's south western corner, adjacent to the Collie River which will be developed at a later date.

Winter groundwater levels at the site are approximately 3 m from the surface at the eastern boundary sloping steeply towards the Collie River, in line with surface topography. The objective of this LWMS is to detail the updated best management practices approach to water management that will be undertaken for this development, in accordance with Better Urban Water Management (WAPC, 2008). This will include managing, protecting and conserving the total water cycle of the local environment and the greater catchment. The practices will involve:

- Stormwater management that incorporates the latest's water sensitive urban design practices;
- Groundwater resource management;
- Protection and enhancement of ecosystems dependent on water resources from the subject land;
- Sustainable water servicing.

The effectiveness, efficiency and benefits provided by the best management practices require a collaborative effort between local governments, developers and relevant regulatory authorities. Further summary of the practices to be undertaken for the subject land can be found in the Key Elements section.

1.1 PLANNING SUMMARY

Under the Greater Bunbury Region Scheme the developable portion of the subject land is zoned 'Urban', with the balance zoned 'Regional Open Space'. This corresponds with the 'Development' and 'Regional Open Space' land zonings mapped in the Shire of Dardanup's Town Planning Scheme No.3.

Land zoned 'Development" requires that a Local Structure Plan (LSP) be prepared and endorsed by both the Local Authority and the Western Australian Planning Commission (WAPC) prior to subdivision and development. This LWMS is prepared in support of the LSP for the Subject Land, in accordance with overarching planning requirements.

The current LSP was approved by the Western Australian Planning Commission on 1st October 2019. The LSP Amendment seeks to reconfigure the proposed Public Open Space and Residential cells. The LSP area will accommodate low and medium density residential housing, and outlines a land use and movement network framework for the development of the subject site.

The southern portion of the original subject land has been developed and was designed and constructed in line with the approved Urban Water Management Plan (UWMP) (*Parkridge Estate Stages 3 & 4 UWMP*). This portion is included in the overall Structure Plan Map to provide clarity on connection through the overall area, including interactions from a drainage perspective.

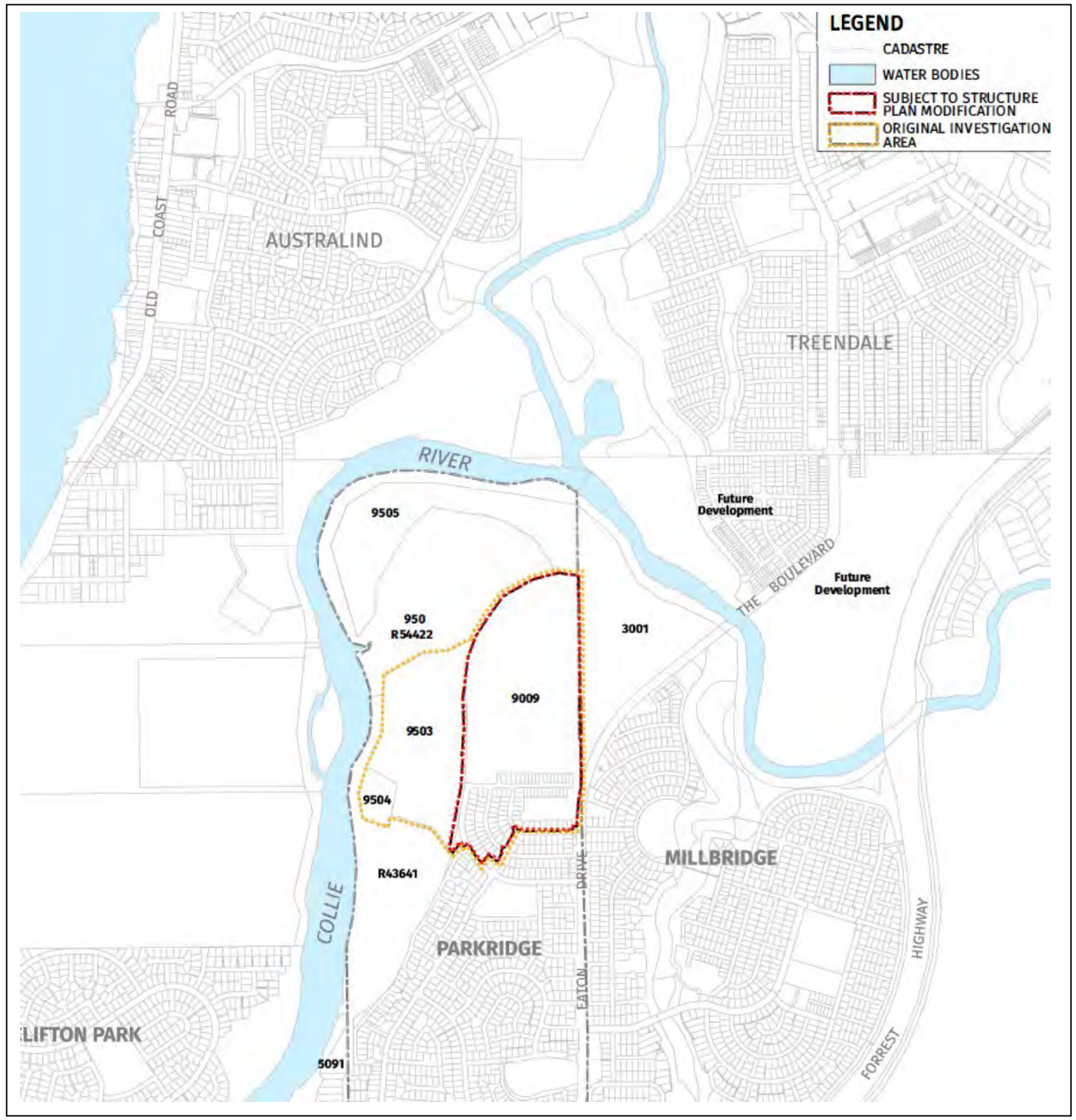


Figure 1 Location Plan and investigation area

2 KEY ELEMENTS PLAN

Water management strategies for the subject land are based on best practice water sensitive urban designs that integrate sustainability and the provision of attractive communities. The strategies will be achieved through the synthesis of planning and designs to manage, protect and conserve the total water cycle. The plans and designs for the development are appropriate for the subject land's residential development, surrounding environment and local drainage characteristics.

A summary of the WSUD elements that will be implemented within the development to achieve best management practices are outlined below:

Water Conservation and Servicing

- All houses are to be provided with a mains potable water (through Water Corporation).
- Each lot is to be connected to a gravity sewer system, managed by the Water Corporation.

Stormwater Management

- Stormwater detention systems, combined with treatment systems including a perimeter bioretention basin and POS basins will capture and treat stormwater flows. All flows leaving the site up to the 20% AEP event match or are below the pre development rate.
- Consistent with Shire policy CP060, soakage devices will be provided on lots where the aggregate impervious area including roofs, carparks, driveways, carports and patio's exceeds 250m² or where the lot size is less than 400m². Modelling assumes 1 m³ of storage for every 65 m² of connected impervious area to be conservative.

Flood Protection

- All finished floor levels will be designed to maintain a clear separation of 300mm between the habitable floor level and the 1% Average Event Period (AEP) event flood level, generated on site;
- All finished floor levels will be designed to maintain a clear separation of 500mm between the habitable floor levels and the 1% Average Event Period (AEP) event flood level of the Collie River of 3.61mAHD.

Ecosystem Protection

- New habitat will be created within the perimeter bioretention basin and POS basin, through the use of locally native plant species;
- The WSUD elements used on site will treat stormwater and groundwater, improving the water quality prior to it entering the downstream ecosystems of Collie River
- Flows to the Collie River will be managed to predevelopment rates for all events up to and including the 20% AEP, minimising changes to the current flows to this ecosystem.
- Existing habitat within the Collie River foreshore area will be retained as Regional Open Space (ROS) as part of the Kalgulup Regional Park and is subject to future planning. Any land use in this area will take into account the Collie River flood regime and need for ecological management.
- All drainage infrastructure is located more than 50m from the Eelup/Elbow Conservation Category Wetland within the foreshore area.
- The landscaping will utilise nutrient and waterwise practices to minimise contamination of the groundwater.
- Eelup Wetland is to be vested in the Conservation and Parks Commission to provide long term protection.

Groundwater Management

- Filling of building pads and roads will be used to manage groundwater so that adequate clearance is maintained between maximum estimated groundwater level and finished surface level.
- A subsoil drainage system is to be used in areas where clearance to groundwater is minimal.
- The perimeter bioretention garden and POS bioretention basins will include subsoils to manage groundwater beneath them.
- Inflows to the groundwater system will be treated through the perimeter bioretention system.
- A change in land use from livestock grazing to sewered residential will reduce nutrient loading to groundwater.

Monitoring And Maintenance

- Monitoring is to be undertaken through the construction phase of each stage for surface water and potential groundwater in relation to possible contamination;
- Post development monitoring is to consider surface and groundwater quality, ecosystem enhancement and WSUD structural performance

Implementation And Governance

- Developers are to undertake detailed UWMP's to provide the necessary information for management of water across the subject land;
- Developers are to undertake detailed Foreshore Management Plans to provide guidance on land management within the Collie River foreshore area.
- The Shire of Dardanup, the Department of Biodiversity, Conservation and Attractions and the Department of Water and Environmental Regulation are to continue to provide guidance, direction and assistance so that the targets outlined in this report are able to be realised.

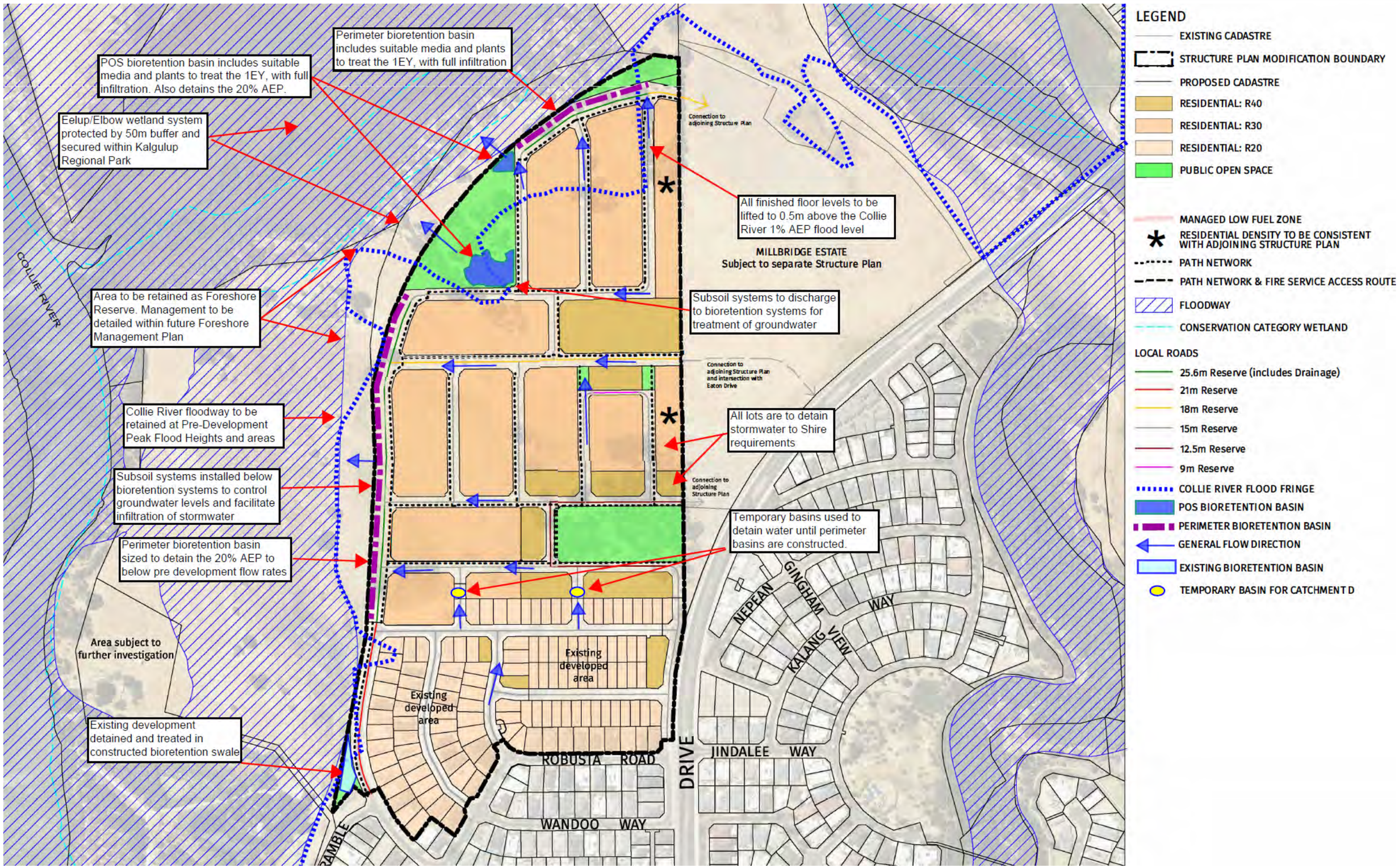


Figure 2 Key Elements Plan

3 GEOTECHNICAL

Golders completed a geotechnical investigation and preliminary acid sulphate soils investigation of the subject land in December 2005. The investigation included the installation of ten boreholes (BH01 to BH10) to a depth of 4m and the excavation of 35 soil investigation pits (TP01 to TP35) to approximately 2.5m deep (Figure 5).

Shortly after the investigation, a small area in the south-eastern corner of the site labelled the 'Borrow Area' was used for fill material. TME Brown completed an additional Geotechnical investigation in 2010 which focused on the Borrow Area and the extension to Peninsular Drive in the west. The investigation included 12 test holes in the Borrow Area and 3 test holes excavated within the future Peninsula Drive extension.

Test locations are shown on Figure 3.

3.1 GEOLOGY

The Bunbury-Burekup Sheet of the 1:50,000 Urban Geology Series maps (GSWA, 1986) indicates the surface geology across the site is characterised by Bassendean Sands (Qpb) overlying fine sandy clays of the Guildford Formation (Qpa). Alluvium sediments associated with river terraces are located adjacent to the subject land within the Collie River flood plain (Figure 4). Surface geology mapping is generally consistent with both geotechnical studies (Golders, 2005 and TME Brown, 2010).

3.2 SUBSURFACE CONDITIONS

As part of Golders geotechnical investigation for the site, subsurface conditions have been separated into 3 groups:

Group 1 (BH03, BH04, BH05 and BH06): A top layer of silty sand overlying fine to medium grained orange/grey sand to a depth of 3m.

Group 2 (BH01, BH02 and BH07) Sand overlying fine to medium grained clayey sand overlying medium grained brownish yellow sand to a depth of 1.7m to 4.0m.

Group 3 (BH08, BH09 and BH10) Silty sand top layer overlying medium to high plasticity mottled clayey sand to a depth of 1m to 3.7m.

Subsurface conditions noted in the TME Brown investigation were generally silty topsoil, overlying sand and sandy clay/ clayey sand to a depth of 2.30m. This agrees with the descriptions provided by Golders.

3.3 SOIL PERMEABILITY

As part of Golders geotechnical investigation, double ring infiltrometer testing was undertaken at two locations (TP05 and TP17). Results indicated soil infiltration rates in this area range between 0.43 to 0.50 m/day. The low permeability is likely due to the underlying clay layer found across the site.

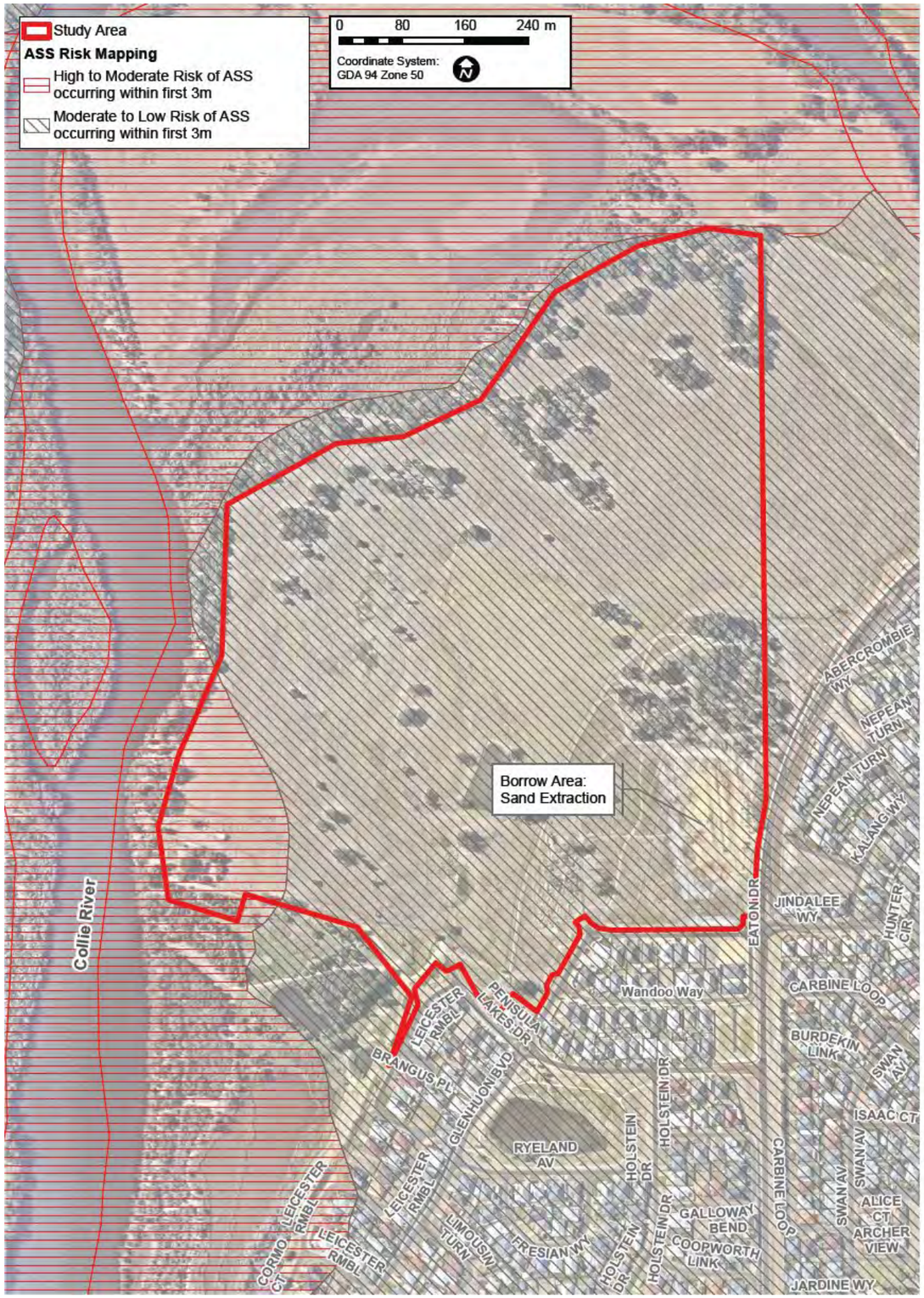
No infiltration testing was completed as part of the TME Brown investigation.

3.4 ACID SULFATE SOILS

Acid Sulfate Soil (ASS) risk mapping of the Swan Coastal Plain shows the majority of the site has moderate to low risk of ASS occurring within 3 m of soil surface. A small section in the south-west corner has been mapped as having high to moderate risk of ASS forming in the first 3m of soil surface. This can be seen in Figure 3.

Results of the preliminary acid sulfate soils assessments from both Golders and TME Brown (2005 and 2010) indicate actual acid sulfate soils can generally be expected to be encountered at depths of 3m or greater across the site and in soil material that has a high clay content.

Towards the northern section of the site, actual acid sulphate soils were encountered by Golders in BH08 to a depth of 1.25m with expected depths in this area even closer to surface. Iron flocing was also observed in ponded surface water in the area of BH08, BH09 and BH10, which is a field indicator of ASS.



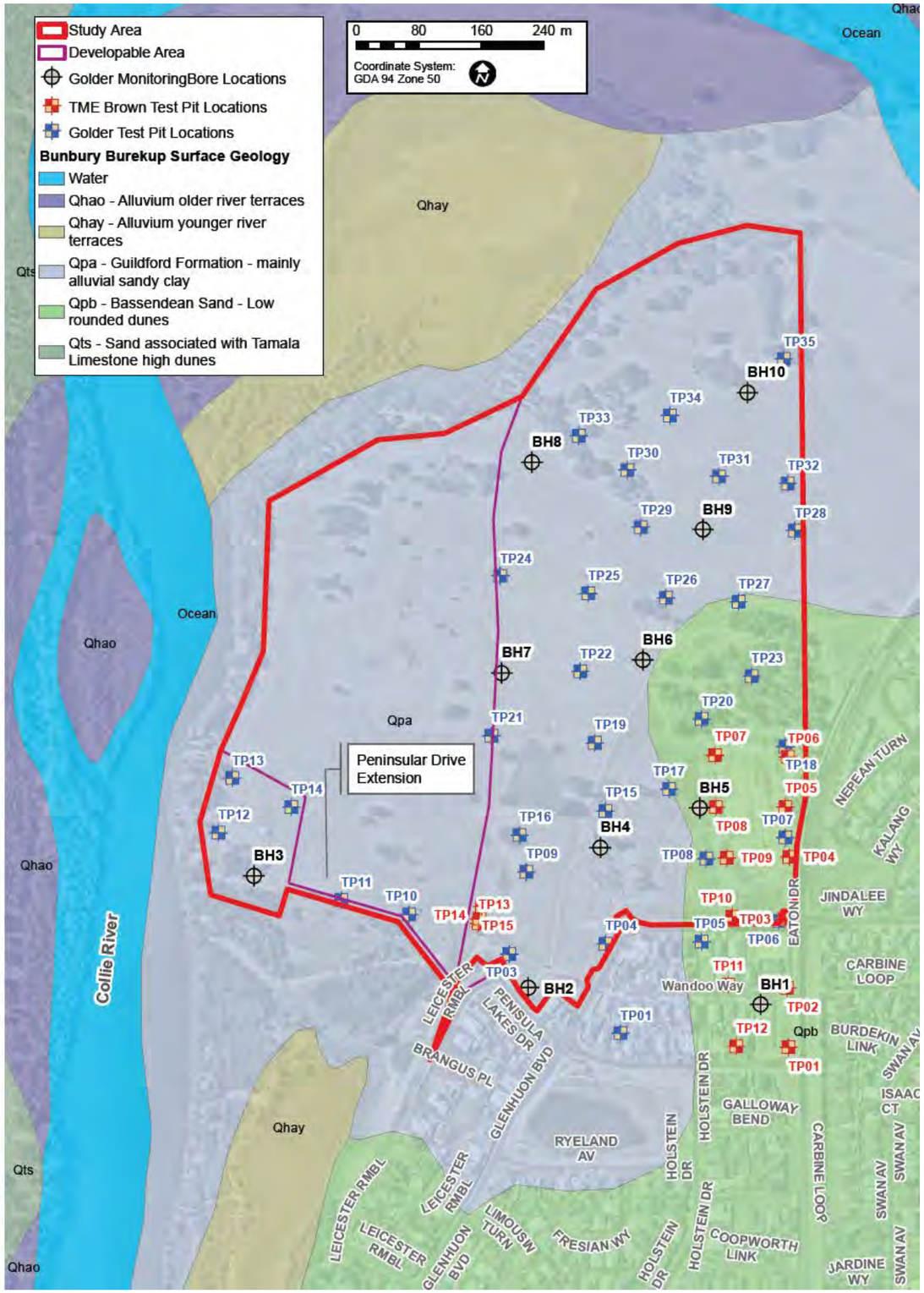


Figure 3 Surface Geology, ASS and Test Locations

4 LANDFORM AND ENVIRONMENTAL CONDITIONS

4.1 LANDFORM

The landform of the study area slopes east to west towards the Collie River at an average gradient of 1:100 (v:h). Undulating sand dunes and swampy low lying areas are evident across the site consistent with the geomorphology of the Collie River. Surface elevations range from 10.50mAHD in the south-eastern corner to 1.30mAHD along the northern boundary within the Collie River floodplain.



Undulating pasture looking westward towards Collie River

4.2 WETLANDS & VEGETATION

A large portion of the study area has been classified as Multiple Use wetland (UFI 1542 and 1383), which does not preclude urban development. Two Conservation Category wetlands (CCW) exist along the northern boundary of the subject land (UFI 1543, 1545). This includes the Eelup /Elbow Wetland system. A 50m buffer has been applied to the CCW areas with all development, associated with the subject land, located outside the buffer area.

Vegetation within the subject land has predominately been cleared and seeded with grass for pasture. There are sparse stands of riparian natives, including *Juncus* spp, *Melaleuca rhaphiophylla*, *Eucalyptus rudis* and *Casuarina obesa*. A large area of degraded *Corymbia callophylla* and *Agonis flexuosa* was noted on the eastern boundary of the subject land, which will be retained within the future POS.

There is some riparian revegetation, outside of the western boundary, along the Collie River. The broader study area includes wetland vegetation in reasonable condition, predominately within he Eelup/Elbow Wetland system.

4.3 WATERWAYS

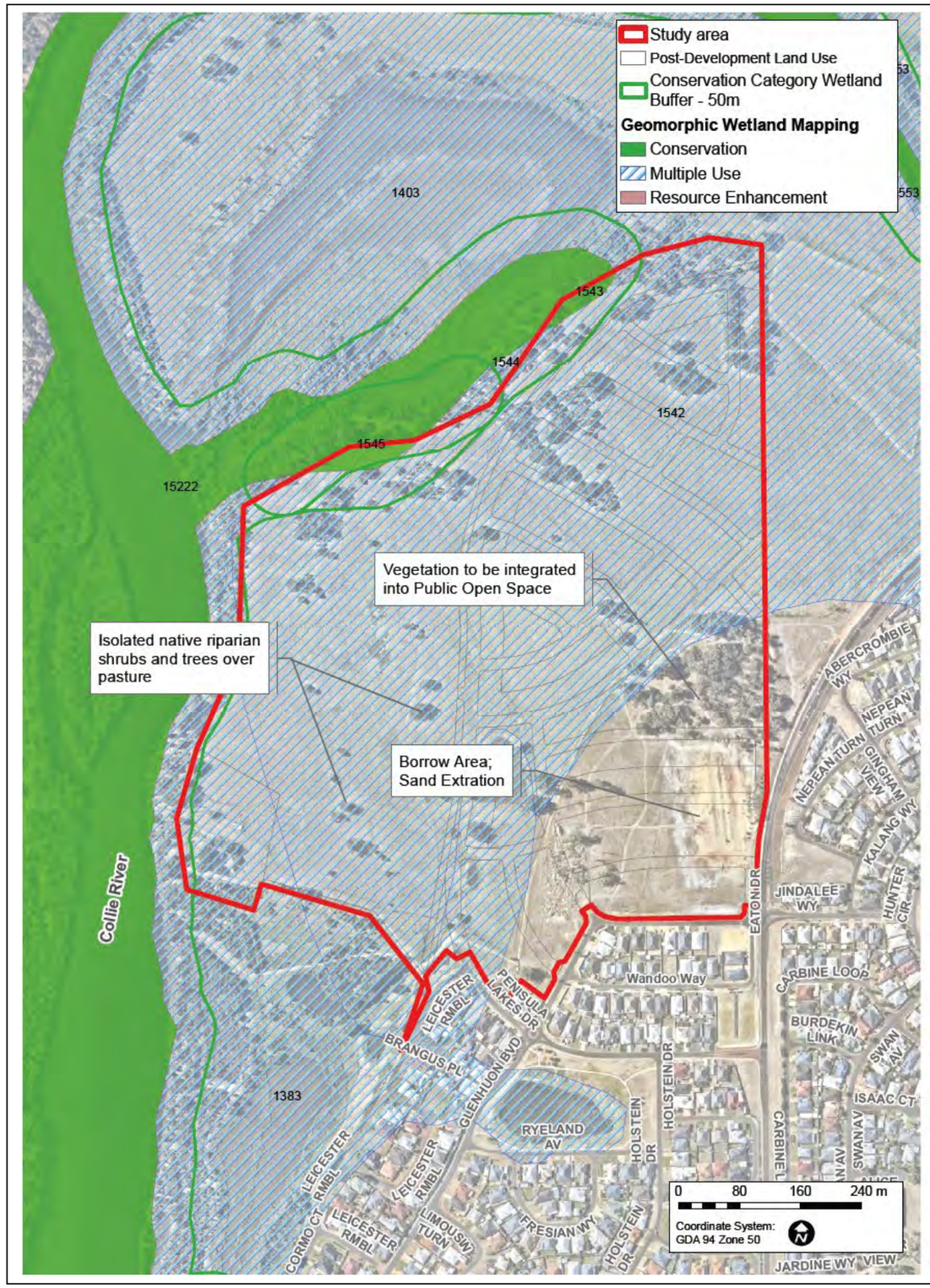
The subject land is presently serviced by the Collie River on the western boundary. The Collie River discharges south into the Leschenault Estuary and ultimately into the Indian Ocean (Figure 4).

4.4 KALGULUP REGIONAL PARK

The subject land is borders the Kalgulup Regional Park along the north and west boundaries. The park extends to the Colie River. The park is managed for conservation and recreational purposes.

4.5 CONTAMINATED SITES

A review of the Department of Water and Environmental Regulation's (DWER) Contaminated Sites Database (DWER, 2018) was undertaken with no known sites found within or in the vicinity of the subject land.



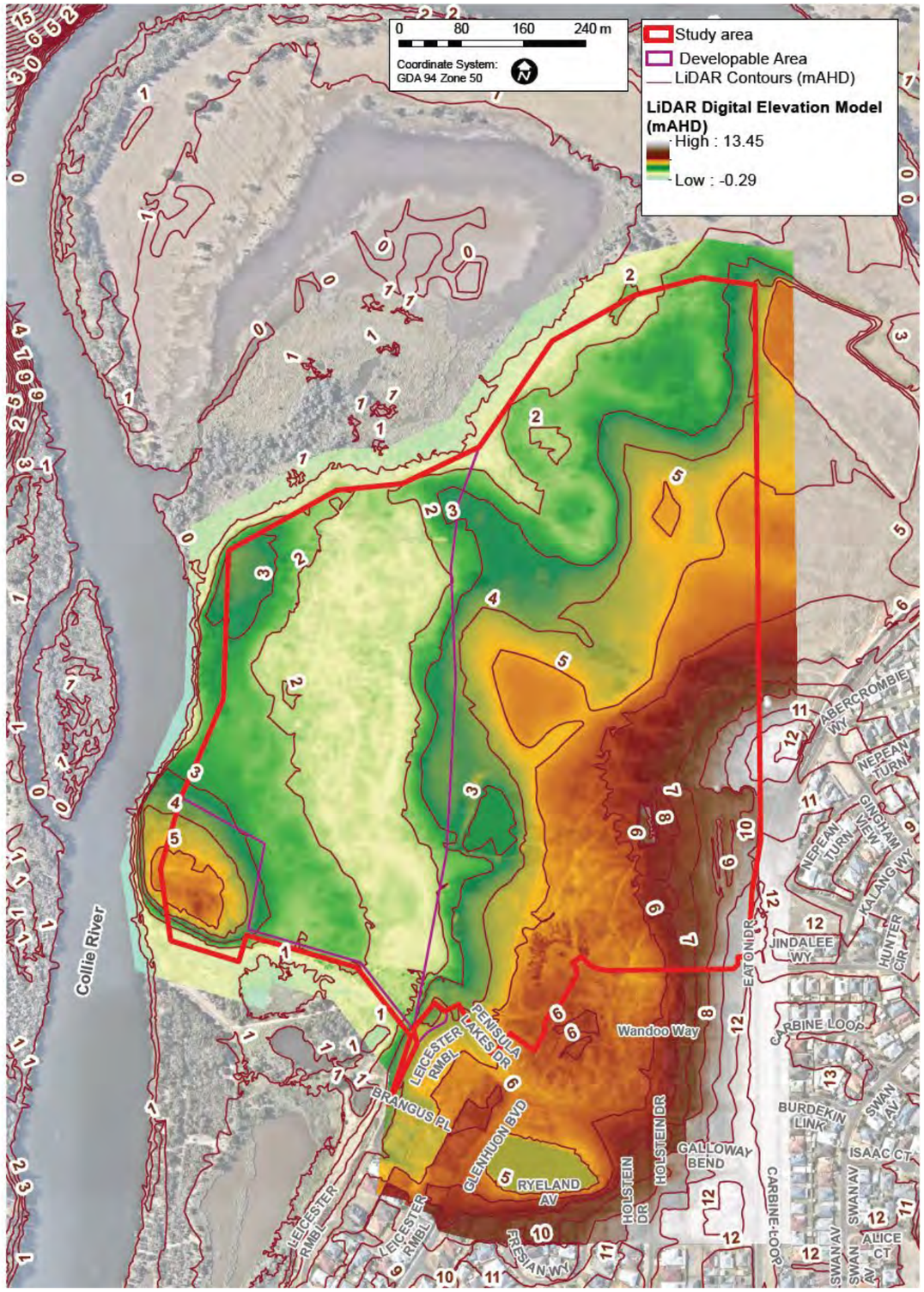


Figure 4 Landform and Wetlands

5 PRE DEVELOPMENT SURFACE WATER SITUATION

5.1 COLLIE RIVER FLOOD SUMMARY

Mapping of the 1% AEP Collie River floodplain and flood height contours was provided to Calibre by the Department of Water and Environmental Regulation. Inundation extents, the floodway and flood levels for the current subject land are shown on Figure 5, with Figure 6 showing the broader floodplain. The peak flood elevation adjacent to the subject land drops from approximately 2.9mAHD in the north to 2.7mAHD in the south. These values have been used as a constant backwater condition in the pre-development modelling for the subject land, summarised below.

5.2 ORIGINAL INTERNAL CATCHMENT ASSESSMENT

The original pre-development modelling involved the division of the site and hydrologically connected areas into 8 pre-development catchments, A through H, ranging in size from 0.75 ha to 16.10 ha. The catchment extents focused on the developable areas within the site and excluded the low-lying floodplain area in the western portion of the subject land. The catchments can be seen in Figure 7.

An analysis of the surrounding development area found Eaton Rd currently acts as a catchment boundary with internal drainage within the road discharging north via an extensive pit and pipe network, towards Collie River. East of Eaton Drive, the existing development discharges towards Millbridge Creek, a tributary of the Collie River.

A small portion of existing development south of the subject land has its own treatment network of roadside bioretention gardens and is noted as Cat-F (Figure 7). Runoff coefficients for Cat-F are based on average lot size, with residential lots assumed to infiltrate the 1 in 1 storm event on site and overflow into the road reserve in larger storm events. A small grouped housing site in the south- east corner of CAT-F is assumed to have a direct lot connection to the Wandoo Way road drainage network. This water is directed to the south west and away from the future development areas.

Roughness coefficients and corresponding runoff coefficients were then assigned to each catchment based on the breakdown of land uses (digitally identified from aerial imagery), surface geology and surface slope towards Collie River. Peak flood elevations within the Collie River were utilised as constant backwater conditions within the model.

Table 1 provides a summary of these catchments, their corresponding land usages by area and peak flow rates for critical storm durations. Table 2 provides a summary of the roughness values used in the modelling of pre-development catchment conditions.

5.3 REFINEMENT FOR CATCHMENT AREAS THAT DON'T FEED EXISTING BUILT BASINS

Further modelling was undertaken to reflect the areas of the current structure plan that do not feed to existing drainage basins. This was to allow for a comparison of pre and post development flows that will discharge to future treatment and detention systems. The catchment areas used for this analysis can be seen in Figure 5, with the results outlined in Table 3. The new modelled areas are effectively a subset of the original catchments Cat-A to Cat-C (29.85ha). The new Catchment D1 is partially constructed and is being drained to temporary basins. It will ultimately feed through to the proposed perimeter bioretention swale. The updated modelling assumed that all areas that are currently developed and discharging to temporary basis were still in a pre development state. DRAINS was used for the refinement modelling. Further modelling assumptions include:

- Soil Factor 2.85 used (Moderate surface infiltration with shallow confining layers)
- Antecedent Moisture Condition 3 used (12- 25mm of rainfall in preceding 5 days)
- Catchments 98% pervious

In the critical 20% AEP storm, the pro rata flow rate from the original modelling would have been 0.297m3/s. The revised modelling discharge rate is 0.309m3/s, which has a difference of less than 10% and therefore suitable for comparing pre and post development flow rates for the revised Structure Plan Area.

The 1EY critical events were the 1.5hour event, with the 20% AEP peaking in the 2-hour event and the 1% AEP peaking in the 25min event.

5.4 SURFACE WATER QUALITY

The subject area sits within the Leschenault Estuary Catchment and as such is covered by the Leschenault Estuary Water Quality Improvement Plan (WQIP). The Estuary and its tributaries are also a Management Area proclaimed under the Waterways Conservation Act 1976 and a catchment included in the state government's Regional Estuary initiative.

The subject area discharges west towards the Collie River and ultimately the Leschenault Estuary.

No surface water quality monitoring has been undertaken specifically for this project. There have been some water quality monitoring results recorded as part of the Leschenault Estuary WQIP. The average winter water quality for Total Nitrogen and Total Phosphorus within the Lower Collie River 1 catchment is 1.5 mg/L and 0.18 mg/L, respectively.

In general, the elevated nutrient levels, for the waterways linked to the site, are due to current farming practices (beef and dairy). The Lower Collie River 1 catchment is considered a recovery catchment in the WQIP, due to elevated nutrient levels. This classification specifies a target Total Nitrogen and Total Phosphorus concentration of 1.0 mg/L and 0.1 mg/L, respectively.

Table 1 Original Pre-Development Internal Catchment Areas and Peak Flows

Catchment	Area (ha)	Peak Flow (m³/s)		
		1EY	20% AEP	1% AEP
A	16.10	0.074	0.170	0.305
B	12.40	0.070	0.146	0.273
C	1.35	0.013	0.025	0.047
D	12.55	0.075	0.152	0.281
E	2.20	0.020	0.038	0.074
F	3.55	0.067	0.090	0.168
G	5.00	0.037	0.073	0.141
H	0.75	0.004	0.008	0.016
TOTAL	**53.90**	**0.360**	**0.702**	**1.305**

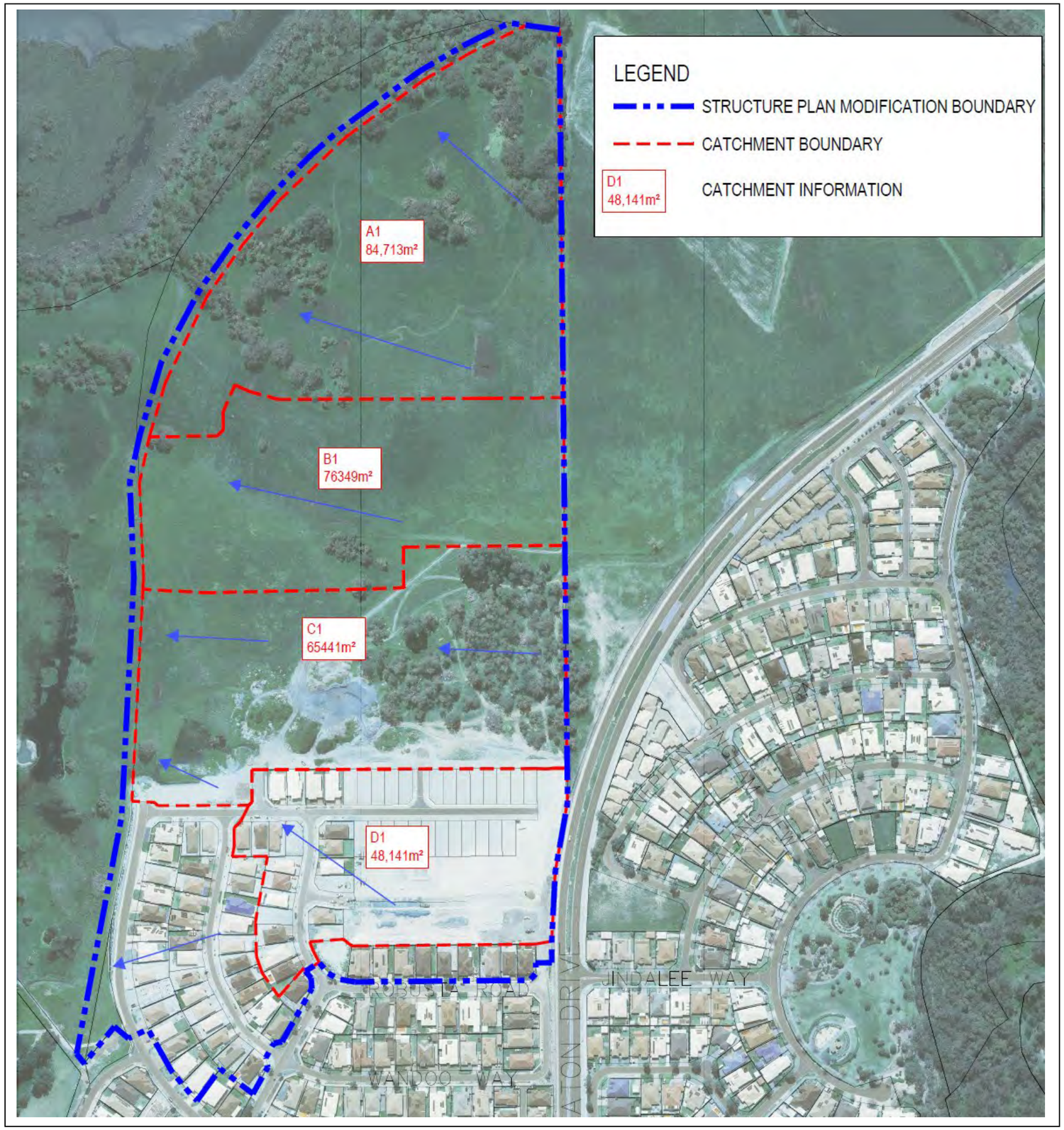
Table 2 Original LWMS Manning's Roughness N' and Runoff Assumptions by Land Use

Land Use	Runoff Assumptions		Mannings n	
	Initial Loss (mm)	Runoff Percentage (%)	Impervious Roughness	Pervious Roughness
Cleared (Pasture)	-	25	0.020	0.035
Vegetation	-	20	0.020	0.040
Open Water	-	90	0.014	0.030
Residential (R2)	11	70	0.014	0.030
Grouped Housing	-	80	0.014	0.030
Road Reserve	-	80	0.014	0.030

Table 3 Revised Pre-Development Internal Catchment Areas and Peak Flows

Catchment	Area (ha)	1EY		20% AEP		1% AEP	
		Flow rate (m3/s)	Critical event	Flow rate (m3/s)	Critical event	Flow rate (m3/s)	Critical event
A1	84731	0.003	1.5hr	0.099	2hr	1.32	25min
B1	76349	0.002	1.5hr	0.09	2hr	1.19	25min
C1	65441	0.002	1.5hr	0.081	2hr	1.03	25min
D1	48141	0.001	1.5hr	0.059	2hr	0.754	25min
Total	274662	0.008	1.5hr	0.329	2hr	4.294	25min

Figure 5 Revised catchments for future perimeter basins



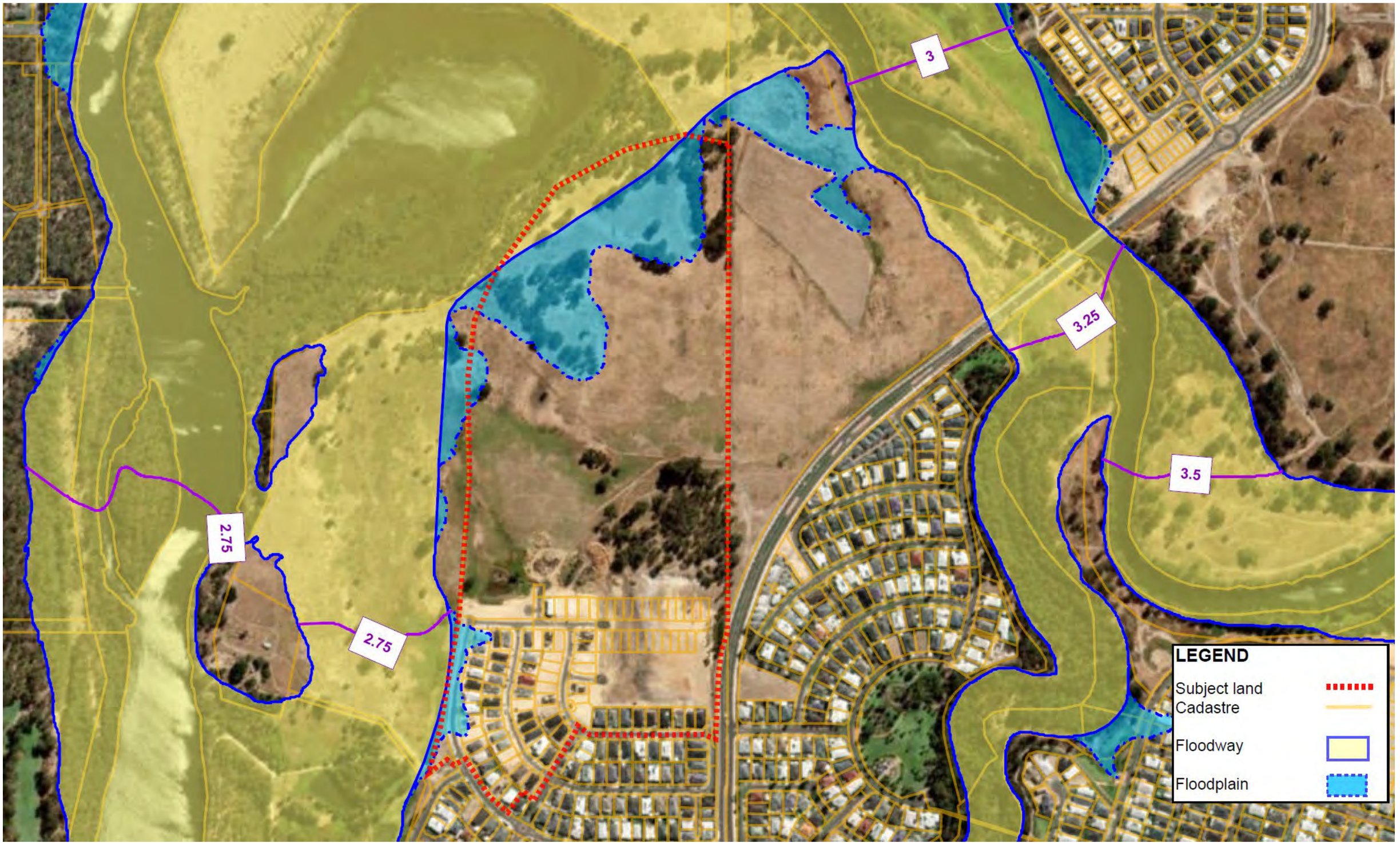
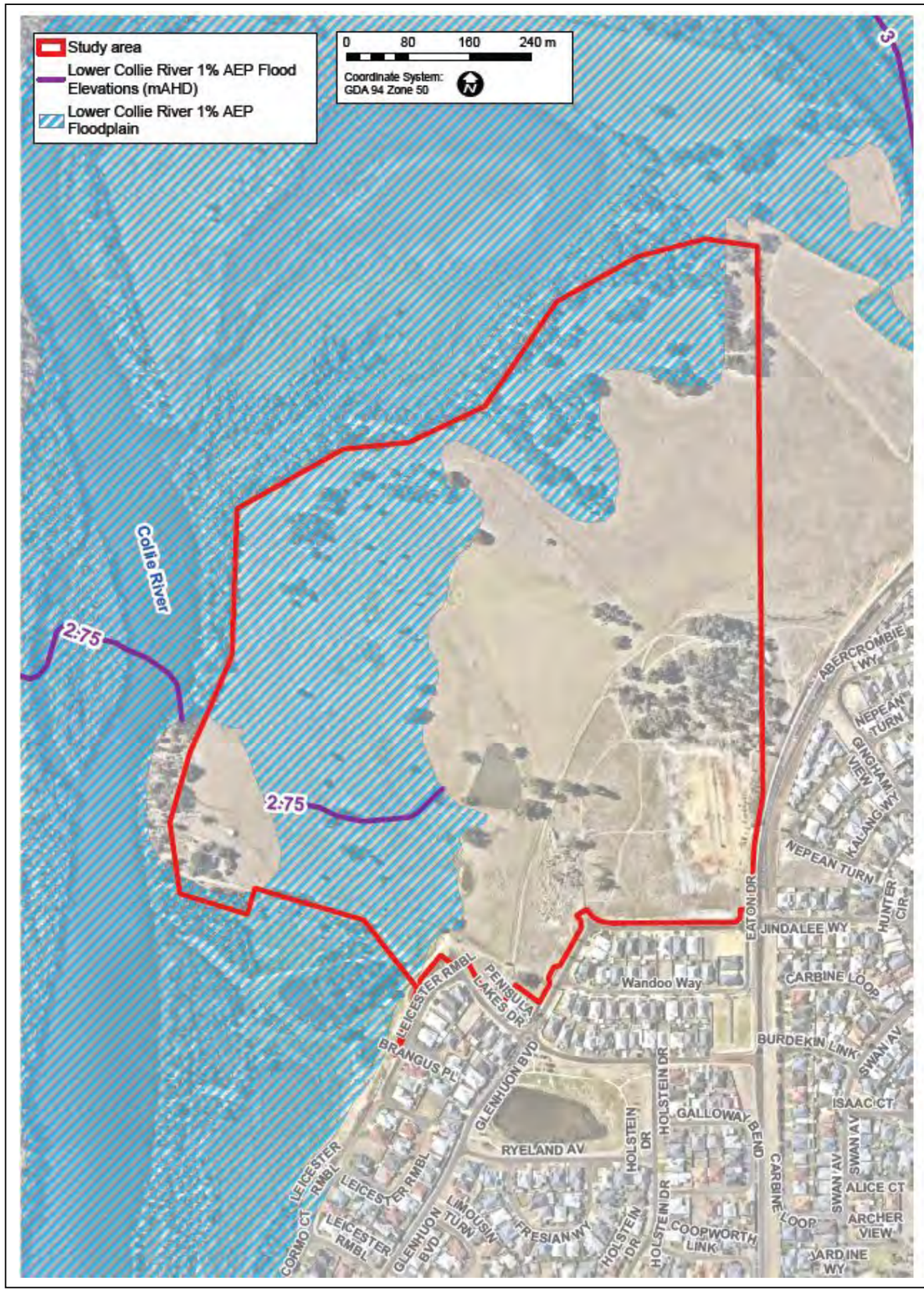


Figure 6 Current subject land with floodway and floodplain mapping



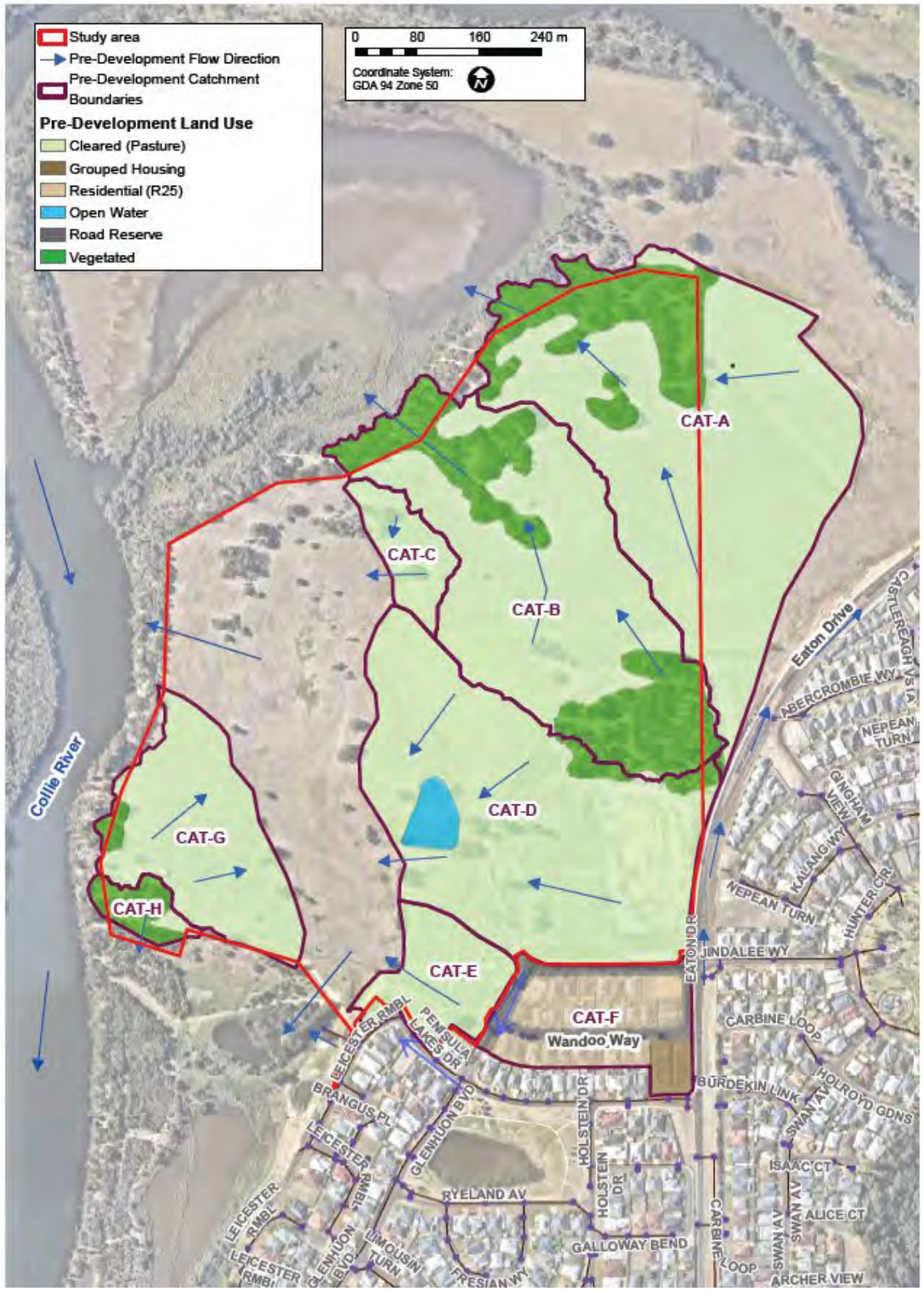


Figure 7 Pre development catchments and Collie River flood extents

6 GROUNDWATER (PRE DEVELOPMENT)

6.1 GROUNDWATER LEVELS

To determine likely seasonal maximum groundwater levels across the subject land, onsite groundwater level monitoring was undertaken by Calibre (as TME) between May 2009 and October 2010. The investigation included the installation of 23 monitoring bores across the site, to a depth of approximately 2.1m Below Natural Surface (BNS).

As required by DWER groundwater levels were measured across two winter periods, with a total of 10 monitoring events for each bore. The maximum recorded groundwater level occurred in 2009, which coincides with an above average rainfall year (1975 to 2017, Rainfall Station No. 009657).

Maximum groundwater levels, estimated maximum groundwater contours and depth to groundwater are shown on Figure 8. Groundwater levels generally fall towards the low lying areas of the Collie River floodplain, from east to west with depth to groundwater ranging from above surface to 5.6m BNS.

Groundwater level hydrographs, taken from the monitoring report, are included in Figures 6 and 7.

Groundwater was also found in 27 of the 35 test pits as part of the Geotechnical Investigation (Golder Associates, 2005). Groundwater depth ranged between 0.3 and 2.0 m BNS, consistent with Calibre monitoring results. The rate of groundwater inflow into the test pits was generally observed to be very slow or slow in areas with clayey material at shallow depth. This was considered to be related to perched groundwater sitting above semi-impermeable clayey material and the associated low permeability of the clayey material.

6.2 GROUNDWATER QUALITY

Groundwater quality sampling has not been undertaken to date. It is likely that the groundwater will be typical of Swan Coastal Plain Bassendean sand farmland. As such it is likely to have elevated levels of nutrients, be high in Iron and Aluminium and slightly acidic.

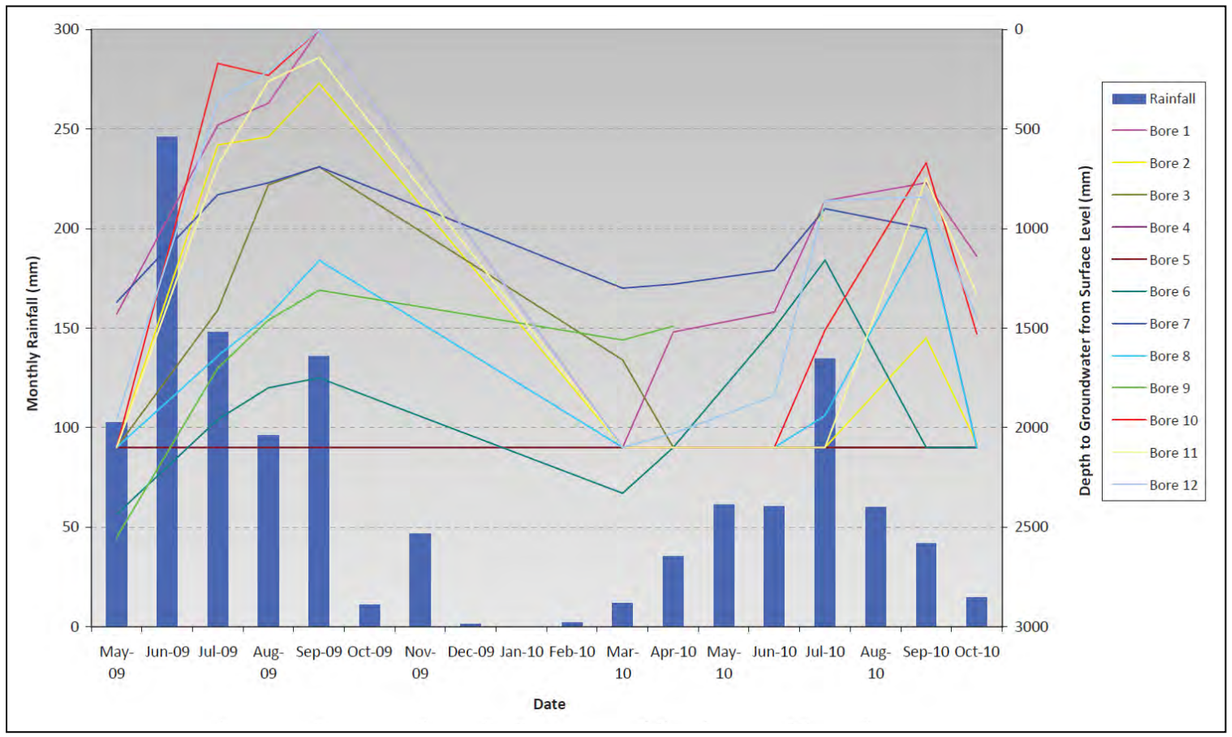


Figure 8 Groundwater Level Hydrographs: Monitoring Bores 1 to 12

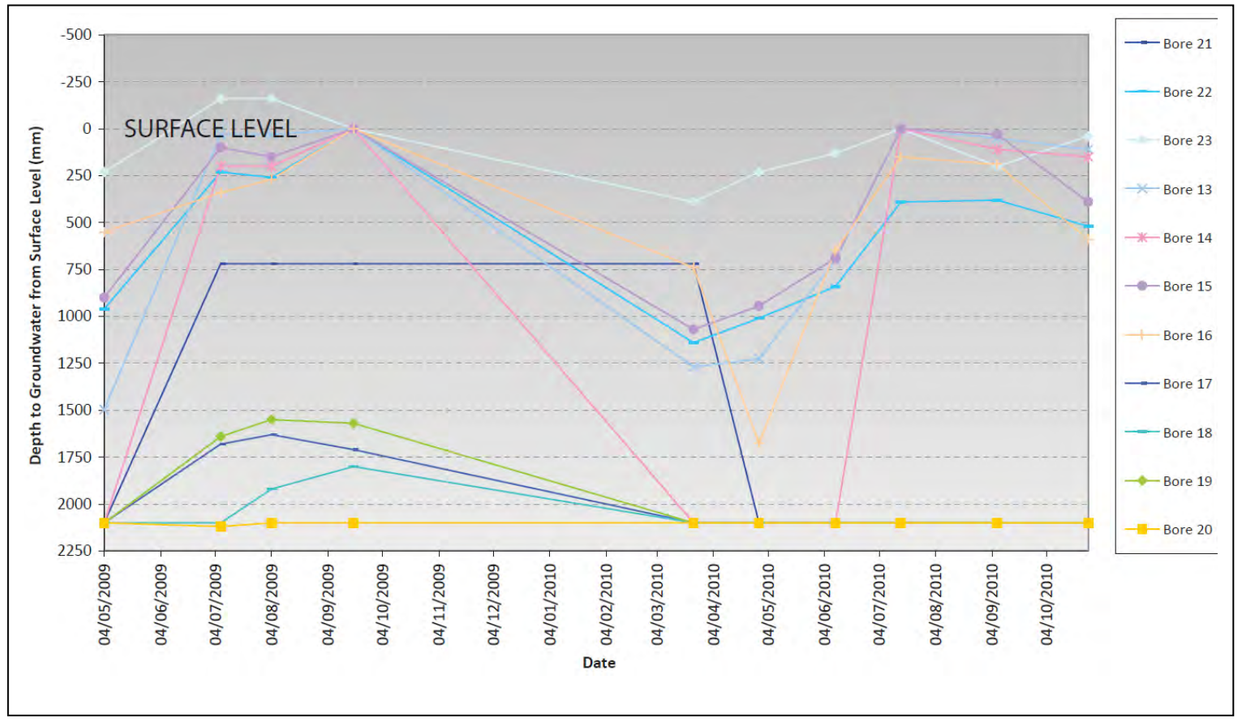


Figure 9 Groundwater level hydrographs: Monitoring Bores 13 to 23

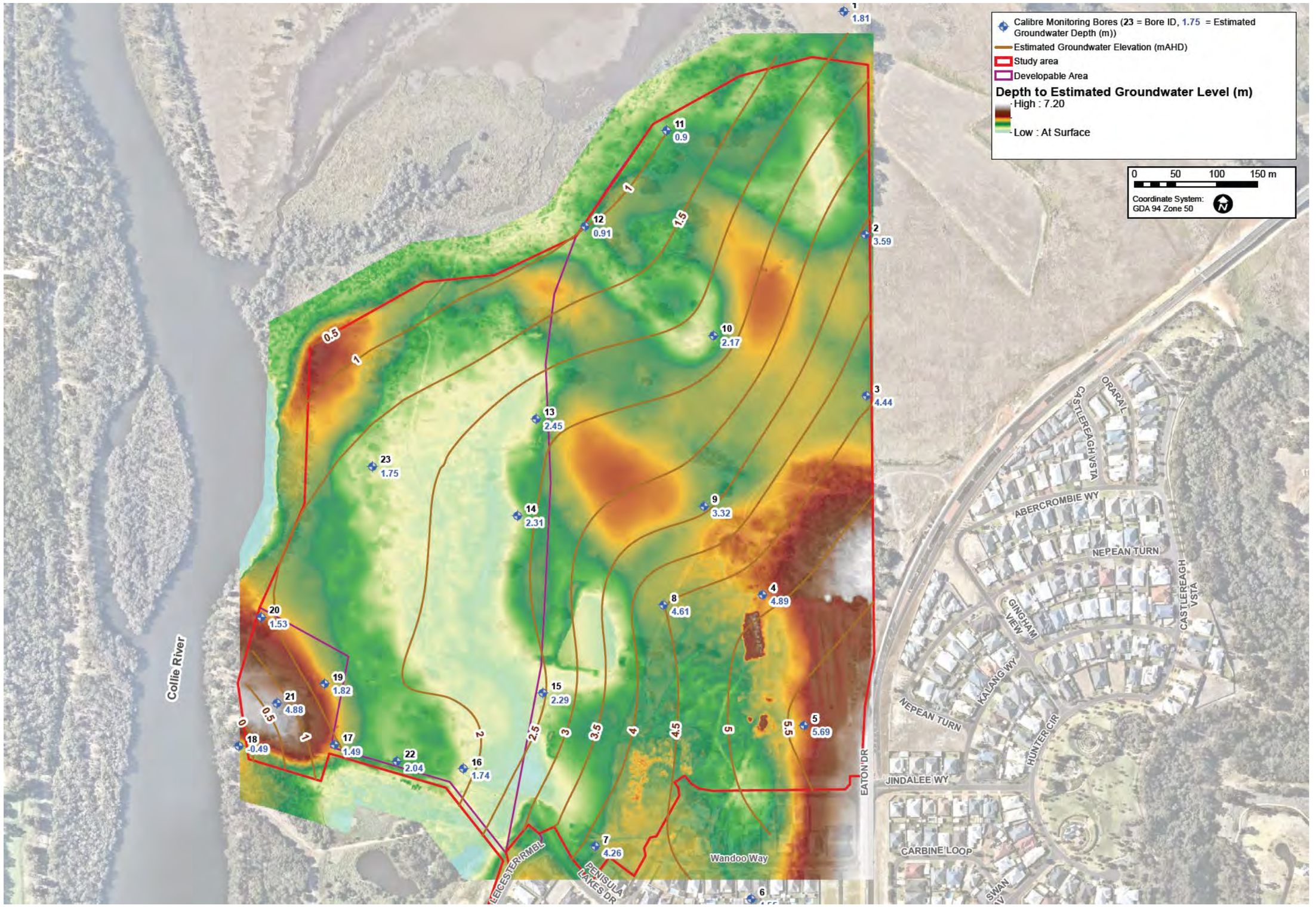


Figure 10 Groundwater depths and monitoring bore locations

7 DRAINAGE MANAGEMENT STRATEGY OVERVIEW

7.1 SUMMARY

The aim of Drainage Management for the subject land is to generally manage the water flows so that water treatment is achieved and that the major storms are controlled prior to release.

All flows up to the 1EY are to be treated to reduce nutrients, sediments and other contaminant prior to discharge offsite. Above the 1EY, the main function is to control the flow of drainage water throughout the subject land and its release from the subdivision. This water will predominately be captured and infiltrated while protecting lots from internally generated flooding and regional floods from the Collie River.

Figure 11 shows the catchment boundaries, including the areas already finalised as well as the partially constructed areas draining to temporary basins.

The following sections show in more detail how water is treated and conveyed in three different AEP scenarios;

- 7.3 – 1EY
- 7.4 – 20%AEP
- 7.5 – 1% AEP

This builds on the previous assessment undertaken as part of the approve LWMS and takes into account the changed catchment boundaries and road layout. It also considers the works approved as part of the Parkridge Estate Stages 3 & 4 Urban Water Management Plan. Any areas remaining the same as the approved LWMS or dealt with in the UWMP in detail were not remodelled. The original LWMS also showed Catchment F flows going into Catchment C1/D1, however this water is now directed to the south west, bypassing the Structure Plan area. Figure 11 show the general flow direction of each of the remodelled catchments.

7.2 MODELLING

The proposed development is designed to achieve a water sensitive design outcome for the 1EY, 20% AEP and 1% AEP. The system has been designed so that it achieves these outcomes while also controlling groundwater rise via subsoils.

The post development modelling has been updated from the approved LWMS to take into account the revised catchment areas due to the new layout (where relevant). The outflow rates have been designed to match the previously approved outflow rates and the revised pre development modelling (see Section 5). The permitter bioretention basin has been retained for the area developed as part of the approved UWMP. The future development areas will also drain to two new perimeter bioretention basins located within the road reserve as well as two POS basins. The original catchments A-D have been refined into 4 catchments A1-D1, with D1 representing the area already partially constructed. A1 has been further divided (A1x, A1y and A1z) to reflect the potential for 3 different detention systems, working in combination. Each catchment has been further divided in the model to reflect the roads and lots as different entities, as well as the POS areas. This allows for modelling of the lots for onsite detention. The catchment details can be seen in Table 4, while the basin details are in Table 5. The catchment boundaries as well as the future basins are shown in Figure 11.

A cross section of the perimeter bioretention basin can be seen in Figure 12. This highlights the shape and detention area. It also details the subsoil beneath the system to control groundwater rise, allowing the system to infiltrate effectively throughout the year. As a failsafe, trickle outlet pipes at the basin floor invert will also be installed. These are to have screw caps installed to stop any flow, unless there is an issue with the basin that results in extended standing water. The caps can then be undone to allow the held water to drain away. Once the issue has been rectified the caps can be screwed back on.
While the pocket parks higher in the catchment may contain bioretention gardens, to be conservative, these have not been included in the current drainage modelling.

Table 4 A1 – D1 Catchment details

Catchment	Catchment areas (m^2)					Discharge point
	Lots - *General*	Lots – *Group Housing*	POS	Road	Total	
A1x	27484		2996	10986	41466	Perimeter Road Basin 1 (northern roadside basin, then foreshore)
A1y	3097		2621	2178	7896	POS Basin 1 (POS basin in corner, then foreshore)
A1x	12620	2639	12518	7592	35369	POS Basin 2 (POS basin in corner, then foreshore)
B1	51204	2638	900	21607	76349	Perimeter Road Basin 2 (southern roadside basin, then POS Basin 2/foreshore)
C1	35512		11593	18336	65441	
D1	35042		0	13099	48141	
Total	164959	5277	30628	73798	274662	

The post development key modelling assumptions and characteristics are as follows:

- The modelling used ARR rainfall figures for Bunbury.
- Catchments were designed to be logical areas of stormwater capture and discharge.
- Areas previously developed and not contributing to new detention systems were not remodelled.
- General Lots were assumed to be 70% impervious, of which 10% is supplementary impervious (eg initially flows to pervious areas as overland flow).
- Group Housing Lots were assumed to be 80% impervious, of which 10% is supplementary impervious (eg initially flows to pervious areas as overland flow).
- Road areas were assumed to be 80% impervious (road and footpath).
- Directly connected impervious areas had an assumed retardance coefficient of 0.01, while indirectly connected impervious areas had an assumed retardance factor of 0.13.
- Pervious surfaces (eg areas of grass or landscaping) were assumed to have a conservative retardance coefficient of 0.1 for Lots and Roads and 0.2 for POS areas.
- Lots are assumed to detain the stormwater in soakwells at $1m^3$ of storage for every $65m^2$ of impervious area. Above this they are assumed to discharge to the roadside gutter as overland flow.
- On lot infiltration was assumed to be 2m/day and modelled with 1.2m deep soakwells (noting that shallower soakwells or other infiltration systems may be used, provided at least 0.3m of separation to groundwater available).
- The bioretention media is assumed to have a hydraulic conductivity of 2m/day which is a conservative estimate to account for potential clogging of the bioretention media (3.6-7.2m/day is in line with FAWB guidelines).
- The sides of the POS basins was assumed to have an infiltration rate of 3m/day, while the perimeter road side basins had none(as these are composed of limestone blocks).
- The basin systems have been modelled as per Table 5.
- The final storms modelled were the 5min,10min,15min, 20min,25min, 30min, 45min, 1 hr, 1.5hr 2hr, 3hr, 4.5hr and 6 hr. Longer events were not modelled as the peak events were generally between 25min and 2 hours. These were modelled for the 1EY, 20% AEP and 1% AEP.

Table 5 Basin details for catchment A1- D1

Catchment	Detention structure name	Basin details						Comments
		Total height (m)	Low flow Outlet pit level (m)	Overflow weir height (m)	Surface area (m^2)	Volume to weir (m^3)	Side slope	
A1x	Perimeter Basin 2	0.6	Outlet pipe at basin invert	0.55	798	439	Straight block	Flows directly into Basin 2
A1y	POS Basin 2	0.6	0.38	0.5	112	21.3	1 in 6	Outlet pipe discharges to foreshore spreader
A1z	POS Basin 1	0.6	0.17	0.5	1992	818	1 in 6	Outlet pipe discharges to foreshore spreader
B1	Perimeter Basin 2	0.6	Outlet pipe at basin invert	0.55	1680	924	Straight block	Flows directly into Basin 1
C1								
D1								
Total					4582	2202.3		

Note: Heights are from basin base.

7.3 1EY STORM EVENT AND WATER QUALITY

The 1EY detention and treatment will use a combination of on lot infiltration and the bioretention basins. The design parameters for treatment and attenuation of minor storms (up to the 1EY event), will be to provide treatment area within the bioretention basins. The treatment areas have been maximised and exceed the 2% minimum area for bioretention areas per effective impervious catchment due to also being the base of the basins for the 20% AEP.

The outlet pipe inverts are set so that the entire 1EY event is infiltrated through the bioretention media.

The bioretention systems will be layered with bioretention media and planted with appropriate species to assist with treatment of low flows. These species will be composed of *Ficinia nodosa* and *Juncus subsecundus* under a range of Melaleuca species.

The bioretention areas are designed according to the latest FAWB Adoption Guidelines for Filter Media in Biofiltration Systems and the Stormwater Management Manual for WA design guidelines. The design for the gardens is composed of a filter media of amended soils to 500mm below the surface, with an average particle size of 0.5mm. The plants will also assist with nutrient absorption because of the surface area provided by their roots for the formation of bio-films and nutrient uptake.

In summary the media will:

- have a hydraulic conductivity of 100-300mm/hr
- have the top 100mm to be ameliorated with appropriate organic matter and trace elements to assist plant establishment (see table 1 in the attachment)
- have a transition layer to be a washed sand (100mm deep)
- have impermeable side barriers eg plastic to stop water flowing sideways preferentially and not being treated.

The bioretention areas should only require sporadic tankering irrigation during the initial 2 to 3 years of establishment when there is extended dry weather. They should require no fertiliser application and irrigation demands should be met by stormwater alone, after this initial establishment period. The gardens will be designed to assist in the removal of nutrients, sediments and other potential contaminants from stormwater as the water infiltrates through to the groundwater.

A subsoil line is to be laid below the bioretention gardens to assist with taking treated water away and controlling localised groundwater mounding. This can be seen in Figure 12.

Table 6 1EY Post development storage and discharge details for catchments A1 – D1.

Catchment	1EY						
	Flow rate (m^3/s)	Critical event	Water height (m)				Total Stored Volume (m^3)
			Perimeter Basin 1	POS Basin 1	POS Basin 2	Perimeter Basin 2	
A1	0	NA		0.17	0.11	0.08	320
B1, C1, D1	0	NA	0.17				291
Total	**0**						**611**

Note: Flow rate is the rate of discharge to the foreshore

7.4 DRAINAGE MANAGEMENT PLAN – 20%AEP

Key points for the design of the major drainage system are as follows.

Peak outflow discharging into the Collie River floodplain will equal or be less than pre-development 20% AEP flows. The outlet pipes will have a rock spreader and then discharge to densely planted area to assist with erosion, while also improving habitat and water quality. All outflow is via pipes and there is no weir flow out in the 20% AEP.

In events greater than the 20% AEP, up to the 1% AEP, stormwater runoff will discharge into the Collie River floodplain via a combination of the outlet pipe and overflow weirs.

The rural area adjacent to the north-eastern boundary of the subject land is currently hydrologically connected to Catchment A**1**. In the post-development scenario, flow generated within the retained rural area will discharge towards the Catchment A**1** development boundary where a spoon drain adjacent to the imported fill will guide flows towards the Collie River. This will continue until such time as the land to the east is developed.

Details of the 20% AEP stormwater storage and discharge are provided Table 7. The discharge is conservatively below the pre development 20% AEP, allowing for refinement of storage areas as part of detailed design. A comparison of the pre and post flow rates can be seen in Table 9.

Quality

It is not an objective of managing the 20% AEP events to treat for water quality, but the bioretention systems, combined with the on lot soakwells will allow for some trapping and settling of suspended sediments, especially after the flood peak has passed. This is primarily due to the residence time in the storage structures. All water infiltrating through the soil profile during the 20%AEP event will receive treatment as it moves through the bioretention media or soil profile.

Table 7 20% AEP Post development storage and discharge details for catchments A1 – D1.

Catchment	20% AEP						
	Flow rate (m^3/s)	Critical event	Water height (m)				Total stored Volume (m^3)
			Perimeter Basin 1	POS Basin 1	POS Basin 2	Perimeter Basin 2	
A1	0.294	2hr		0.495	0.42	0.42	442.4
B1, C1, D1	0	NA	0.51				936.8
Total	**0.294**						**1379.2**

Note: 1% AEP storage volume includes minor flooding (less than 0.1m deep of POS area around basin)

7.5 DRAINAGE MANAGEMENT PLAN – 1%AEP

7.5.1 Regional flood modelling

The proposed development currently lies within the Collie River 1% AEP flood extent. To determine how filling and development within the floodplain affects the hydrology of the Collie River, a flood impact assessment was completed by SKM (SKM, 2007). The assessment included a 2 dimensional hydraulic model of the site, which was calibrated against existing flood extents provided by DWER. The model was created within the MIKE-21 flood modelling package, utilising channel cross-sections used in the Public Works Department (1981) flood study.

The model replicated three development scenarios with each measured in relation to the change in water level at key locations downstream and upstream of the site. This LWMS represents development Scenario 1, which is currently approved. Results of Scenario 1 indicates no change in the 1% AEP top water level upstream or downstream of the site and a 1cm rise in the river channel adjacent to the site.

The area of fill has not changed since the original LWMS was approved, so there has been no change in flood impacts.

7.5.2 On site flood modelling

The Subject area has been designed to safely manage the 1% AEP flood event so that impacts on the subject land and downstream infrastructure, the environment and people's safety are minimised.

All floor levels will be set a minimum of 500mm above the relevant adjoining 1% AEP flood level of the Collie River and 300mm above internally generated flows. For the flood separation from the Collie River flood, the finished floor levels will be a minimum of 3.2mAHD in the south, grading through to 3.4mAHD in the north.

In the 1% AEP event, the 1EY system and 20%AEP systems will fill to overflowing. Water will then flow along the roads to the bioretention basins. Stormwater will fill and spill over the broad weirs to disperse the flow. Spillways will be treated with rock pitching to prevent erosion. The stored volume and discharge rate can be seen in Table 8.

While there is not a need to detain to pre development levels in the 1% AEP, due to adjoining the Collie River, the detention provided for the 20% AEP means that the post development flow in the 1%AEP post development scenario is less than the Pre development situation. A comparison can be seen in Table 9.

Table 8 1% AEP Post development storage and discharge details for catchments A1 – D1.

Catchment	1% AEP	
	Flow rate (m^3/s)	Critical event
A1	1.76	1.5hr
B1, C1, D1	2.26	30min
Total	**4.02**	

Table 9 Pre vs Post development flow summary for catchment A1-D1

Scenario	Discharge rate (m^3/sec)		
	1EY	20% AEP	1% AEP
Pre development	0.008	0.329	4.294
Post Development	0.0	0.294	4.02

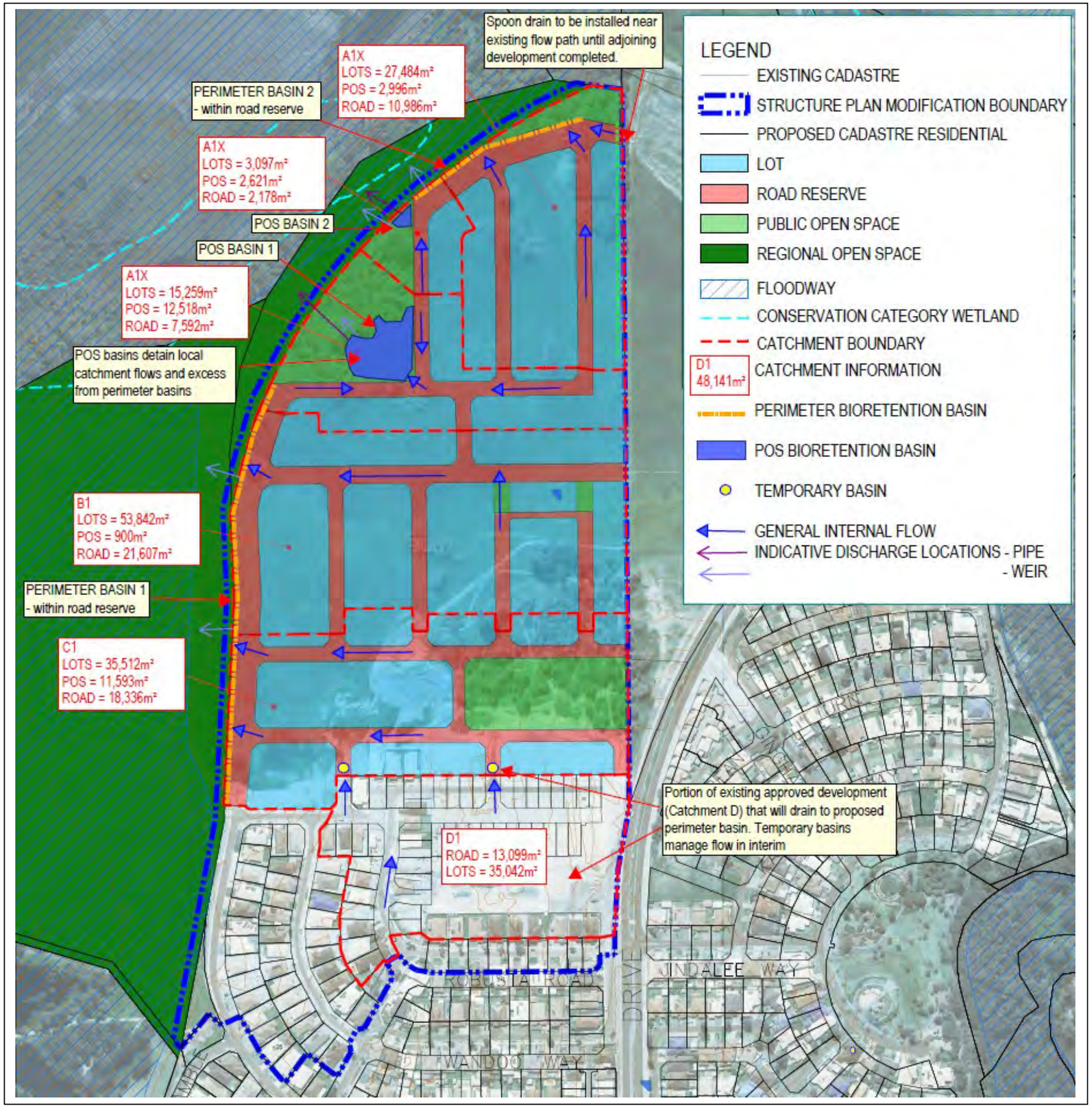


Figure 11 Post Development Drainage Plan

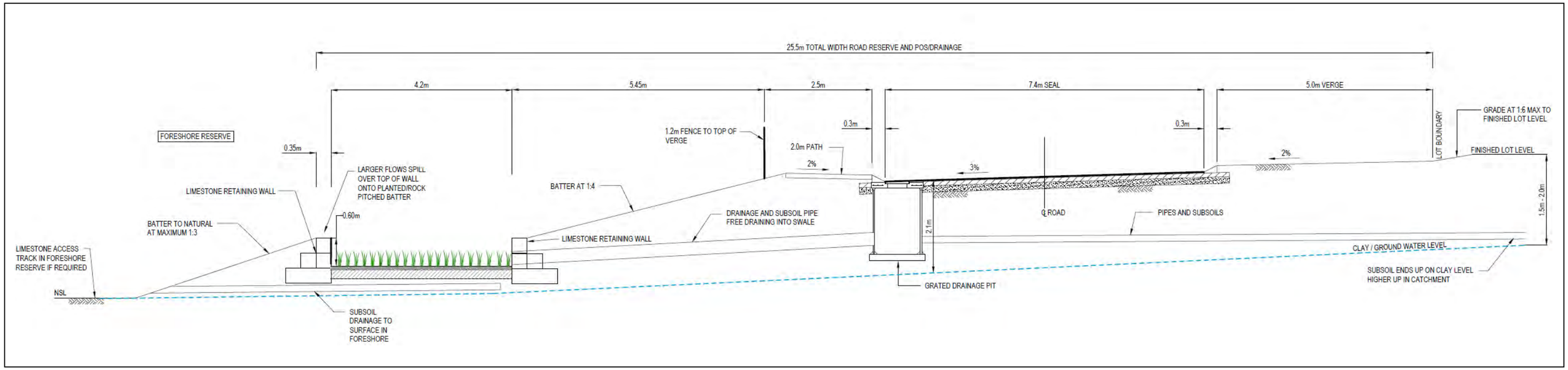


Figure 12 Cross section of perimeter bioretention swale

8 GROUNDWATER MANAGEMENT STRATEGY

Groundwater management for the subject land has been prepared in line with the Stormwater Management Manual for Western Australia (DWER, 2007).

Groundwater management objectives are as follows:

- Manage groundwater levels to protect infrastructure and assets.
- Maintain groundwater regimes for the protection of groundwater dependant ecosystems.
- Protect the value of groundwater resources.
- Adopt nutrient load reduction design objectives for discharges to groundwater.

8.1 GROUNDWATER LEVEL MANAGEMENT

Key points for the management of groundwater levels are as follows:

- A minimum separation of 1.5m from lots to the estimated pre-development groundwater levels or impermeable clay layer will be maintained post-development. Where this separation does not already exist, imported fill and a subsoil pipe network will be utilised. Areas where groundwater is within 2m of pre-development surface is shown on Figure 13. Extents shown are generally consistent with areas containing an underlying impermeable layer.
- Subsoils will be set predominately at the estimated pre-development groundwater level. Subsoil pipes will be laid at a minimum 1:400 grade and will be located within the road reserve.
- The subsoils are to have a free flowing outlet into the stormwater network and ultimately discharge directly into the internal drainage network to be treated in the perimeter bioretention swale and POS bioretention basins prior to discharging into the Collie River foreshore.
- Mounding will occur between the subsoil pipes, with a maximum of 500mm below houses after a 20% AEP event in the wettest month of the year. Mounded groundwater will rapidly drain to the subsoil system, reducing the mounding elevation below residential lots. The use of free draining fill and the distance between subsoil pipes throughout the development will assist in reducing mounding of groundwater. The permeability of all sand fill is to be a minimum of 4m/day with this to be tested insitu.
- All bioretention basins are to be a minimum of 300mm above the groundwater and will include subsoil systems to control groundwater rise under the treatment systems. The design can be seen in Figure 12.
- All lot soak wells are to be installed with a suitable separation to groundwater, so that their infiltration rate is not adversely influenced by high groundwater levels.
- Wherever possible, water will be infiltrated on site to maintain similar overall infiltration volumes to the pre-development scenario. This is to be achieved through the use of pervious surfaces, bioretention gardens and soakwells, which are designed to infiltrate water.

8.2 GROUNDWATER QUALITY

Key points for the management of groundwater quality are as follows:

- Due to the removal of stock and the use of a main sewer system and smaller lots, nutrients and other potential pollutants will mainly be restricted to uses associated with house gardens. Information on nutrient wise gardening is to be provided to lot purchasers to assist with minimising nutrient inputs. This will include information currently available through the Shire.
- POS areas will be vegetated using mainly native vegetation with limited nutrient application used.
- All road stormwater up to the 1EY storm event will be treated in bio-retention gardens. This means that stormwater infiltrating through to the groundwater. The bioretention gardens will be designed and constructed according to the latest FAWB Adoption Guidelines for Filter Media in Biofiltration Systems and the Stormwater Management Manual for WA design guidelines.
- Roof runoff directed to soakwells is another major source of groundwater. This water is relatively clean, which will assist with keeping groundwater pollutant concentrations within acceptable limits.
- Suitable soil amelioration products will be laid within gardens and turf areas in POS, to assist with binding nutrients in the soil profile. This will reduce potential movement of nutrients to the groundwater.
- The subsoil network from all new development areas is to discharge into the bioretention systems for treatment.

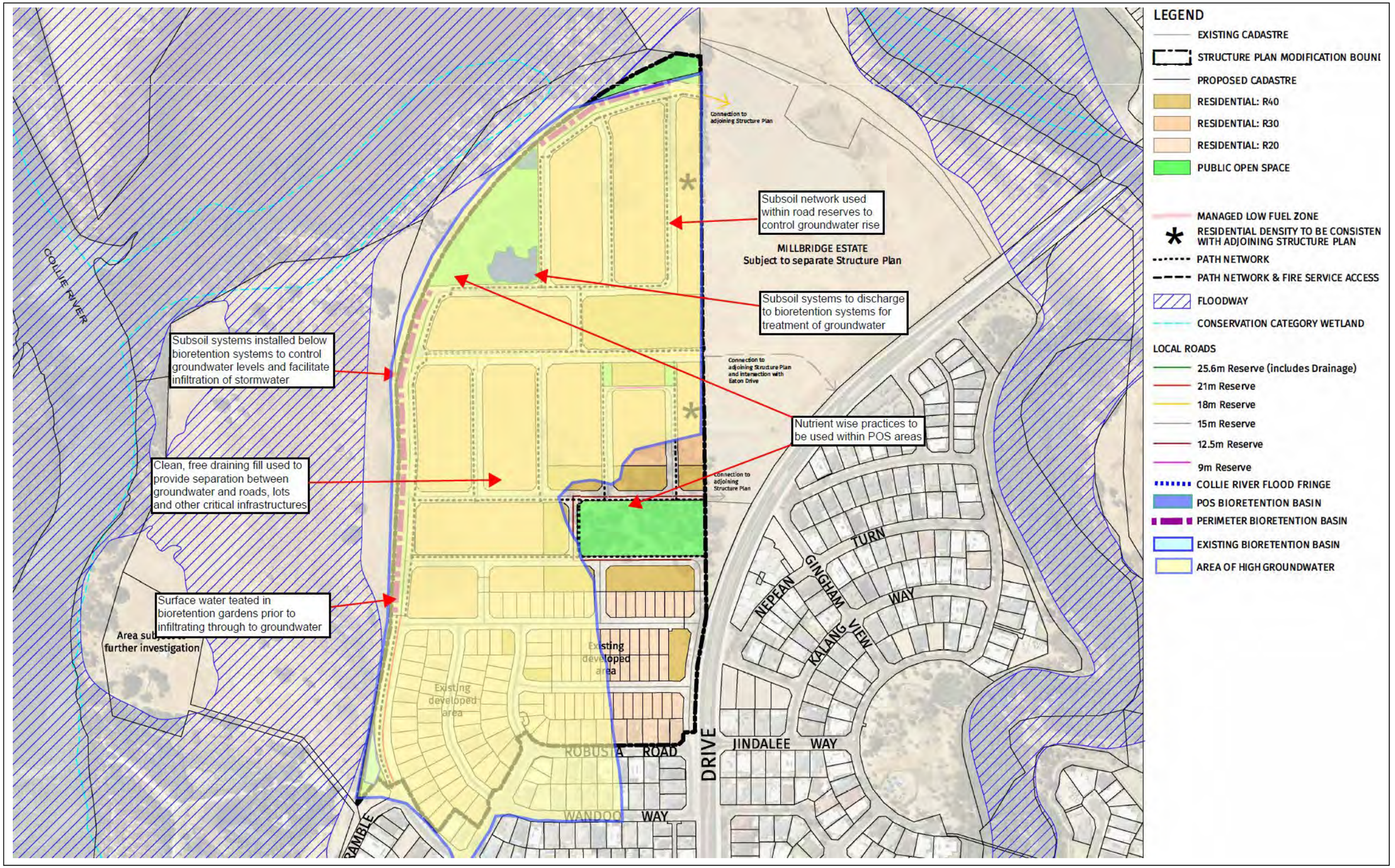


Figure 13 Post development groundwater management

9 WATER SERVICING AND SUSTAINABLE USAGE STRATEGY

9.1 LANDSCAPING

Landscaping will use suitable native species and other waterwise species throughout consistent with the Shire's landscaping requirements. The objective of the landscaping is to implement strategies that minimise the quantity of irrigation required including mulching, low use of slow-release fertilisers, retention of native trees where possible and new plantings of native species.

The landscaping has taken into account the stormwater management, with a focus on shedding stormwater to the planted bioretention basins where possible. This will provide a significant portion of the irrigation requirement for the landscaping. Top up water will be provided as required during establishment, with this water applied via a water tanker. No permanent irrigation is proposed.

9.2 FIREFIGHTING WATER SUPPLY

Firefighting water supply will be provided by way of hydrants designed and installed to Australian Standard AS 2419.1-

2005.

9.3 POTABLE WATER

The proposed subdivision will connect to existing adjacent Water Corporation water mains.

Water Corporation have previously confirmed that adequate water capacity exists to serve the proposed development.

9.4 WASTEWATER MANAGEMENT

The Site is currently serviced by a surrounding 150mm PVC sewer from Peninsula Lakes Drive at varying invert levels. This southern part of the proposed development will be directed to the existing sewer reticulation network via the gravity sewer. This part of the catchment will be directed to the existing wastewater pump station located in the south-western area of the Site.

The remainder of the Site will be directed to the vacuum sewer that services this part of the Site via Millbridge. The Water Corporation has confirmed that this strategy is the intention. The Water Corporation has confirmed that no pre-fundable infrastructure is required for the vacuum sewer area.

10 WATER DEPENDENT ECOSYSTEMS MANAGEMENT STRATEGY

There are two main focuses for the management of water dependent ecosystems (WDE) as part of the subject land's future development: firstly protection and enhancement of the adjoining Collie River and associated foreshore ecological system and secondly the creation of new WDE habitat associated with the subject land's bioretention systems, which will also treat water prior to discharge into the downstream existing ecosystems.

10.1 ON SITE ECOSYSTEMS

The bioretention systems constructed as part of this development will provide some ephemeral and seasonal riparian type habitat to generalist riparian species. The location and planting of these basins will maximise this effect as they will be located near to the existing foreshore areas and its associated riparian habitat, allowing for ease of movement of fauna into this new ecosystem. The use of locally native plants that occur within wetland and river systems will provide suitable habitat for generalist species. This will be complemented by utilising native plantings in surrounding POS and streetscape areas.

As such, these areas can act as areas for future colonisation by a variety of small fauna and assist with fauna movement between larger natural system that are being retained in the surrounding reserves. The bioretention systems are to include both an understorey of sedges and rushes as well as an overstory of wetland shrubs, while taking into account bushfire management. Species should be chosen from the Vegetation guidelines for stormwater biofilters in the south west of Western Australia (Monash University, 2015), or similar publications related to bioretention systems and local riparian networks.

10.2 COLLIE RIVER ECOSYSTEM PROTECTION AND ENHANCEMENT

The Collie River and its associated foreshore wetlands and floodplain is contained within a foreshore reserve separate to the current subject land. This includes the Eelup/Elbow Conservation Category Wetland. This foreshore area was annexed from the original landholding as part of earlier development processes, with this area now included in the Regional Open Space. The foreshore areas are now also contained within the Kalgulup Regional Park, with the Eelup/Elbow Wetland to be vested in the Conservation and Parks Commission.

All development, including drainage infrastructure is set a minimum of 50m from the mapped Conservation Category wetland boundary, to provide a buffer to this ecosystem. The setback to the river itself is over 300m at its closest point, which provides a large foreshore floodplain for ecological functioning. These areas are to be managed so that they complement and enhance the ecological functioning of the River and associated wetland systems. This will include weed control, planting of native species and management of stormwater within the ROS areas and road reserves, with associated creation of new riparian habitat.

Revegetation and regeneration of the foreshore area is expected to be slow and non-uniform with some areas over time likely to establish into low open forest. As a precautionary approach and in line with the bushfire management plan the foreshore area and adjacent ROS are classified as a Class A forest, with the development setting infrastructure back accordingly.

The perimeter bioretention swale and POS areas provides a further distance buffer between the foreshore area and the future houses and roads, with this area be predominately planted with appropriate locally native species. The POS areas will also retain the existing native trees.

To further guide management and ecological principles to be implemented within the foreshore reserve, a Foreshore Management Plan will be developed at detailed design stage. The Foreshore Management Plan will be consistent with the bushfire management strategy for the subject land and take into account the relevant management practices outlined within the Kalgulup Regional Park Management Plan. This will include liaison with the Department of Biodiversity, Conservation and Attractions as to appropriate revegetation and other works.

11 MONITORING & MAINTENANCE

Monitoring within the subject land and the contingency actions to address any related problems are shown in Table 8. The following is a summary of the monitoring that has been and will be undertaken in relation to water management.

11.1 PRE-DEVELOPMENT

11.1.1 Groundwater

Pre-development monitoring of groundwater levels was undertaken between 2009 and 2010 by Calibre. The full details can be seen in the previous groundwater sections.

11.1.2 Surface Water

Surface water monitoring for water quality is not considered necessary, given there are no natural flowing water systems or expressed groundwater, associated with wetlands, found within the current subject land.

11.2 CONSTRUCTION PHASE

Installation of drainage control structures ahead of the construction phase of the development will be utilised. This will include the use of Water Sensitive Urban Design techniques such as sediment curtains, hydro mulching and temporary detention basins to maintain the quality of the water leaving the development area during construction. The bioretention gardens and basins will be monitored for any damage, including compaction, sediment build up, oils, and litter during and at the completion of construction to ensure the structure's effectiveness is not diminished. Sediment and litter on roads will be monitored, with removal completed as necessary with street sweeping.

To minimise issues with degradation of vegetated treatment systems, it is recommended that planting should be delayed until the risk of high sediment loads has passed. The systems should be stabilised with geofabric or similar in the interim. Once the risk has passed, the accumulated sediment and geofabric should be removed and the system vegetated.

Construction monitoring and maintenance regimes are to be developed and finalised within the relevant UWMP.

11.3 POST- DEVELOPMENT

11.3.1 Groundwater

Post-development groundwater monitoring is to be undertaken for a further 2 years after 80% completion of subdivisional works. Monitoring is to be monthly for levels and quarterly for quality.

Trigger values set at 10% above the pre-development rates will be set in place. Should these trigger values be reached, contingency actions will be undertaken to rectify the issue.

Indicative monitoring locations are shown on Figure 13. Pre-development bores located within the Collie River floodplain will be utilised in the post-development monitoring program. The exact location and monitoring regime is to be determined as part of the relevant UWMP's. These locations will be determined in consultation with the relevant entity in which he land will be vested or managed and will include the Shire of Dardanup and the Department of Biodiversity, Conservation and Attractions.

11.3.2 WSUD and other infrastructure

Performance monitoring of WSUD elements will be completed to ensure the system is working effectively. Indicators will be used as a cost effective method to evaluate the adequacies of WSUD performance. It can be assumed that if the WSUD elements operate in accordance to design, then the desired management objectives are being met.

The key WSUD elements to be monitored will include:

- Ensuring the inlet and outlet structures are free of debris through regular removal of material and control of catchment generated debris eg. street sweeping, leaf removal, appropriate locating of rubbish bins to reduce rubbish;
- Vegetative cover of the systems is maintained;
- Sediment build up is not impeding the functionality (note, design vegetated systems so that excessive short term sediment in early stages is not an issue eg do not plant until high risk sediment movement has passed);
- Erosion is not present;
- Soils are not compacted;
- Litter is removed;
- Excessive hydrocarbons are not present in the system;
- Weeds controlled;
- Infiltration of stormwater is maintained to reduce standing water (in non-wetland systems);
- Flows are not excessively detained;
- Stormwater pipes are flowing freely;
- Gross Pollutant Traps are functioning and are not blocked; and
- Subsoil pipes are flowing freely (should they be required in localised areas).

Compared to traditional engineered structures for stormwater runoff management, the WSUD elements require different

routine maintenance and these are generally of a landscape maintenance nature. The most common maintenance is the removal of weeds, debris and siltation. The most time intensive period of maintenance for a vegetated WSUD system is during plant establishment (which typically includes two growing seasons), when supplementary watering, plant replacement and weeding may be required. The WSUD elements will be constructed and utilised in different stages so that the functions of the WSUD elements are protected from elevated pollutant loads generated from a developing catchment.

It is recommended that vegetated WSUD elements are monitored by personnel with floristic knowledge and/ or qualifications and be capable of identifying evasive species within the natively vegetated WSUD systems. Furthermore, personnel in charge of monitoring should have a good understanding of principles and the functional design of the WSUD elements and the treatment system. The maintenance activities prompted through monitoring activities will generally require coordination between landscape and civil services.

The pit and piped network will also require maintenance to ensure they continue to function as designed. This will include rodding, removal of sediments and other debris, as well as the replacement of broken components due to general longterm corrosion and wear.

Maintenance inspections should be conducted after significant storm events (mobilised sediments and coarse material). Inspections should focus on ponding time for the different systems, unequal surface flow distribution and scouring.

A key focus should also be on the control of litter and sediment that is often generated during the house/building construction phase. This is the most common time when systems are degraded or fail, due to large volumes of pollutants such as nonbiodegradable litter, cement fines, direct vehicle compaction, sand movement and other sedimentation issues. Compliance aspects will need to be discussed with the Local Authority, so that rectification of the source problems can be achieved.

11.4 REPORTING

All information collected from the monitoring programs should be recorded and provided in a report, prepared by the developer, to the Department of Water and Environmental Regulation and Local Government. The report will compare monitoring results with target design and performance criteria to ascertain what, if any, actions may be required, and will provide ongoing assessment of the suitability of monitoring and reporting strategies. If a trigger value for a contingency action is reached, a more detailed report on the occurrence, its impact and proposed action to prevent recurrence is to be compiled by the developer and submitted to the Local Authority and Department of Water and Environmental Regulation. After 2 years of monitoring for the relevant Stage by the developer, the local authority will become responsible for any further monitoring they wish to undertake.

Figure 14 Post development Monitoring

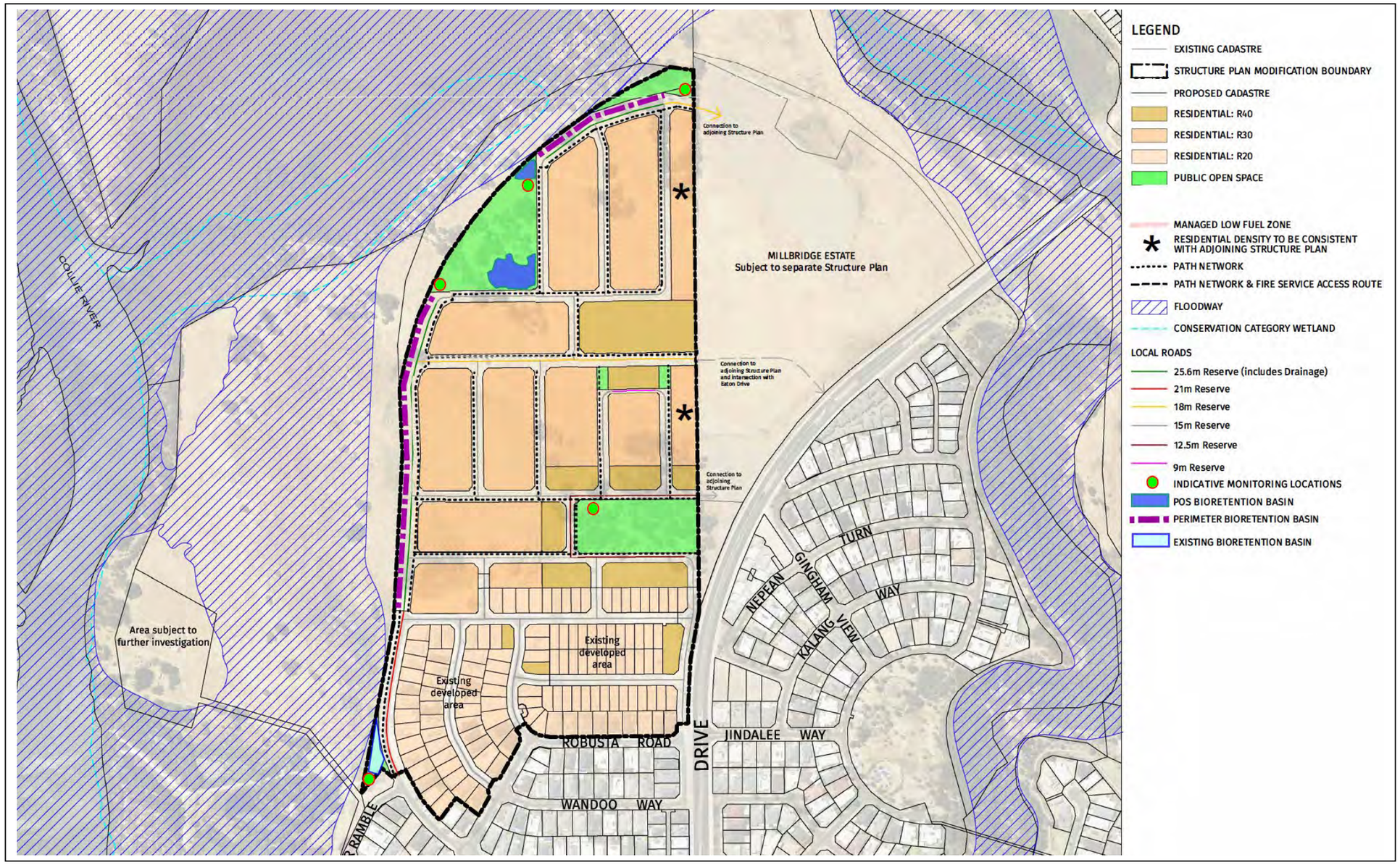


Table 10 Monitoring and Maintenance Schedule

Function	Item to Monitor	Purpose of Monitoring	Trigger for Immediate Action	Maintenance Action Required	Monitoring Frequency	Responsibility
Drainage Management Systems	Structural Effectiveness (inlets, traps and outlets)	Inspection for debris, litter and sediments surrounding structural components.	Debris, litter or sediments causing blockages or impairing functions.	Remove any debris or blockages. Inspect system for any erosion related issues.	Every 3 months	Developer until handover to Council
	Erosion	Inspection for erosion.	Presence of severe erosion or erosion impairing functions.	Investigate, identify and rectify the cause of the erosion. Replace filter media as required.	Every 3 months	Developer until handover to Council
	Sediment Build Up	A) Inspection for sediment accumulation within pits, on the surface of swale systems and within soakwells. B) Inspection of sediment build up on roadways.	A) Accumulation of large volumes of sediments in swale or on the surface or greater than 50% of the swale/basin's depth. B) Accumulation of sediment on roadway	A) Investigate, identify and stabilise cause of sediment source. Remove accumulated sediments and replace filter media or plants removed. B) Street sweeping to remove sediment	Every 3 months	Developer until handover to Council
	Weeds	Inspection for the presence of weeds.	Weeds are noxious or highly invasive or if weeds cover more than 25% of area.	Manual removal or targeting herbicide application, with waterway approved products.	Monthly	Developer until handover to Council
	Plant Condition	Inspection of vegetation health and cover, and presence of dead plants.	Plants dying or a pattern of plant deaths.	Investigate cause of plant deaths and rectify. Infill plantings may be required.	Monthly	Developer until handover to Council
	Organic Litter	Inspection for the presence of organic litter (e.g. leaves) on surface.	Litter coverage is thick or extensive, or detracting from the visual appearance of the system.	Investigate source of litter and undertake appropriate response, e.g. alter landscaping maintenance practices, community education). Remove litter.	Monthly	Developer until handover to Council
	Rubbish/Litter	Inspection for the presence of litter.	Litter is blocking structures or detracting from the visual appearance of the system.	Identify source of litter and undertake appropriate responses. Remove litter.	Monthly	Developer until handover to Council
Groundwater	Pre development levels	To acquire baseline for wetland protection and to allow for effective post development management strategies. Eg fill levels	NA	NA as pre development base line.	Monitoring has been completed to DWER requirements already.	Developer (has already undertaken monitoring).
Surface Water/Wetlands	Wetland revegetation work	Determine if revegetation has been successful.	A) Death of plants above 20%. B) Weed invasion at a level where it hinders native regeneration, species composition maintained.	A) Replanting of native vegetation, irrigation if necessary. B) Removal of weeds,	Every 3 months (for 2 years after practical completion)	Developer until handover to Council
	Levels pre development	Provides baseline for wetland and drain water levels	Extreme levels of flooding	Investigate and identify source of flooding. Undertake appropriate responses to rectify the flooding if not due to extreme rainfall.	Monthly for at least 1 year	Developer
	Levels post development	Allows for assessment of wetland and drain levels in comparison to predevelopment state	Results above agreed upon standards and or 10% variation from pre development monitoring results..	Investigate and identify source of change. Undertake appropriate responses to rectify the level change if not due to extreme weather conditions.	Quarterly for two year after final stage of construction.	Developer until handover to Council

12 IMPLEMENTATION PLAN

The developer is committed to undertaking the water management strategies outlined in this report. Implementation of the strategies outline in this report will be undertaken prior to developmental works, as part of subdivisional works and into the post development phase. To assist with this implementation, an Urban Water Management Plan (UWMP) will be completed as part of subdivisional works. The UWMP will provide more detailed information on the relevant implementation of the water management aspects. This is to include:

- Detailed WSUD treatment design, including full calculations to rationalise water quality treatment sizing and location.
- Clearly identify geotechnical requirements for imported fill to meet assumptions of surface and groundwater modelling.
- Prepare detailed lot stormwater management requirements for the proposed residential and commercial lots.
- Identify interim management measures for stormwater and groundwater if necessary.

The following is a summary of activities and responsibilities that are to happen as part of the remaining development process.

COMMITMENTS BY DEVELOPER

- Construction of the bioretention systems.
- Construction of overall drainage and groundwater control system.
- The maintenance of the bioretention systems until handover to the Council.
- Appropriate fill used across the site, with in situ testing of compacted imported fill to be undertaken to confirm modelling assumptions.
- Provide lot owners with information regarding Waterwise practices inside and outside the house.
- Provide lot owners with information regarding nutrient wise practices and designs for gardens.
- Produce and implement a landscaping plan based on Waterwise and Nutrient wise principles.
- Undertake further detailed drainage analysis of the site as a part of subdivisional work.
- The preparation of Urban Water Management Plans as part of subdivision conditions.
- Monitoring of the site's water as outlined in the monitoring regime.
- Sediment control during construction.
- Preparation and implementation of Foreshore Management Plan for adjacent Collie River foreshore reserve.

COMMITMENTS BY DEPARTMENT OF BIODIVERSITY, CONSERVATION AND ATTRACTIONS

- Review the Foreshore management plan and provide advice as required.
- Management of foreshore areas in combination with Shire.

COMMITMENTS BY THE SHIRE OF DARDANUP

- Responsibility for the maintenance of the stormwater system installed, after a mutually agreed upon time period after construction. The Shire will monitor and maintain the system as per their asset management programs and legal requirements.
- Ongoing encouragement of Waterwise and nutrient wise practices for residents.
- Approval of drainage design and other water management works.
- Approval of building licences including appropriate finished floor levels.
- Management of foreshore areas in combination with DBCA.

COMMITMENTS BY DEPARTMENT OF WATER AND ENVIRONMENTAL REGULATION

- Assist the Shire of Dardanup in relation to assessing the UWMP as required.
- Review the Foreshore management plan and provide advice as required.

COMMITMENTS BY THE WATER CORPORATION

- Responsibility for the management of the sewer system.
- Responsibility for the management of the potable water supply to residents.

LOT OWNERS

- Implement on lot water management in keeping with the guidelines set out in the UWMP.

13 REFERENCES

Australian and New Zealand Environment and Conservation Council (ANZEEC), 2000, Australian and New Zealand Guidelines for Fresh and Marine Water Quality, Volume 1: The Guidelines

Standards Australia, 2005, AS 2419.1-2005 Fire Hydrant Installations

Department of Water and Environmental Regulation, 2007, Stormwater Management Manual for Western Australia, Perth

Department of Water and Environmental Regulation, 2009, Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes, Perth

Department of Water and Environmental Regulation, 2015, Geomorphic Wetland Mapping of the Swan Coastal Plain
Department of Water and Environmental Regulation, 2010, Leschenualt Estuary Water Quality Improvement Plan, Bunbury Draft Country Sewerage Policy (2003). WA State Government.

Geological Society of Western Australia (1986) Bunbury-Burekup Urban Geology Mapping Golders, 2005, Lot 9004 Geotechnical Investigation and Preliminary Acid Sulfate Soil Study

Loh, M. and Coghlan, P (2003) Domestic Water Use Study In Perth, WA 1998 – 2001. Water Corporation. SKM (2007) Parkridge Estate Flood Assessment

TME - Calibre (2010) Parkridge Estate Further Geotechnical Investigation

Western Australian Planning Commission, 2008, Better Urban Water Management, Perth

Appendix A SERVICING REPORT

Appendix B DRAINAGE REPORT

Appendix C GEOTECHNICAL REPORT

App

CONTACT US

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Water and Environmental Management

Brendan Oversby
Director

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APPENDIX E | BUSHFIRE MANAGEMENT PLANS

Bushfire Works
A.B.N. 945 23123 843
PO Box 1249, Bibra Lake DC WA 6965
E: david.deeley@bushfireworks.com.au
www.bushfireworks.com.au

Bushfire statement in support of the Parkridge SP amendment

Item 14 B
A technical note, addendum, or much more clarity in the updated fire management plan justifying the use of a fire service access route (in lieu of the perimeter road).

Response:
Modified concept plan now includes public roads that are the equivalent of a perimeter road.

14b (i)
There are cogent reasons to depart from the policy position, which contemplates perimeter roads.
Response:
Modified concept plan now includes public roads that are the equivalent of a perimeter road.

14b(iii)
….during an emergency, only emergency vehicles are permitted to use it, which is a net improvement when compared to the policy position.
Response:
The modified concept plan now includes public roads that are the equivalent of a perimeter road.

16 Public open space:
The revised Amendment 1 does not provide any detailed landscape concept plans for the proposed public open space areas.
Response:
A landscape concept will be provided which shows that the 1ha public open space (POS Q) will be managed in such a way that it will be classified post-development as low threat under AS 3959. This will include the retention of any habitat trees protected by the EBPC regulations and thinning or branch removal to achieve and overall averaged crown density of ≤15% cover as per Table 9 of the WAPC guidelines (Version Nov 2024).

Staging:
The submitted bushfire management plan does not provide any necessary management measures specific to staging of subdivision.
Response:
Vegetation management to achieve Low-threat status will occur as each stage is progressed. This will include slashing and maintaining Grassland to ≤10 cm in height from early Spring to Late Autumn and removal, trunk thinning or branch thinning of A. Forest or B. Woodland to achieve Low-threat status.

16 Emergency access ways:
No evidence has been provided by the proponent that the Shire of Dardanup consents to this arrangement.
Response:
A signed agreement from the owner/developer of the adjoining property's to the E representative agreeing to temporary EAW access through Millbridge Estate is attached here. This will be submitted to the Shire of Dardanup for their review as part of the revised Concept plan package.

16 Perimeter road and fire service access route:
The modified concept plan now includes public roads that are the equivalent of a perimeter road.

Signed:
Dr David M Deeley BPAD Level 2

29th August, 2025.

I hereby declare that I am a BPAD Accredited bushfire practitioner.
Accreditation No. 37575
Signature
Date 29/08/2025

Taylor Burrell Barnett

t: (08) 9226 4276
e: admin@tbbplanning.com.au

taylorburrellbarnett.com.au

Our Ref: 17/079a

29 April 2025

Attention: Matthew Tallon

Department of Planning, Lands and Heritage
Reform, Design and State Assessment
via email: matthew.tallon@dplh.wa.gov.au; planningappeals@dplh.wa.gov.au

Dear Matthew

AMENDED PARKRIDGE ESTATE STRUCTURE PLAN – AMENDMENT NO.1 - SUBMISSION

This submission has been prepared by Taylor Burrell Barnett, on behalf of our client, Ardross Estates (S.A) Pty Ltd, in response to an amended Parkridge Estate Structure Plan – Amendment No.1 (Amended Structure Plan) currently being advertised for public comment.

Ardross Estates (S.A) Pty Ltd is the owner of Lot 3001 Eaton Drive, Eaton located to the east of the Parkridge Estate and responsible for the development of Millbridge (located on the eastern side of Eaton Drive). Ardross Estates has been progressing planning of Lot 3001 (commonly referred to as "Southbank") in the form of a Modification to the Garden of Eaton Local Structure Plan - Agreed Structure Plan 27 (ASP 27) which was released for public comment by the Shire of Dardanup on 17 April 2025 for a period of 42 days. The WAPC also granted subdivision approval on 14 March 2025 for 101 single residential lots across the majority of "Southbank" (WAPC ref no. 201093).

Ardross Estates has been in close contact with the planning consultant of Parkridge Estate (Harley Dykstra) to discuss the proposals and integration between both LSP areas. The preparation of the Amended Parkridge Estate Structure Plan has taken into consideration the structure planning and subdivision layout for the "Southbank" as envisaged by the Modification to ASP 27, with careful consideration given to the interface between the two developments and to optimise connectivity and integration.

Ardross Estates supports the proposed amended Parkridge Estate Structure Plan as resubmitted to the Department of Planning, Lands and Heritage (DPLH) in order to achieve an integrated outcome and to ensure an alignment between both plans, particularly to ensure a coordinated and functional movement network is achieved.

These aspects are discussed in further detail below.

Movement Network

The Amended Structure Plan provides for orderly connection of local roads from Parkridge to the adjoining "Southbank" and to the wider road network and is supported. The Traffic Impact Assessment (TIA) prepared in support of the Proposed Amendment to ASP 27 and Conditional Subdivision Approval WAPC ref no. 201093 addresses how the subdivision of "Southbank" will integrate with the proposed movement network of the neighbouring Parkridge Estate.

Toddville Prospecting Pty Ltd (ACN 008 735 153)
ATF The Taylor & Burrell Unit Trust trading as Taylor Burrell Barnett
(ABN 74 831 437 925)

Office address:
Level 7
160 St Georges Terrace
Perth WA 6000

Postal address:
PO Box 7130
Cloisters Square
Perth WA 6850

The location and alignment of connection points and road reserve widths between the two estates as proposed under the Parkridge Estate Structure Plan and ASP 27 will facilitate the integration of the movement networks. The alignment and design of the central east-west access road as a 'boulevard' type road with a 18.0m wide road reserve is supported and will provide an important connection from the estates to Eaton Drive. The northern-most and southern-most connections as depicted on the Amended Structure Plan are supported as 15.0m wide local access roads aligning with those approved under WAPC ref no. 201093 and as depicted on the proposed Modification to ASP 27.

Bushfire Management

As part of assessing bushfire risk for the proposed Modification to ASP 27 and Conditional Subdivision Approval WAPC ref no. 201093, bushfire hazards surrounding Lot 3001 located within the adjoining Parkridge Estate have been considered. Lots adjacent to the eastern boundary of the Parkridge Estate are impacted by temporary hazards from undeveloped stages of the estate. Bushfire management for the development of the south-eastern portion of "Southbank" has assumed that the POS proposed within the adjacent development (Parkridge Estate) will be unmanaged.

Ensuring that both developments have egress to multiple destinations and that temporary no through roads occur will also require coordination of bushfire management measures. Due to staging of development, temporary emergency access way(s) may be required which will need to be confirmed in consultation with the Shire and the relevant parties.

In this regard, the POS location and configuration within the south-eastern corner of the Parkridge Estate and proposed movement network as depicted on the Amended Structure Plan is supported on the basis that a coordinated approach to bushfire management between both parties will occur.

Conclusion

We trust our comments will be taken into consideration during the DPLH's consideration of the Amended Parkridge Estate Structure Plan - Amendment No. 1. Should you require any clarification regarding the above, please do not hesitate to contact the undersigned from our Office.

Yours faithfully



KATHERINE SHIRLEY
SENIOR ASSOCIATE

CC: Kylie Shaw – Harley Dykstra
Daniel Skerratt – Ardross Estates

BushFire Works



BUSHFIRE MANAGEMENT PLAN
Parkridge Estate, Robusta Rd, Eaton

CLIENT:	Harley Dykstra
SITE LOCATION:	Robusta Rd Eaton
DATE:	24/02/2025
SHIRE/CITY:	Shire of Dardanup
FIRE CONSULTANT:	David Deeley
CLIENT CONTACT #	Kylie Shaw
BFW FILE #:	20241206
VERSION #:	1.0

Acacia Springs Pty Ltd
trading as
BushFire Works
ABN 945 23123 843
enquiries@bushfireworks.com.au
www.bushfireworks.com.au

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BPAD / Fire Protection Association Australia

Bushfire Management Plan Coversheet

This Coversheet and accompanying Bushfire Management Plan has been prepared and issued by a person accredited by Fire Protection Association Australia under the Bushfire Planning and Design (BPAD) Accreditation Scheme.

Bushfire Management Plan and Site Details					
Site address / Plan reference:	Parkridge Estate Structure Plan				
Suburb:	Robusta Street Eaton	State:	WA	Postcode:	6330
Local government area:	Shire of Dardanup				
Description of the planning proposal:	Multi-lot structure plan				
BMP / Reference number:	20241206	Version:	1.0	Date of issue:	02/25
Client / Business name:	Harley Dykstra				

Reason for referral to DFES[1]	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 an outcomes-based approach?		✔
Strategic planning proposal (including rezoning applications)		✔
Local planning scheme amendment containing supplementary provisions, additional to the deemed provisions for bushfire risk management		✔
Where a bushfire local planning policy, or variation to the acceptable solutions or the APZ is proposed		✔
Where there is a conflict of opinion between the decision maker and proponent		✔
Expert technical advice on bushfire behaviour, emergency management, or other occasions where bushfire technical advice is required to support planning decision-making		✔
Expert technical advice on bushfire matters referred to State Administrative Tribunal (SAT) or Development Assessment Panel (DAP)		✔
Comments on future buildings' compliance with FES Commissioner's operational requirement guidelines		✔
Decision maker discretionary referral, (e.g. renewable energy, hazardous materials, vulnerable land use)		✔

If the development is a special development type as listed above, explain why the proposal is considered to be one of the above listed classifications (E.g. considered vulnerable land-use as the development is for accommodation of the elderly, etc.)?

Note: The decision maker (e.g. local government or the WAPC) should only refer the proposal to DFES for comment if one (or more) of the above answers are ticked "Yes".

BPAD Accredited Practitioner Details and Declaration

Name	Accreditation Level	Accreditation No.	Accreditation Expiry
David Deeley	BPAD Level 2	37575	September 2025
Company		**Contact No.**	
Bush Fire Works		0438 527 446	

I declare that the information provided within this bushfire management plan is to the best of my knowledge true and correct.

Signature of Practitioner  Date 24/02/2025

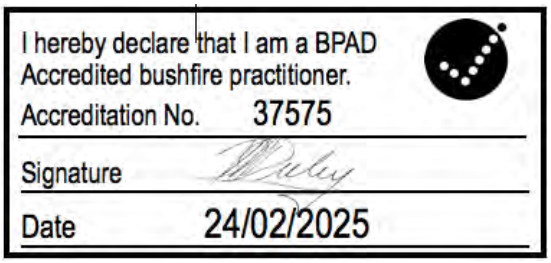
[1] For more information please refer to DFES Referral to DFES Checklist

Document control

Property address: Parkridge Estate Robusta Road Eaton WA 6232
Lot size: 24.75 ha (current development stage).
Landowner: C/- Harley Dykstra
Development Application ref: TBA
Prepared by: David Deeley

Client:

Report version	Purpose	Author/reviewer and accreditation details	Date submitted
Draft 1.0	Document for review	Susan Deeley	23/02/2025
Final 1.0	Edits and lot layouts modified	David Deeley	24/02/2025



Disclaimer

The recommendations and measures contained in this assessment report are based on the requirements of the Australian Standards 3959 – Building in Bushfire prone Areas, WAPC / DFES Guidelines for Building in Bushfire Prone areas (State Planning Policy 3.7) and CSIRO's research into Bushfire behaviour. These are considered the minimum standards required to balance the protection of the proposed dwelling and occupants with the aesthetic and environmental conditions required by local, state and federal government authorities. They DO NOT guarantee that a building will not be destroyed or damaged by a bushfire. All surveys and forecasts, projections and recommendations made in this assessment report and associated with this proposed dwelling are made in good faith on the basis of the information available to the fire protection consultant at the time of assessment. The achievement of the level of implementation of fire precautions will depend amongst other things on actions of the landowner or occupiers of the land, over which the fire protection consultant has no control. Notwithstanding anything contained within, the fire consultant/s or local government authority will not, except as the law may require, be liable for any loss or other consequences (whether or not due to negligence of the fire consultant/s and the local government authority, their servants or agents) arising out of the services rendered by the fire consultant/s or local government authority.

Section 1: Proposal Details

This Bushfire Management Plan is for a modification to the previously-approved Parkridge Estate Structure Plan. Earlier stages are either completed with established residential areas or currently undergoing development after approval. The current stage is the final 27.45 ha of the Parkridge development. It is proposed to create a range of lots including areas of R20, R30-40 and R40. Areas of POS and ROS have also been identified and are to be set aside (Figure 1). The proposed development is surrounded by the Collie River foreshore reserve and floodway on its northern and western boundaries and these areas contribute most of the ROS. The Millbridge Estate structure plan is currently under review and joins Parkridge Estate development along its eastern boundary.

The subdivision design reflects previously-approved regional and local structure plans with direct access onto Eaton Drive/The Boulevard, a significant regional connector that offers egress to multiple destinations. This stage of Parkridge Estate also connects to Glenhuon Boulevard which provides a second egress option south.

The development area has been classified a bushfire prone because of the unmanaged grazing pastures and remnant forest and woodland scattered through the development area (Figure 2). The topography of the site is generally flat but the NW portion of the development area slopes downward to the NW and the W toward the Collie Rive (Figure 3).

The property has been previously cleared of much of its original vegetation which has been replaced by pastures (G. Grassland 26). There are plots of A. Forest and B. Woodland to the SE and stands of A. Forest in the NW of the property associated with the Collie River floodway.

It has been determined that future dwellings will be able to achieve ratings of ≤BAL-29. This includes modest boundary setbacks for several lots in close proximity to the areas of POS around the NW boundary. The 'Acceptable Solutions' described in this BMP will ensure bushfire risks are appropriately managed and that the development conforms to all relevant policies and standards, as required by SPP 3.7 for an FDI of 80, including the latest WAPC Guidelines Version 2024.

This BMP document and the recommendations contained within it are aligned to the following:

- Consistency with SPP 3.7 and the planning requirements for local government;
- Identification of bushfire risks using vegetation types and slopes as in AS3959 – 2018;
- Identification of assets at risk including: life, property, infrastructure and the environment;
- Identification of bushfire risk mitigation measures as acceptable solutions within SPP 3.7 and the WAPC Guidelines Version November 2024;
- Allocation of responsibilities to persons / entities for the implementation of recommendations and management measures; and,
- Compliance with the Shire of Dardanup's firebreak and fuel hazard reduction notice (Appendix 3).

Section 2: Environmental Considerations

The current stage of the development of 27.45 ha is to occur within largely cleared grazing paddocks. There is a requirement to remove or modify during subdivision up to 3.49 ha or 77.4% of the 4.52 ha of remnant A. Forest vegetation remaining within the development boundary and 1.07 ha or 77.7% of the 1.37 ha of remnant B. Woodland remaining.

Subsection 2.1: Native Vegetation – modification and clearing

A search of DBCA on-line mapping resources found no priority fauna, flora or TECs within the area. This included Threatened and Priority Flora (DBCA-036), Threatened and Priority Fauna (DBCA-037) and Threatened Ecological Communities (DBCA-038). The scale of clearing or modification of A. Forest vegetation is considered minor and is therefore not considered as a constraint to the subdivision proceeding.

Subsection 2.2: Re-vegetation/Landscape Plans

Any future re-vegetation or landscaping within the nominated APZs will need to be to Low-threat specifications of Schedule 1 (Appendix 1). Any future re-vegetation or landscaping elsewhere within either lot will need to be consistent with the Shire of Nannup's bushfire risk compliance notice (Appendix 3)

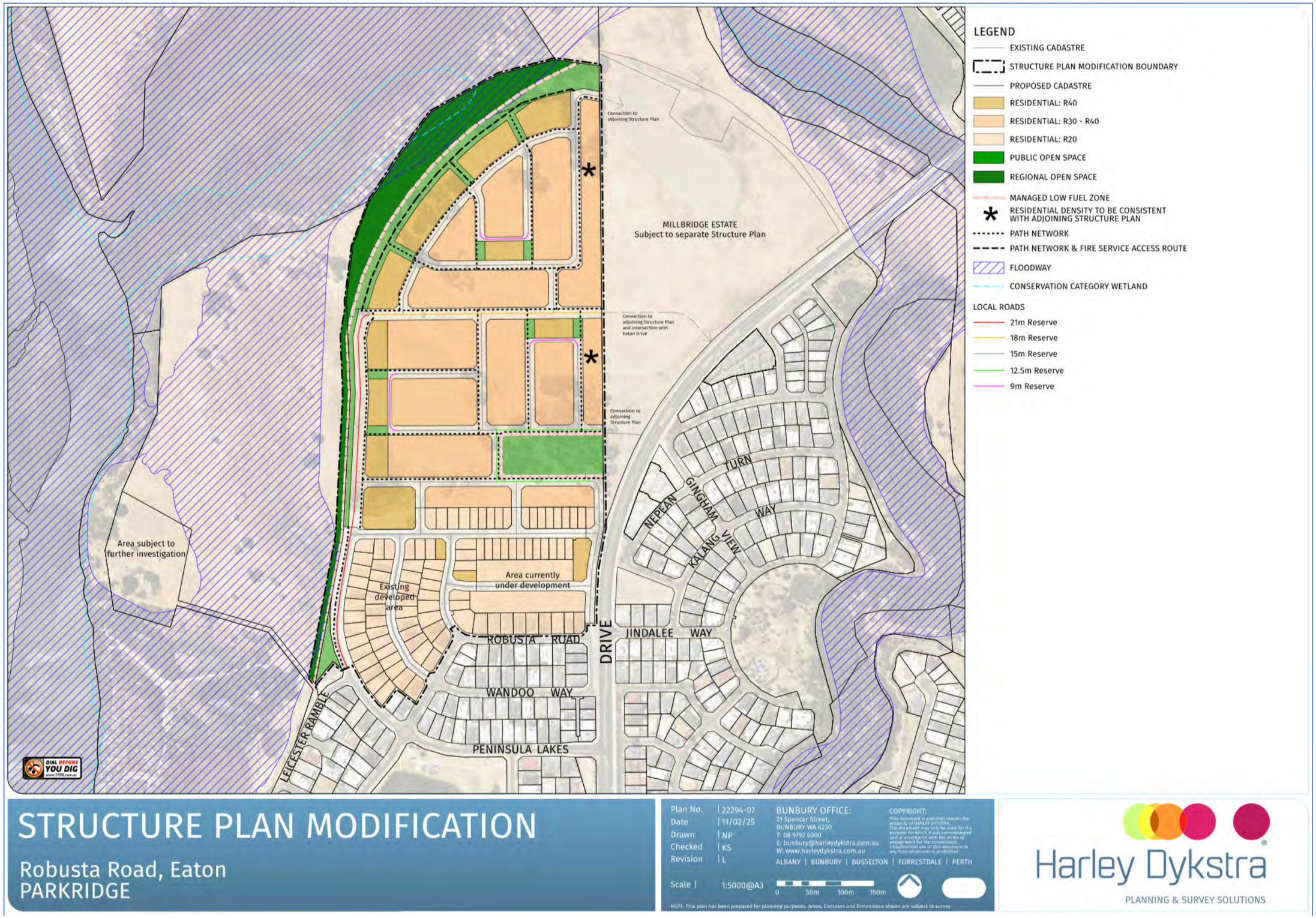


Figure 1 Site Plan

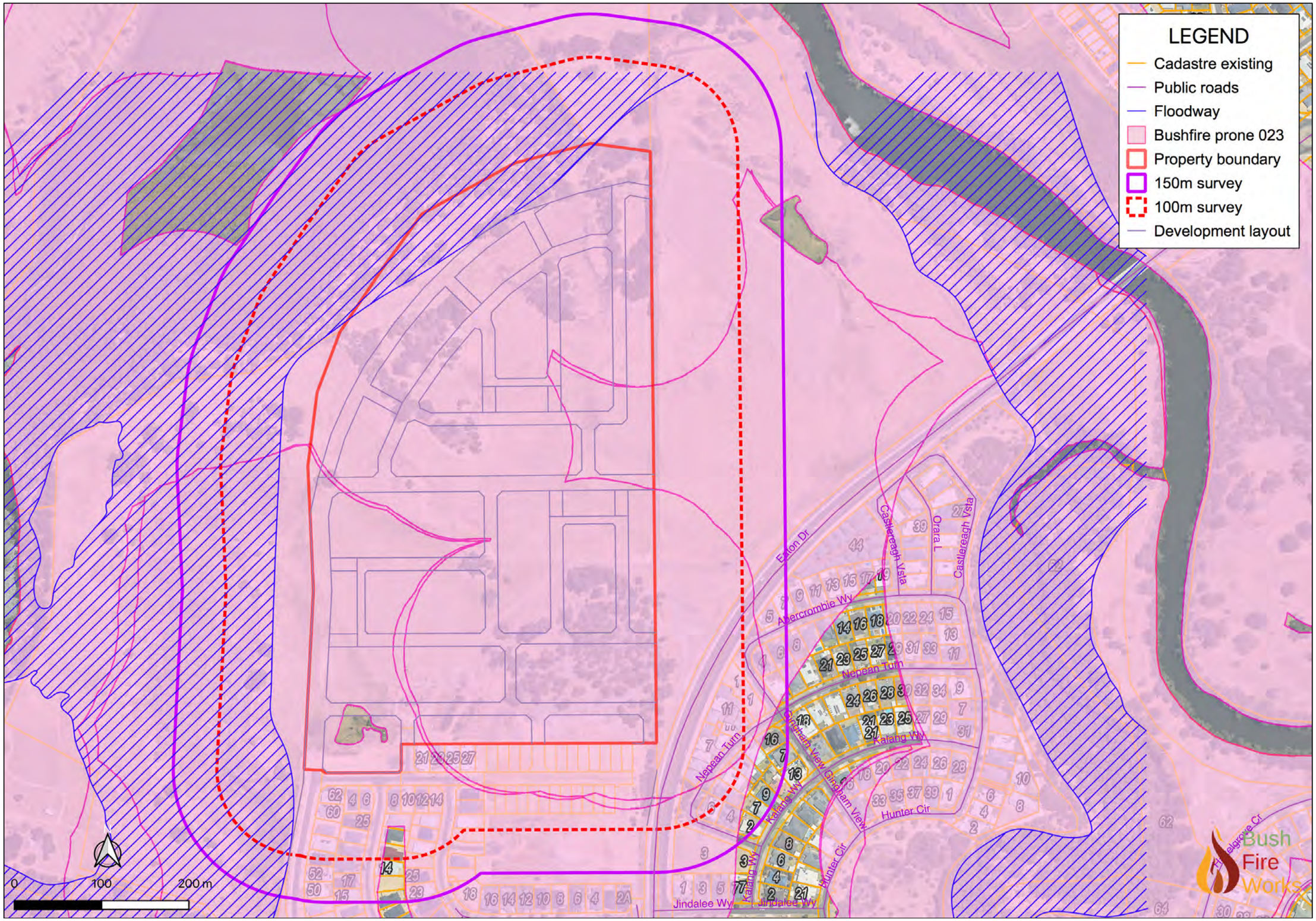


Figure 2 Bushfire prone areas

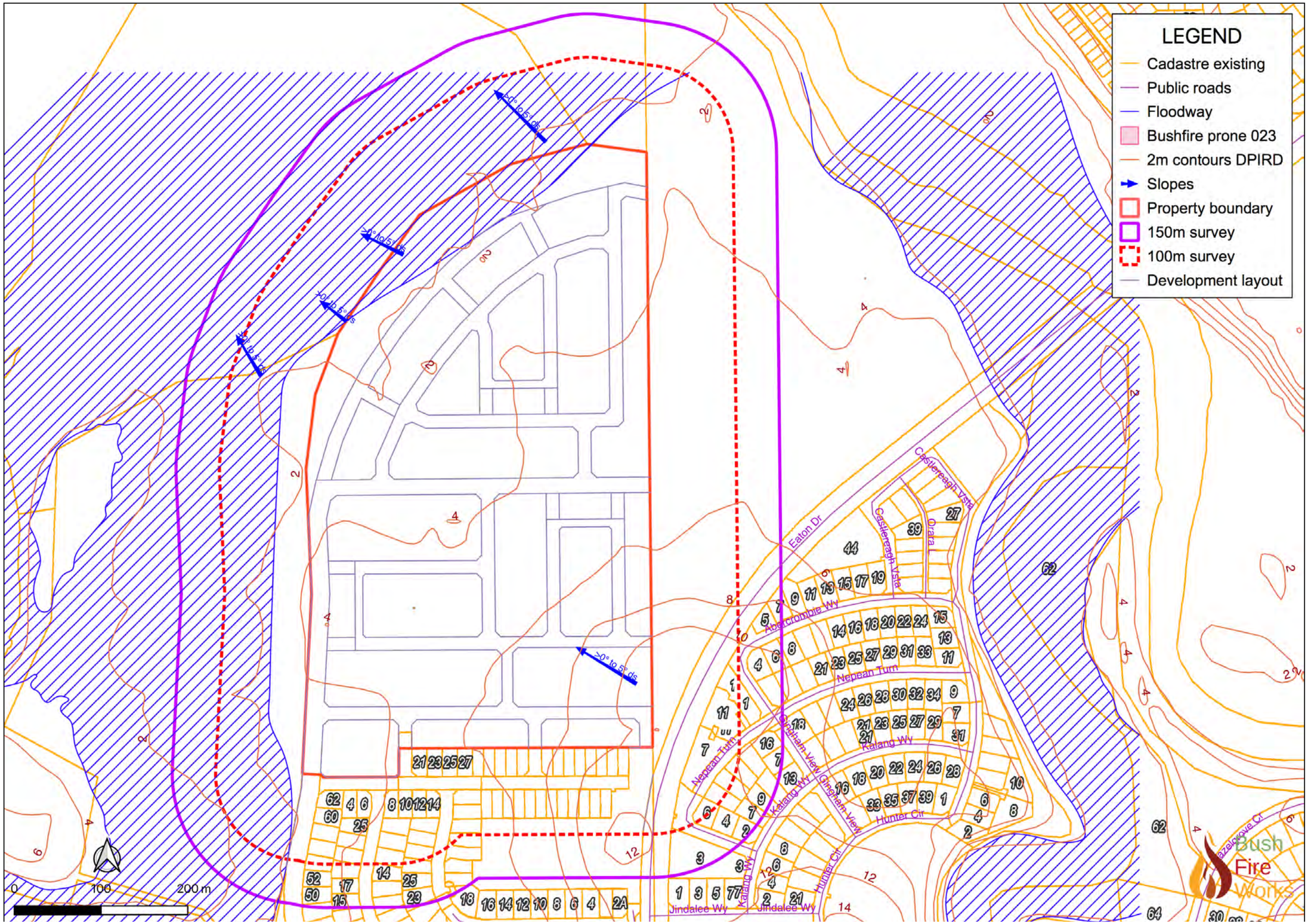


Figure 3 Location

Section 3: Bushfire Assessment Results

A site visit and Bushfire Attack Level assessment were completed on the 24th January 2025. Photo points were established across the site (Figure 4, Section 7).

Subsection 3.1: Simplified BLA

YES The subject site is within a kilometre of an urban area as a suitable destination.

YES The road pattern from the development to the closest urban area is direct.

YES The majority of vegetation is managed Class G Grassland, within the broader landscape assessment area.

YES The planning proposal is exposed to two or less aspects with external bushfire hazards (excluding Class G Grassland).

The development area as Broader Landscape Type A.

Subsection 3.2: BAL Contour Map Inputs

All vegetation within 150 m of the project site has been classified (Figure 5) in accordance to AS 3959:2018, Construction of Buildings in bushfire-prone areas Table 2.3 and the WA Department of Planning Visual guide for bushfire risk assessment in Western Australia. Seven (7) different classes of vegetation were recorded (Table 1), including:

Plot 1 A. Forest 03 (Open forest 03) >0° to 5° ds, to the NW of the subject property associated with the Collie River floodway;

Plot 2 A. Forest 03 (Open forest 03) flat land, to the NW and SE of the subject property;

Plot 3 Class B. Woodland 05 (Woodland) upslope/flat land, to the SE of the subject property;

Plot 4 D. Scrub (Open scrub 14) upslope/flat land, two small stands in the S;

Plot 5 Class G. Grassland (Tussock grassland 22) flat land, to the NW of the property associated with the Collie River floodway;

Plot 6 Class G. Grassland 26 (Sown pasture) upslope/flat land, across much of the subject property and within the cleared areas surrounding it;

Plot 7 Excluded (Clause 2.2.3.2e) as being non-vegetated areas.

Table 1 Pre-development BAL assessment

Plot	Vegetation Classification	Effective Slope	Separation (m)	BAL
1	A. Open forest 03	>0° to 5° ds	0	BAL-FZ
2	A. Open forest 03	Upslope / Flat	0	BAL-FZ
3	B. Woodland 05	Upslope / Flat	0	BAL-FZ
4	D. Open scrub 14	Upslope / Flat	0	BAL-FZ
5	G. Tussock grassland 22	Upslope / Flat	110	BAL-LOW
6	G. Sown pasture 26	Upslope / Flat	0	BAL-FZ
7	Non veg Ex 2.2.3.2(e)	N/A	N/A	BAL-LOW
Determined Bushfire Attack Level				**BAL - FZ**

Subsection 3.3: BAL Contour Map Outputs

The property is to be fully developed leaving a modest area of POS in the SE corner (Table 2, Figure 5).

Table 2 Post-development BAL assessment

Plot	Vegetation classification	Effective slope °	Current separation (m)	Current rating	Achievable rating	Total separation required (m)
1	A. Tall open forest 03	>0° to 5° ds	0	BAL-FZ	BAL-12.5	62.5
2	A. Open forest 03	Upslope / Flat	0	BAL-FZ	**BAL-40***	18
3	B. Woodland 05	Upslope / Flat	0	BAL-FZ	BAL-12.5	62.5
4	D. Open scrub 14	Upslope / Flat	0	BAL-FZ	BAL-LOW	110
5	G. Tussock grassland 22	Upslope / Flat	110	BAL-LOW	-	-
6	G. Sown pasture 26	Upslope / Flat	0	BAL-FZ	BAL-12.5	18
7	Non veg Ex 2.2.3.2(e)	N/A	N/A	BAL-LOW	-	-
8	Low threat Ex 2.2.3.2(f)	N/A	N/A	BAL-LOW	-	-5
Determined Bushfire Attack Level					**BAL–29 & BAL- 40**	

Note BAL-40*: Lots adjoining Plot 1, A. Forest 03 can achieve BAL-29 with 9 m building setbacks from their WNW boundaries.

Post development BAL contour analysis (Figure 7), confirmed ratings of ≤BAL-29 as being achievable for all lots with APZs contained within respective lot boundaries and modest building setbacks for several lots adjacent to areas of POS in the NW.

Section 4: Identification of bushfire hazard issues

The subject lots are bounded by the Collie River foreshore reserve and floodway to the NW. This represents an 'Extreme' BHL. There are and will be residential areas on all other aspects which will provide adequate egress opportunities in the event of an evacuation and/or bushfire suppression emergency.

The acceptable solutions described in the BMP means the development is able to comply with the Bushfire Protection Criteria.

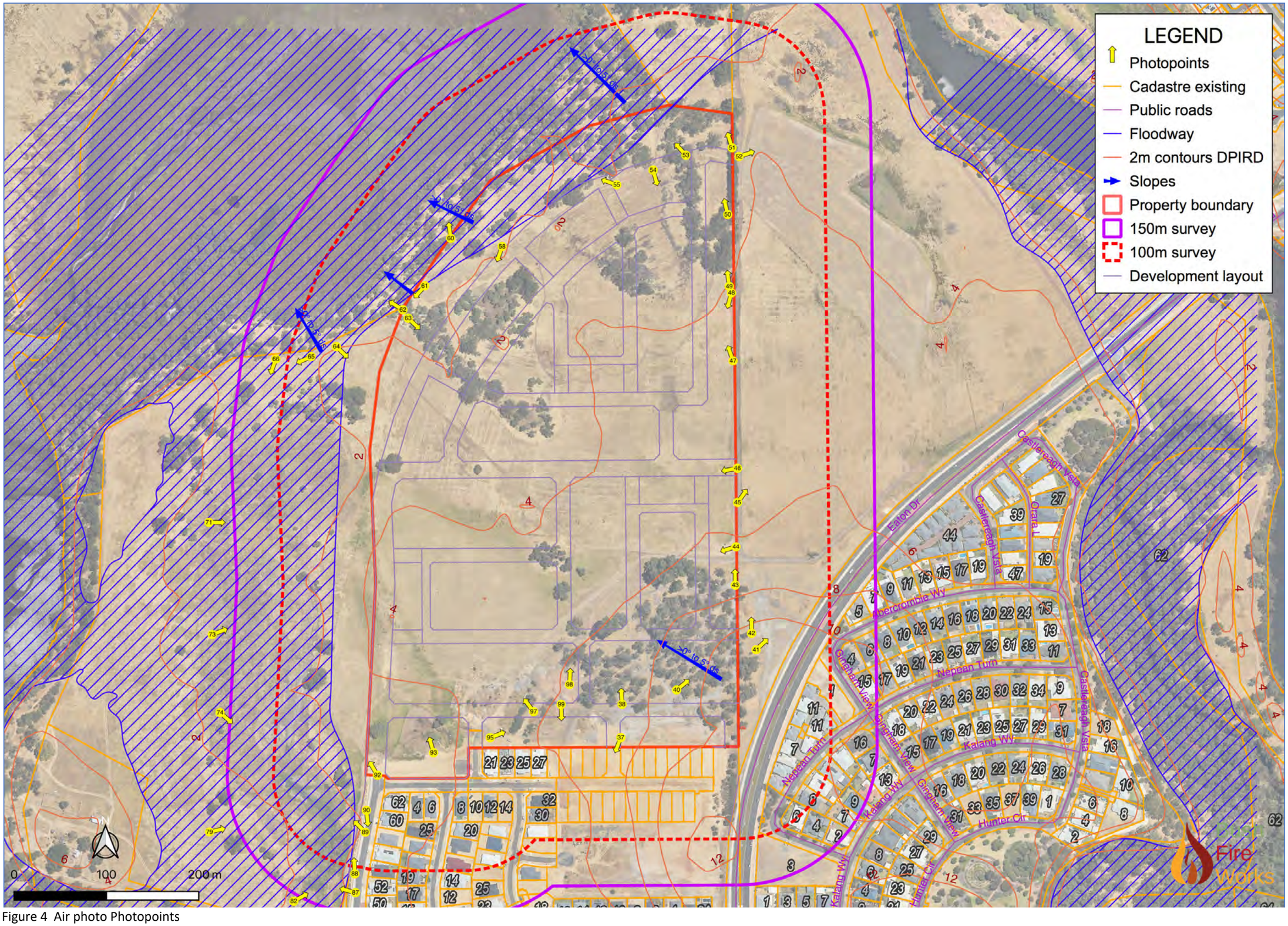


Figure 4 Air photo Photopoints

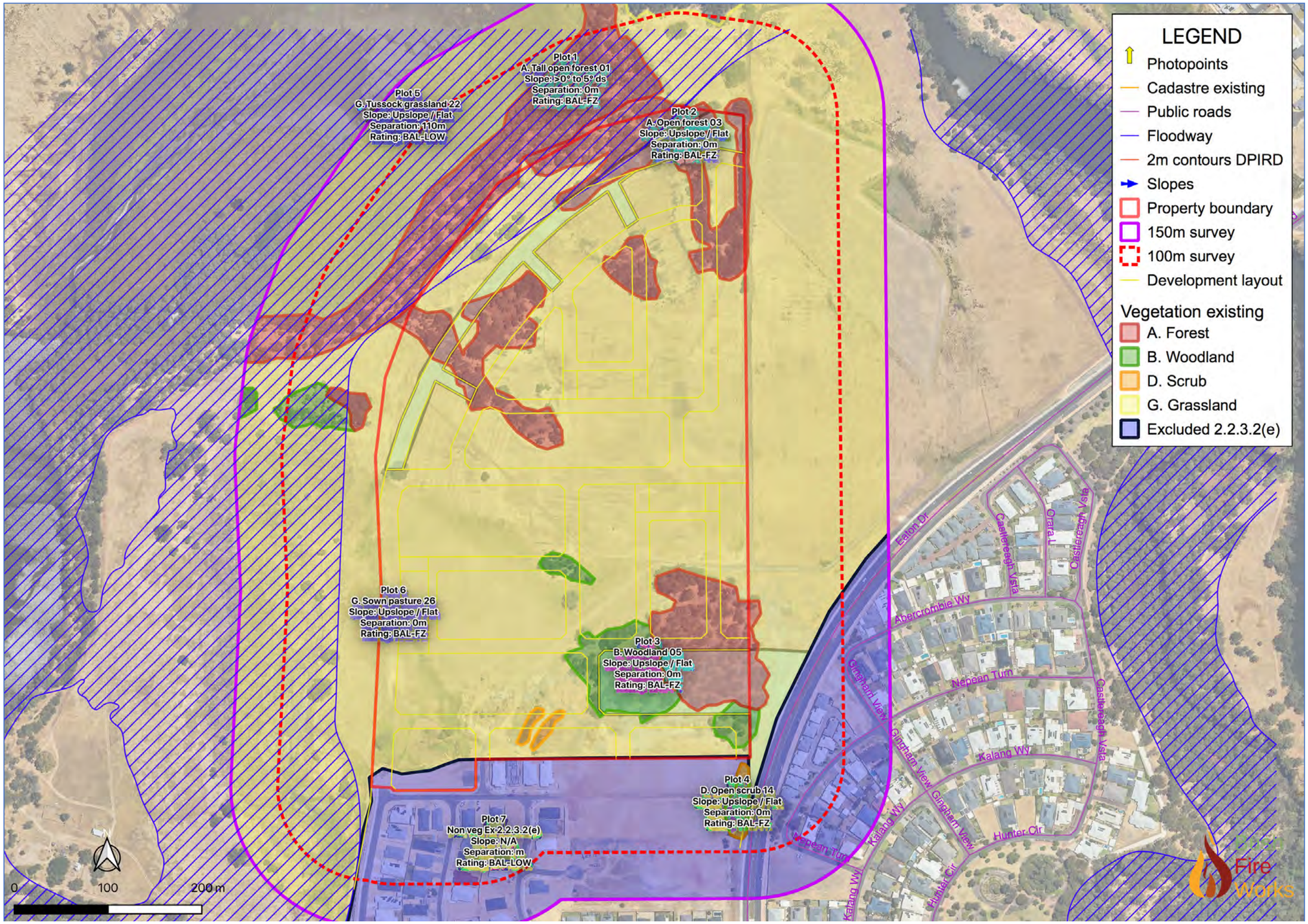


Figure 5 Classified vegetation existing

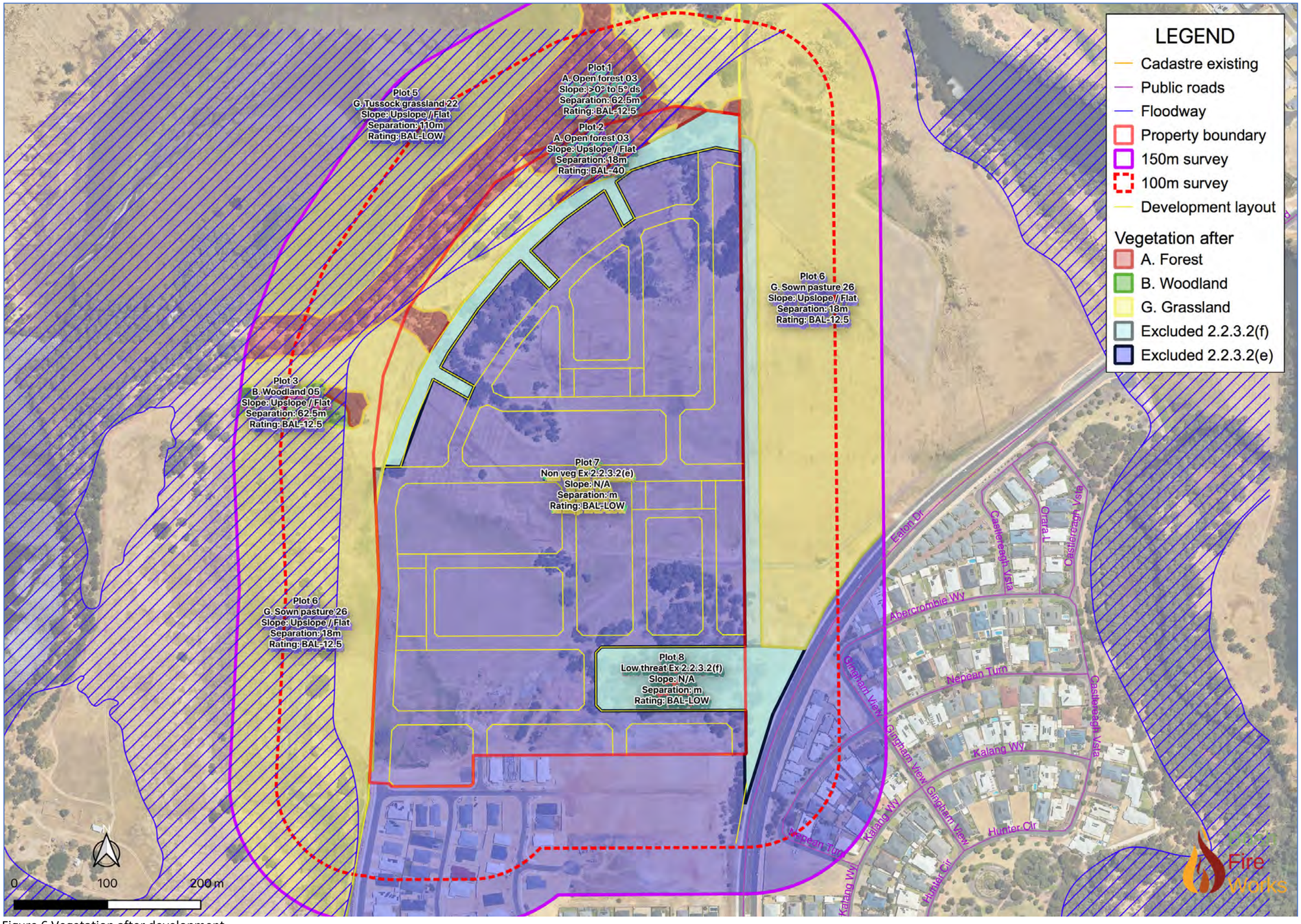


Figure 6 Vegetation after development

Section 5: Assessment against the Bushfire Protection Criteria

Subsection 5.1: Compliance

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
Element 1: Location	**A1.1 Broader landscape type A** A simplified BLA analysis (Section 3.1 above) confirmed the development area as Broader Landscape Type A. **This meets the intent of Element A1.1.**	Access/egress is directly on to the public road network that provides the option of two separate destinations. Scheme water is available.
Element 2: Siting and design	**A2.1 Siting and design** The proposed development and this BMP is a modification of previously-approved regional and local structure plans. **This meets the intent of Element A2.1.**	The subdivision layout provides adequate permeability and opportunities for egress to two destinations.
	A2.1 Asset Protection Zone On completion for dwellings built within the nominated lots, ratings of ≤BAL-29 can be achieved. **This meets the intent of Element A2.1.**	Several lots in the NW and adjacent to the POS areas will require 9 m building setbacks from their front boundaries to provide a separation of 27 m to the A. Forest >0 to 5° downslope within the Collie River floodway such that they will achieve ratings of ≤BAL-29 (Figure 8).
	A2.3 Clearing of native vegetation There is a requirement to remove or modify during subdivision, up to 3.49 ha of remnant A. Forest vegetation remaining within the development boundary. **This meets the intent of Element A2.3.**	The development area of this final stage of the Parkridge Estate is 27.45 ha and it is to occur within largely cleared grazing paddocks. The loss of native vegetation has been minimised and an area of POS will be retained in the SE including remnant native vegetation.
Element 3: Vehicular access	**A3.1 Public roads** Public roads within the development will be constructed to the required standards. **This meets the intent of Element A3.1.**	Public roads will be built to Table 10 column 2 specifications (Appendix 3).
	A3.2 Access routes Multiple access routes are available for all lots. **This meets the intent of Element A3.2.**	It is anticipated that the Millbridge Estate main entrance onto Eaton Drive and its internal road network will be constructed prior to the time of planned lot sales and dwelling occupation at Parkridge Estate. A slashed buffer along Parkridge's eastern boundary and a temporary EAW to Eaton Dve will be provided in the unlikely event that this does not happen in time (Figure 8). Direct access is also available for all Parkridge lots south, onto Glenhuon Bvd (Figure 8).
	A3.3a No-through roads N/A A3.3b No through road requirements N/A.	There are no non-through roads.
	A3.4 Emergency access routes Existing private and public roads provide adequate emergency access. **This meets the intent of Element A3.4.**	A temporary EAW to Eaton Dve will be provided should the Millbridge Estate main entrance to Eaton Rd currently being assessed through its structure plan is delayed.

Bushfire protection criteria	Method of compliance Acceptable solutions	Proposed bushfire management strategies
	A3.5a Perimeter road The equivalent of a perimeter road is available. **This meets the intent of Element A3.4a.**	A fire service access road is to be established at the NW edge of Parkridge Estate along the proposed POS.
	A3.5b Fire service access route **This meets the intent of Element A3.4a**	A fire service access road is to be established at the NW edge of Parkridge Estate along the proposed POS.
	A3.6 Battle-axe legs N/A Of the 21 proposed lots, three lots require short battle axe legs, necessitated by the subdivision design and the road and parent lot layout. There is no alternative. **This meets the intent of Element A3.5.**	Three lots (1, 9, & 20), have short battle axe legs from 20 m to 59 m long. Lots 10, 11, 19 and 21 will have shared reciprocal rights of access along the battle-axe legs.
Element 4: Water	A4.1 Identification of future water supply N/A	A scheme water supply is available.
	A4.2 Provision of water for fire-fighting purposes Scheme water is to be provided to all lots to the required standard. **This meets the intent of A4.2.**	
Element 5: Vulnerable Tourism Land Uses	A5 Provision of Vulnerable Tourism Land Uses N/A	If in the future, any lot was to be changed for Vulnerable Tourism Land Uses, this would need to be addressed during future planning stages.

Subsection 5.2: Bushfire Mitigation Measures

Should the approval of the adjoining Millbridge Estate Development currently being assessed by the WAPC stall for some unforeseen reason, the developer of the Millbridge Estate has provided in-principal support for a 17m-wide managed grass buffer be established and maintained along the Parkridge Estate's eastern boundary so that BAL-29 will be achievable for all lots along said eastern boundary.

Additionally, a temporary EAW will be constructed on the proposed alignment of the main entrance of the two developments, providing direct access onto Eaton Drive (Figure 8). It should connect to at least two Parkridge Estate internal roads thus providing two egress routes out of Parkridge Estate for all lots.

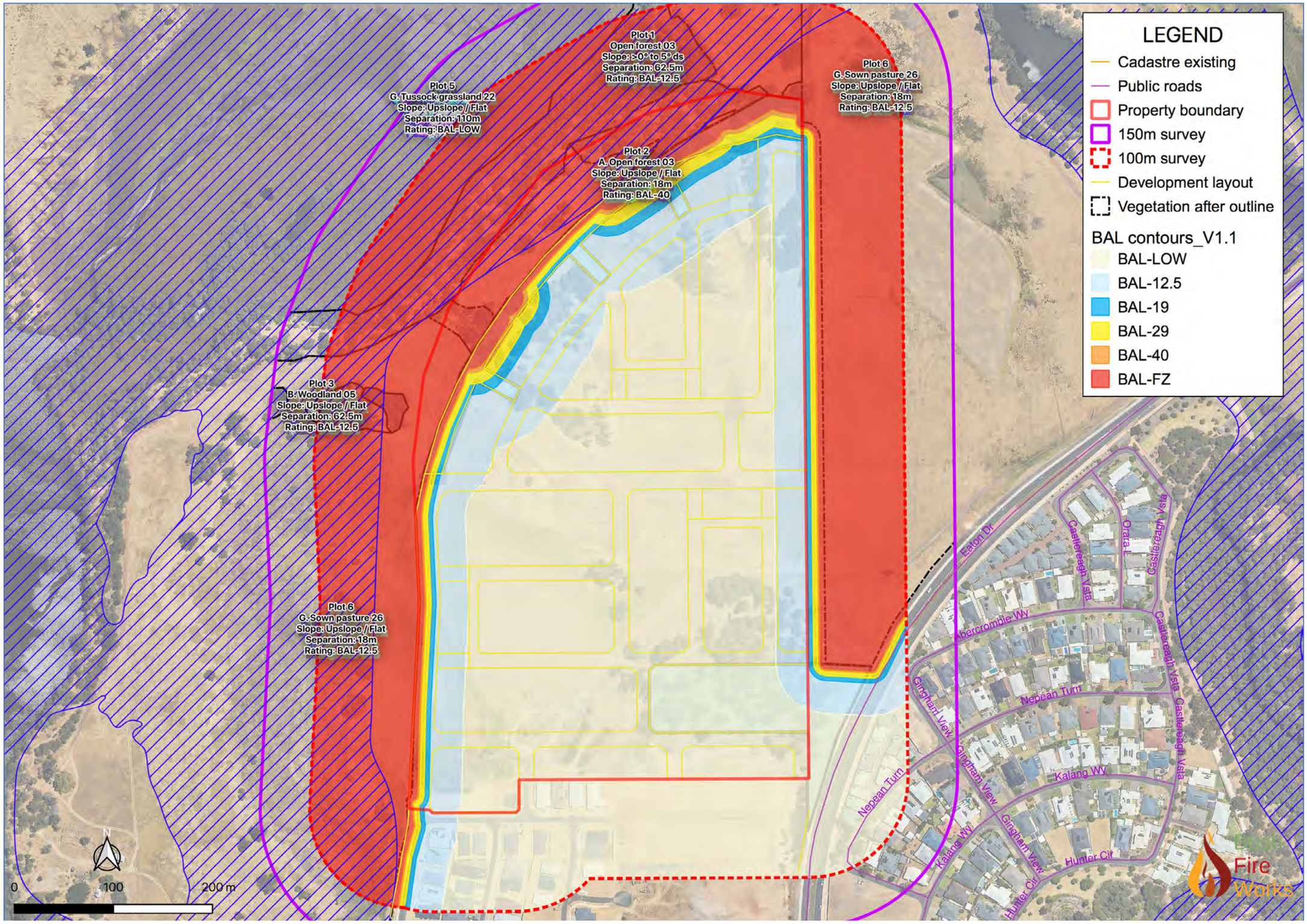


Figure 7 BAL contours after development

Section 6: Responsibilities for Implementation and Management of the Bushfire Measures

DEVELOPER/LANDOWNER – PRIOR TO SUBDIVISION, SALE OR OCCUPANCY	
No.	Implementation Action
1	Provide public roads and cross overs up to the boundaries of all lots to the standard stated in the BMP.
2	Provide a scheme water connection to all lots.
3	Manage any vegetation on the subdivided lots in a low-threat condition up to the point of sale and/or hand over.
4	Provide and manage areas of POS to the standard stated in the BMP.
5	Establish the Fire Service Access Route around the NW of the development to complete the perimeter road network as stated in the BMP.
6	Should the WAPC review of the Millbridge Estate Structure Plan be stalled for any reason: 6a Establish a formal agreement with the Millbridge Estate Developer to establish a 17 m-wide slashed grass buffer along the length of the Parkridge Estate eastern boundary. 6b Establish a formal agreement with the Millbridge Estate Developer to construct a temporary EAW on the alignment of the proposed Millbridge Estate main entrance. This should connect to at least two of the Parkridge Estate internal roads and be maintained until such time that the Millbridge Estate main entrance and internal road network have been completed.

LANDOWNER/OCCUPIER – ONGOING MANAGEMENT	
No.	Management Action
1	Construct and maintain private driveways up to any dwelling the standard stated in the BMP.
2	Maintain the Asset Protection Zone (APZ) around any dwelling to the standard stated in the BMP.
3	Connect to the provided scheme water supply.
3	Comply with the relevant local government annual firebreak notice issued under s33 of the Bush Fires Act 1954.

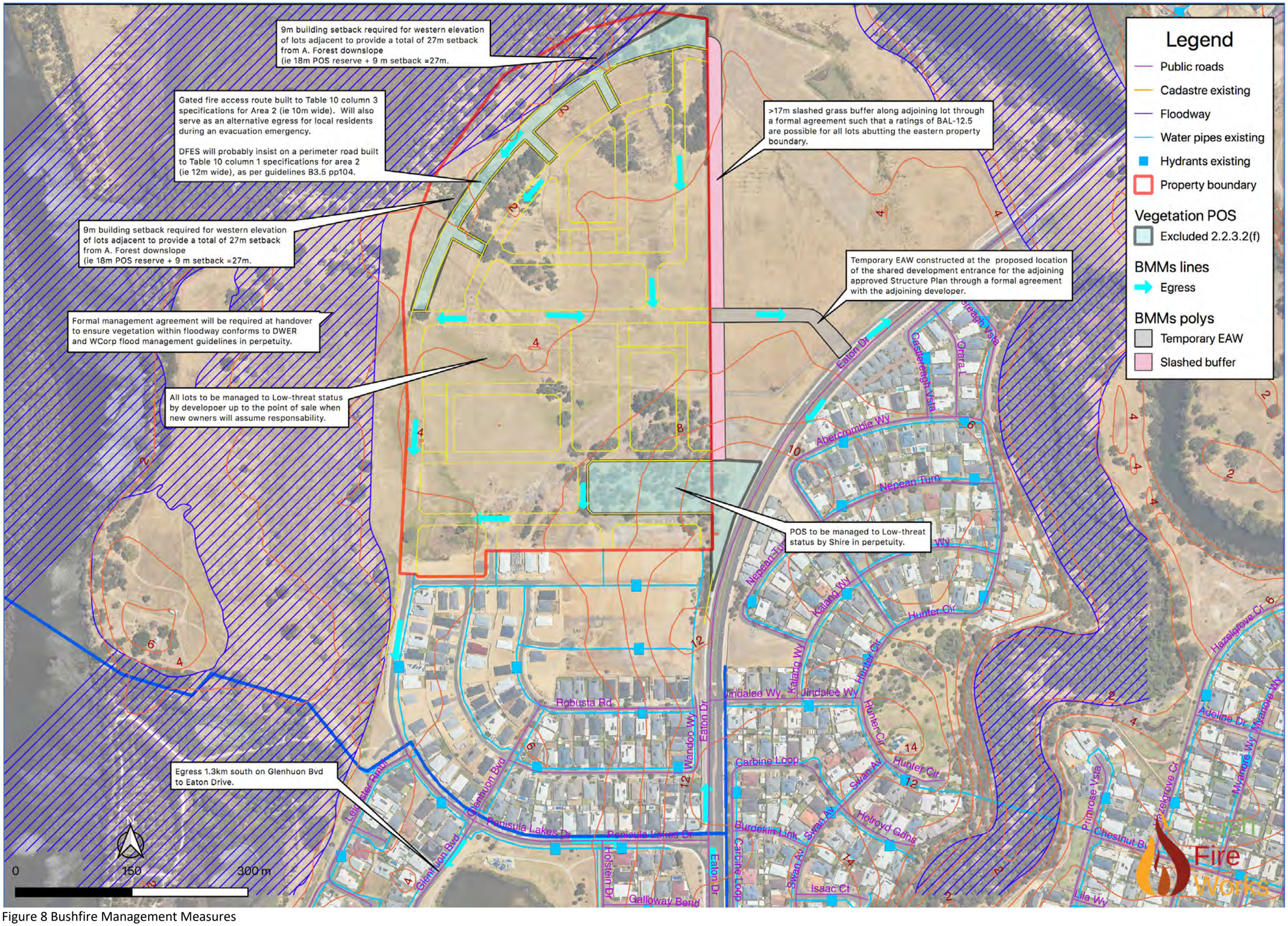


Figure 8 Bushfire Management Measures

Section 7: Photographs



Photo 37 Plot:7 Type: Excluded



Photo 38 Plot: 3 Type: B.Woodland 05



Photo 40 Plot: 2 Type: A. Open forest 03



Photo 41 Plot: 6 Type: G. Grassland 26



Photo 42 Plot: 6 Type: Grassland 26



Photo 43 Plot: 6 Type: Grassland 26



Photo 44 Plot: 6 Type: G. Grassland 26



Photo 45 Plot: 6 Type: G. Grassland 26



Photo 46 Plot: 6 Type: G. Grassland 26



Photo 47 Plot: 6 Type: G. Grassland 26



Photo 48 Plot: 6 Type: G. Grassland 26



Photo 49 Plot: 2 Type: A. Forest 03



Photo 50 Plot: 6 Type: G. Grassland 26



Photo 51 Plot: 2 Type: A. Forest 03



Photo 52 Plot: 6 Type: G. Grassland 26



Photo 53 Plot: 2 Type: A. Forest 03



Photo 54 Plot: 6 Type: Grassland 26



Photo 55 Plot: 1 Type: A. Forest 01



Photo 58 Plot: 1 Type: Grassland 26



Photo 60 Plot: 9 Type: Excluded



Photo 61 Plot: 2 Type: A. Forest 03



Photo 62 Plot: 2 Type: A. Forest 03



Photo 63 Plot: 2 Type: A Forest 03



Photo 64 Plot: 6 Type: G. Grassland 26



Photo 65 Plot: 6 Type: G.Grassland 26



Photo 66 Plot: 6 Type: G.Grassland 26



Photo 71 Plot: 6 Type: G.Grassland 26



Photo 73 Plot: 6 Type: G.Grassland 26



Photo 74 Plot: 6 Type: G.Grassland 26



Photo 79 Plot: 6 Type: G.Grassland 26



Photo 82 Plot: 6 Type: G.Grassland 26



Photo 87 Plot: 6 Type: G.Grassland 26



Photo 88 Plot: 7 Type: Excluded



Photo 89 Plot:6 Type: G.Grassland 26



Photo 90 Plot: 7 Type: Excluded



Photo 92 Plot: 6 Type: G.Grassland 26



Photo 93 Plot: 2 Type: Grassland 26



Photo 95 Plot: 2 Type: Grassland 26



Photo 97 Plot: 6 Type: G.Grassland 26



Photo 98 Plot: 3 Type: B.Woodland 03



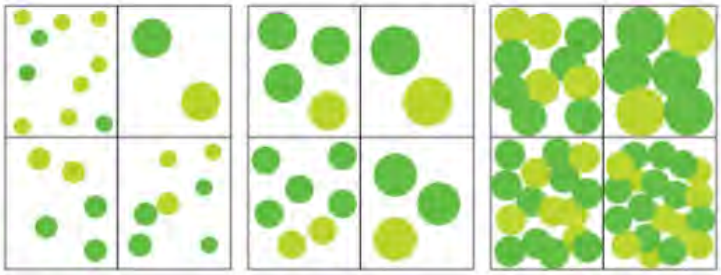
Photo 99 Plot: 7 Type: Excluded

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Appendices

Appendix 1: Specifications for Asset Protection zones

Table 9: Asset Protection Zone (APZ) technical requirements

OBJECT	REQUIREMENT
Fences within the APZ	Should be constructed from non-combustible materials (for example, iron, brick, limestone, metal post and wire, or bushfire-resisting timber referenced in Appendix F of AS 3959).
Fine fuel load (combustible, dead vegetation matter less than 6 mm in thickness)	• Should be managed and removed on a regular basis to be maintained as low threat vegetation • Should be maintained at less than two tonnes per hectare (on average) • Mulches should be non-combustible such as stone, gravel, shells, rock or crushed mineral earth or wood mulch more than five millimetres in thickness.
Trees* (more than 6 m in height)	• Trunks at maturity should be a minimum distance of six metres from all elevations of the building • Branches at maturity should not touch or overhang a building or powerline • Lower branches and loose bark should be removed to a height of two metres above the ground and/or surface vegetation. • Canopy cover within the APZ should be less than 15 per cent of the total APZ area • Tree canopies at maturity should be at least 5 m apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided the total canopy cover within the APZ does not exceed 15 per cent and is not connected to the tree canopy outside the APZ. **Tree canopy cover – ranging from 15 to 70 per cent at maturity**  15% 30% 70%
Shrub* and scrub* (0.5 m to 6 m in height). Shrub and scrub more than 6 m in height are to be treated as trees.	• Should not be located under trees or within three metres of buildings • Should not be planted in clumps more than five square metres in area • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground cover* (less than 0.5 m in height. Ground cover more than 0.5 m in height is to be treated as shrub)	• Can be planted under trees but must be maintained to remove dead plant material, as prescribed in 'Fine fuel load' above • Can be located within two metres of a structure but three metres from windows or doors if more than 100 mm in height.
Grass	• Grass should be maintained at a height of 100 mm or less, at all times • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.
Defendable space	Within three metres of each wall or supporting post of a habitable building; the area is kept free from vegetation but can include ground cover, grass and non- combustible mulches as prescribed above.
Liquid petroleum gas cylinders	• Should be located on the side of a building farthest from the likely direction of a bushfire or on the side of a building where surrounding classified vegetation is upslope, at least one metre from vulnerable parts of a building • The pressure relief valve should point away from the house • No flammable material within six metres from the front of the valve • Must sit on a firm, level and non-combustible base and be secured to a solid structure.

Appendix 2: Vehicle access technical requirements

"Table 6"- Vehicle access technical requirements.

Table 10: Vehicular access technical requirements

	1		2		3		4		5	
TECHNICAL REQUIREMENTS	**PERIMETER ROADS**		**PUBLIC ROADS**		**EMERGENCY ACCESS WAY[3]**		**FIRE SERVICE ACCESS ROUTE[3]**		**BATTLE-AXE & PRIVATE DRIVEWAYS[1]**	
MAP OF BUSH FIRE PRONE AREAS DESIGNATION	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**	**Area 2**	**Area 1**
Minimum horizontal clearance (metres)	12	8	See note 5		10	6	10	6	6	
Minimum vertical clearance (metres)	4.5									
Minimum weight capacity (tonnes)	15									
Maximum grade unsealed road[2]	See note 5		See note 5		1:10 (10% or 6°)					
Maximum grade sealed road[2,4]					1:7 (14.3% or 8°)					
Maximum average grade sealed road					1:10 (10% or 6°)					
Minimum inner radius of road curves (metres)					8.5					

Notes:

1. Driveways and battle-axe legs to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision where not required to comply with the widths in this Appendix or the Guidelines.
2. Dips must have no more than a 1 in 8 (12.5% - 7.1 degrees) entry and exit angle.
3. To have crossfalls between 3 per cent and 6 per cent.
4. For sealed roads only the maximum grade of no more than 1 in 5 (20 per cent) (11.3 degrees) for no more than 50 metres is permissible, except for short constrictions to 3.5 metres for no more than 30 metres in length where an obstruction cannot be reasonably avoided or removed.
5. As outlined in the Institute of **Public Works Engineering Australasia (IPWEA) subdivision guidelines, Liveable Neighbourhoods, Austroads Standards** Main Roads standard, supplement, policy or guideline and/or any applicable or relevant local government standard or policy.

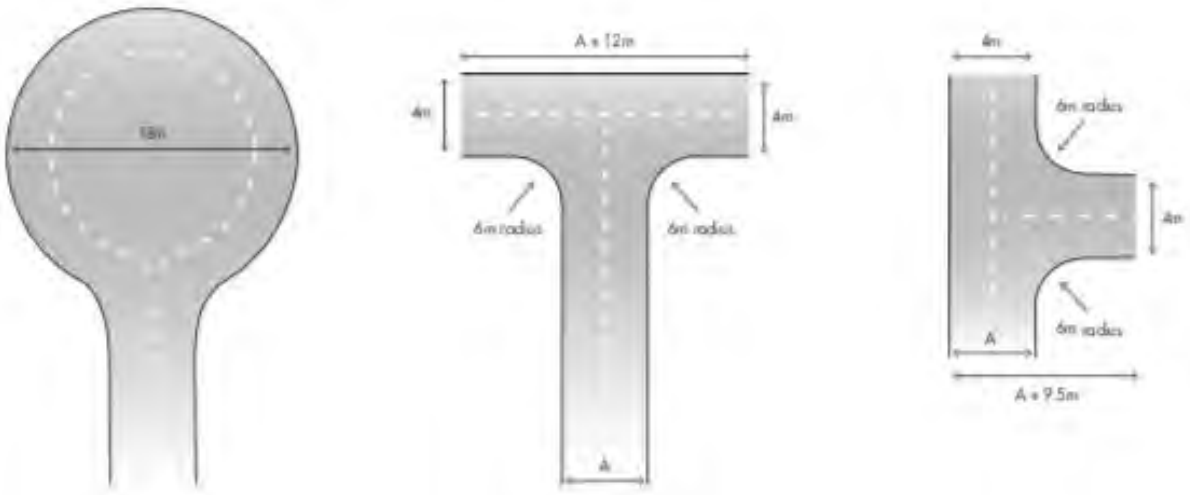
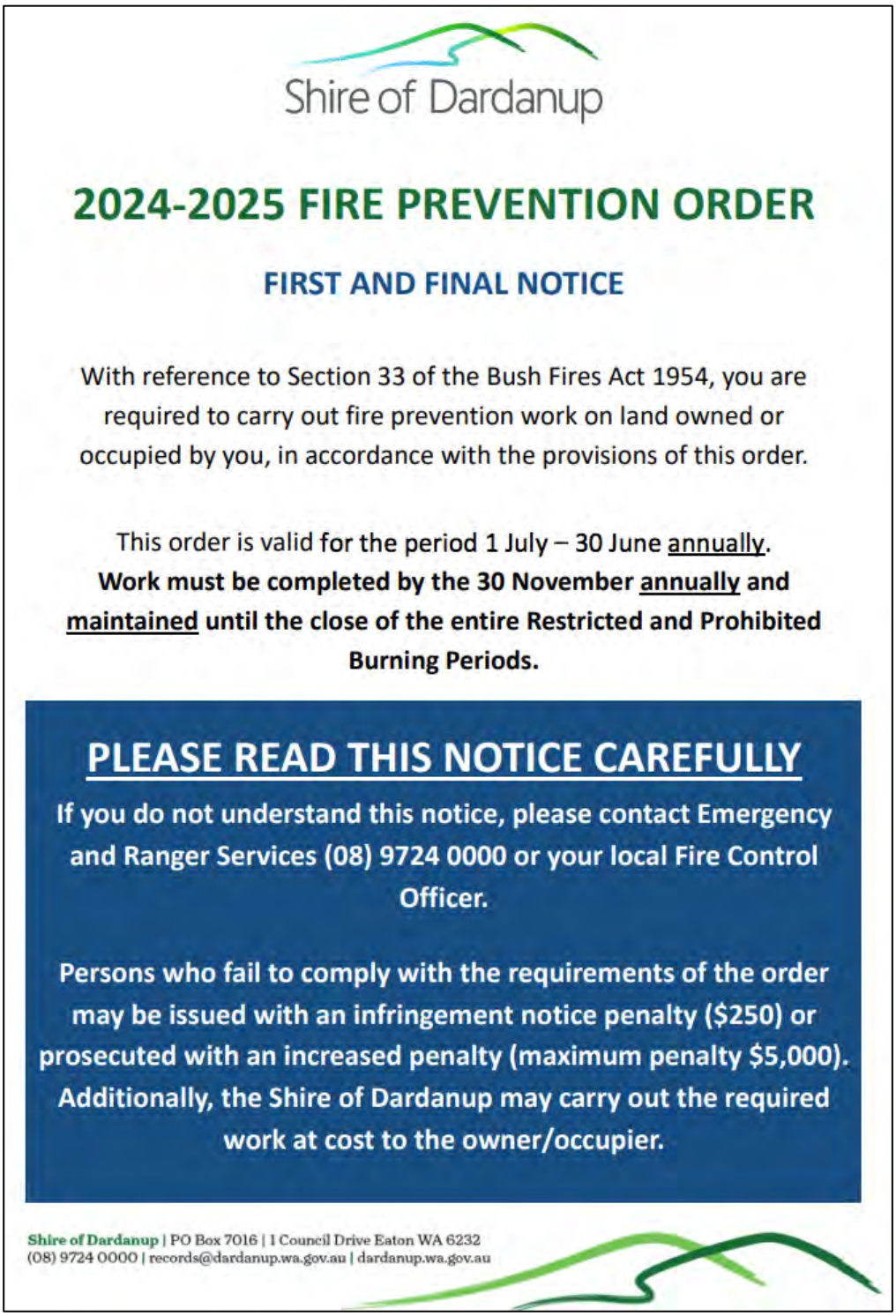


Figure 24: Turn-around area dimensions for a no-through road

Appendix 3: Local authority annual firebreak and fuel reduction notice

The Local authority annual firebreak and fuel reduction notice can be accessed by clicking on the following link:

https://www.dardanup.wa.gov.au/Profiles/dardanup/Assets/ClientData/Documents/Fire___Emergency/2024-2025_SoD_Fire_Prevention_Order_Combined_-_current.pdf



Shire of Dardanup

2024-2025 FIRE PREVENTION ORDER

FIRST AND FINAL NOTICE

With reference to Section 33 of the Bush Fires Act 1954, you are required to carry out fire prevention work on land owned or occupied by you, in accordance with the provisions of this order.

This order is valid for the period 1 July – 30 June annually.
Work must be completed by the 30 November annually and maintained until the close of the entire Restricted and Prohibited Burning Periods.

PLEASE READ THIS NOTICE CAREFULLY

If you do not understand this notice, please contact Emergency and Ranger Services (08) 9724 0000 or your local Fire Control Officer.

Persons who fail to comply with the requirements of the order may be issued with an infringement notice penalty ($250) or prosecuted with an increased penalty (maximum penalty $5,000). Additionally, the Shire of Dardanup may carry out the required work at cost to the owner/occupier.

Shire of Dardanup | PO Box 7016 | 1 Council Drive Eaton WA 6232
(08) 9724 0000 | records@dardanup.wa.gov.au | dardanup.wa.gov.au

APPENDIX F | TRAFFIC MANAGEMENT REPORT

Parkridge Structure Plan Modification

Transport Impact Assessment

Stantec

Prepared for:
Parkridge Group Pty Ltd

Prepared by:
Stantec Australia Pty Ltd

3 September 2025

Project/File:
300305774

Stantec Australia Pty Ltd

Parkridge Structure Plan Modification

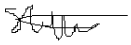
Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
002	Update	SG/DH	03/09/2025	DH	03/09/2025	RI	03/09/2025
001	Update	SC	28/01/2025	DH	28/01/2025	RJC	28/01/2025
A	Final	SA	20/03/2023	DH / PM	20/03/2023	RJC	20/03/2023

Parkridge Structure Plan Modification

The conclusions in the Report titled Parkridge Structure Plan Modification are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk.

Stantec has assumed all information received from Parkridge Group Pty Ltd (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein.

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Prepared by 

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Sebastian Cano/Sophie Gittins

Printed Name

Reviewed by 

Signature

Desmond Ho

Printed Name

Approved by 

Signature

Richard Isted

Printed Name

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1 Introduction

Stantec has been commissioned by Parkridge Group Pty Ltd to prepare a Transport Impact Assessment for the proposed modification of the Parkridge Structure Plan located in Eaton, within the Shire of Dardanup.

The original structure plan was approved in 2019. Since then, the development of 71 lots located on the southern end of the structure plan has been completed. Modification of the remaining structure plan area to the north is proposed to include 297 lots: 253 (R30) lots and 44 (R40) lots (including a Grouped Housing site comprising 47 dwellings).

This report aims to assess the impact of the proposed structure plan modification on the surrounding road network. The report will focus on access, public transport, pedestrian and cycle networks, and road network performance.

This Traffic Impact Assessment (TIA) report was prepared in accordance with the *WAPC TIA Guidelines Volume 2 – Planning Schemes, Structure Plans and Activity Centre Plan*s, with the checklist attached in **Appendix A**.

2 Structure Plan Proposal

2.1 Regional Context

The proposed structure plan is located in Eaton, Shire of Dardanup. It is located approximately 9km east-northeast of Bunbury (see **Figure 2-1**), and about 150km south of Perth.

Figure 2-1. Regional Context



Source: Metromap

2.2 Proposed Land Uses

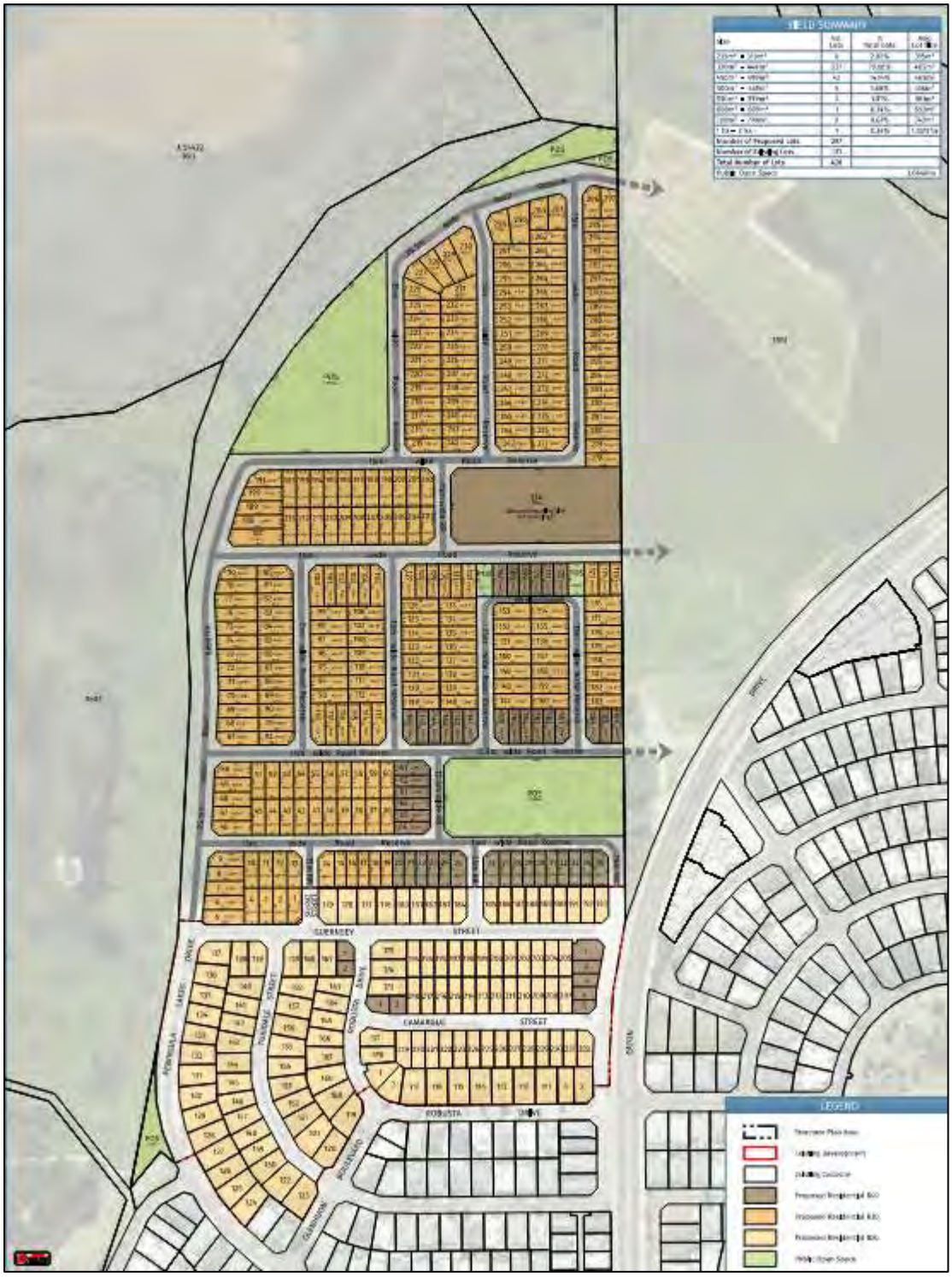
The proposed structure plan modification is illustrated in **Figure 2-2**. It shows that the modification includes the southern part of the original structure plan as these are already developed. The structure plan originally approved in 2019 includes a total area of 32.1533ha, with an anticipated total yield of 436 lots and an estimated population of 1090 persons. From the approved structure plan, 71 lots have already been developed (as shown in red hatch in **Figure 2-2**). A high-resolution version of the structure plan modification area is provided in **Appendix B**.

The proposed structure plan modification includes the following:

- Residential R30 – 253 lots
- Residential R40 – 44 lots (including one grouped lot comprising 47 dwellings)
- Public and Regional open spaces

Table 2-1 shows the table of land use and quantities proposed within the modified structure plan compared with the original structure plan. The total area covered by the structure plan modification is 28.7215ha with an anticipated yield of at least 297 lots including one grouped housing lot comprising 47 dwellings. In the modified structure plan, there is an anticipated decrease of 8 lots from the original structure plan and a total of 343 dwellings. This is approximately equivalent to an increase of 95 persons in terms of the total population of the area.

Figure 2-2. Proposed Structure Plan Modification



Source: Harkey Dykstra (August 2025)

Table 2-1. Land Uses and Quantities

Item	Units	Original SP		Modified SP		Difference from Original SP
		Total	Developed	Updated Sections Only	Including 'Developed' sections	
Area	Hectares	32.1533	3.4318	28.7215	32.1533	0
Number of Lots	Lots	436	131	297	428	-8
Population	People	1090*	328*	858* (includes 47 grouped dwellings)	1185* (includes 47 grouped dwellings)	+95

** Approximate based on ABS 2021 Eaton Data of 2.5 persons per household*

Figure 2-3 shows the developed lots on the southern section of the original structure plan. The latest aerial image below indicates that the majority of the residential dwellings within the developed area has already been built.

At the time when this TIA report was originally prepared in 2023, it was noted that 51 lots were still undeveloped, meaning no dwelling units have been built yet. Considering the figure below, this updated TIA report now considers the then-undeveloped 51 lots to contribute to the current traffic generation in the area, details of which are further discussed in **Section 7.2**.

Figure 2-3. Aerial Image of Developed Lots



Source: Metromap (2024)

3 Existing Situation

3.1 Existing Land Uses within Structure Plan

The approved Structure Plan illustrated in **Figure 3-1** shows the existing land uses within the proposed Parkridge Structure Plan area. The land uses within the proposed Parkridge Structure Plan Site are 'Residential', 'Public Open Space', and 'Regional Open Space'. The southern section of the original structure plan has already been developed as illustrated in **Figure 2-3**.

Figure 3-1. Original Structure Plan



Source: Parkridge Estate Structure Plan (2019)

3.2 Existing Land Uses within 800m of Structure Plan Area

The latest aerial image shown in **Figure 3-2** indicates the existing land uses within 800m from the proposed structure plan modification area. Existing surrounding areas are mostly comprised of residential and public open spaces.

Figure 3-2. Surrounding Land Uses



Source: Metromap (2024)

3.3 Existing Road Network within Structure Plan Area

In the most recent aerial image of the Site, the extensions of Robusta Road, Wandoo Way (Tukidale Street), and Peninsula Lakes Drive within the South Stage of the original structure plan are already laid out. Other roads including Guernsey Street, Shiraz Street, and Camargue Street have also been constructed, as shown in **Figure 3-3**.

Figure 3-3. Existing Roads within the Structure Plan



Source: Metromap (2024)

The proposed Parkridge Structure Plan area is easily accessed from the south via Eaton Drive. The newly constructed bridge on Collie River also provides good connectivity from the north. Trips heading in the east/west direction are anticipated to utilise Forrest Highway. Therefore, the proposed Parkridge Structure Plan area is considered to be adequately connected to the surrounding transport networks.

3.4 Existing Road Network within 2 (or 5) km of Structure Plan Area

Road classifications are defined in the Main Roads Functional Hierarchy as follows:

- **Primary Distributors (light blue):** Form the regional and inter-regional grid of Main Roads WA traffic routes and carry large volumes of fast-moving traffic. Some are strategic freight routes, and all are National or State Roads WA.
- **Regional Distributors (red):** Roads that are not Primary Distributors, but which link significant destinations and are designed for efficient movement of people and goods within and beyond regional areas. They are managed by Local Government.

- **District Distributor A (green):** These carry traffic between industrial, commercial and residential areas and connect to Primary Distributors. These are likely to be truck routes and provide only limited access to adjoining properties. They are managed by Local Government.
- **Distributor B (dark blue):** Perform a similar function to District Distributor A but with reduced capacity due to flow restrictions from access to and roadside parking alongside adjoining property. These are often older roads with traffic demand in excess of that originally intended. District Distributor A and B roads run between land-use cells and not through them, forming a grid that would ideally be around 1.5 kilometres apart. They are managed by Local Government.
- **Local Distributors (orange):** Carry traffic within a cell and link District Distributors at the boundary to access roads. The route of the Local Distributor discourages through traffic so that the cell formed by the grid of District Distributors only carries traffic belonging to or serving the area. These roads should accommodate buses but discourage trucks. They are managed by Local Government.
- **Access Roads (grey):** Provide access to abutting properties with amenity, safety and aesthetic aspects having priority over the vehicle movement function. These roads are bicycle and pedestrian friendly. They are managed by Local Government.

The roads surrounding the proposed Parkridge Structure Plan area are illustrated in **Figure 3-4**. Eaton Drive to the east is classified as *Distributor A*, while all other roads in the immediate vicinity of the proposed Parkridge Structure Plan area are classified as *Access Road.* Eaton Drive becomes The Boulevard just before the bridge crossing Collie River to the east of the Site. **Table 3-1** describes the characteristics of the roads in the vicinity of the Parkridge Structure Plan area.

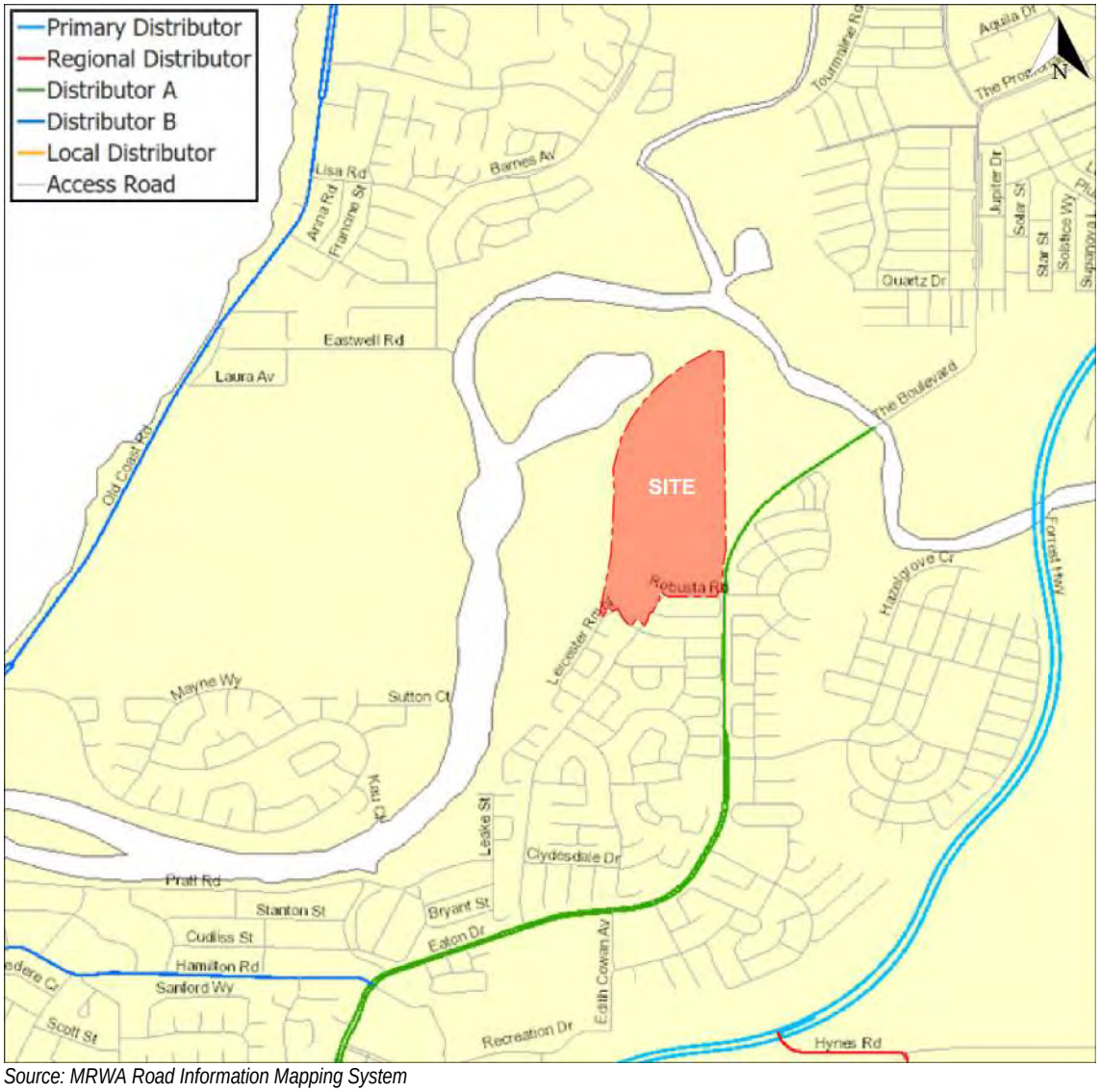
Table 3-1. Characteristics of the Surrounding Road Network

Road Names	Road Hierarchy	Jurisdiction	No. of Lanes	No. of Footpaths	Road Width (m)	Posted Speed Limit (km/h)
Eaton Drive	Distributor A	Local Government	4	2	20.0 (including 6.0 median)	60
Peninsula Lakes Drive	Access Road	Local Government	2	1	7.42	50
Glenhuon Boulevard	Access Road	Local Government	2	1	7.2	50
Wandoo Way	Access Road	Local Government	2	1	6.2	50
Robusta Road	Access Road	Local Government	2	1	6.2	50

Source: MRWA Road Information Mapping System

No traffic data is available for the newly constructed roads within the structure plan.

Figure 3-4. Existing Road Network Hierarchy Map



Source: MRWA Road Information Mapping System

3.5 Existing Traffic Volumes

The latest traffic volumes on Peninsula Lakes Drive are presented in **Table 3-2**. The traffic data was extracted from the Main Roads Traffic Map. The volumes are considered low, ranging from 137 to 148 vehicles during the weekday/weekend peak hour periods.

Table 3-2. Existing Traffic Volumes – Peninsula Lakes Drive

	Thursday / 09 June 2022			Saturday / 11 June 2022	
Direction	AM 07:45-08:45	PM 16:45-17:45	12hr Total 06:00-18:00	Midday 11:00-12:00	12hr Total 06:00-18:00
Eastbound	102	56	600	73	638
Westbound	37	92	586	64	565
Total	139	148	1186	137	1203

Source: MRWA Traffic Map

3.6 Existing Pedestrian and Cycle Networks

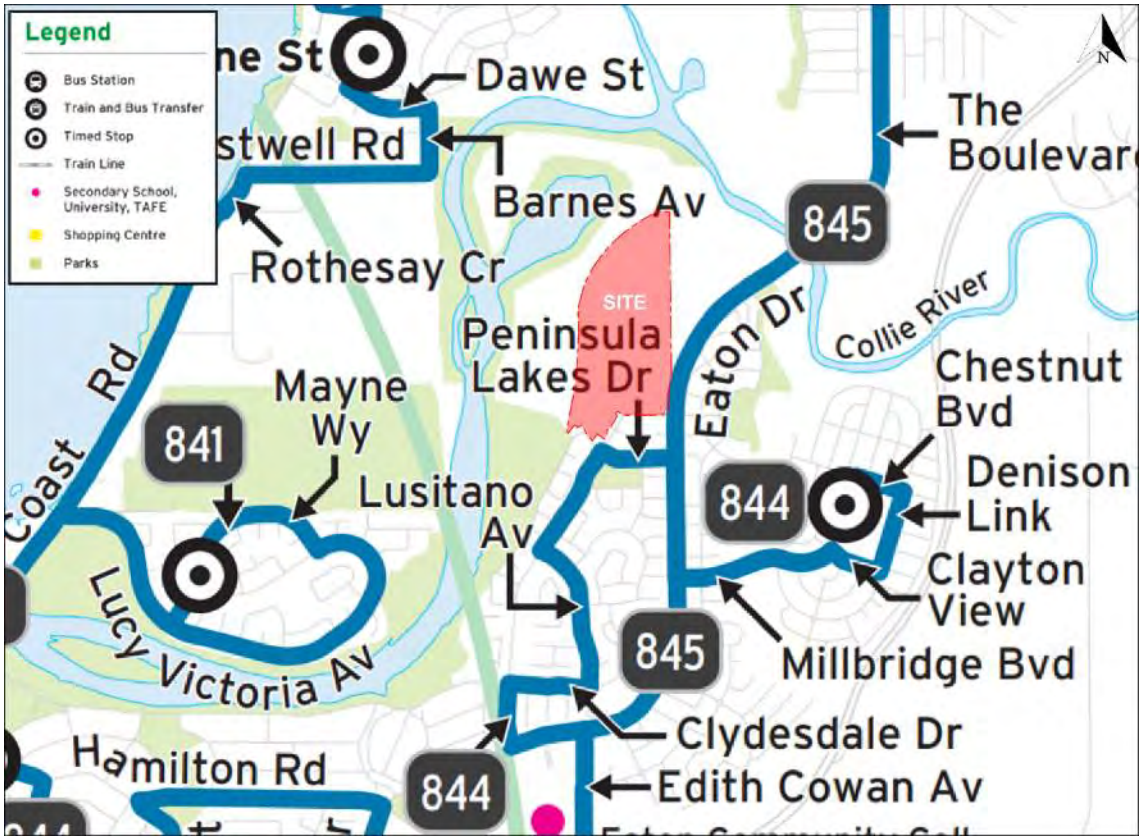
Footpaths are present on both sides of Eaton Drive which are anticipated to be the primary walk/bike paths from the Site to the surrounding areas. In addition, **Figure 3-3** also shows the footpaths provided on the roads within the structure plan's southern stage. The location of these footpaths relative to the internal roads are as follows:

- Robusta Road – east side
- Tukidale Street – east side
- Peninsula Lakes – west side
- Guernsey Street – north side
- Camargue Street – south side
- Shiraz Street – east side

3.7 Existing Public Transport Services

The bus routes surrounding the proposed Parkridge Structure Plan area are shown in **Figure 3-5**. Route 844 runs along Peninsula Lakes Drive to the south of the proposed Parkridge Structure Plan area, while Route 845 runs along Eaton Drive to the east. Both routes begin at the Bunbury Bus station. Route 844 terminates at Millbridge Boulevard/Braddon Way to the southeast of the proposed Parkridge Structure Plan area, while Route 845 terminates at Kingston Drive/Holbrook Road to the northeast of the Site. The frequency of service of the bus routes near the proposed Parkridge Structure Plan area is summarised in **Table 3-3**.

Figure 3-5. Existing Public Transport Network



Source: TransBunbury

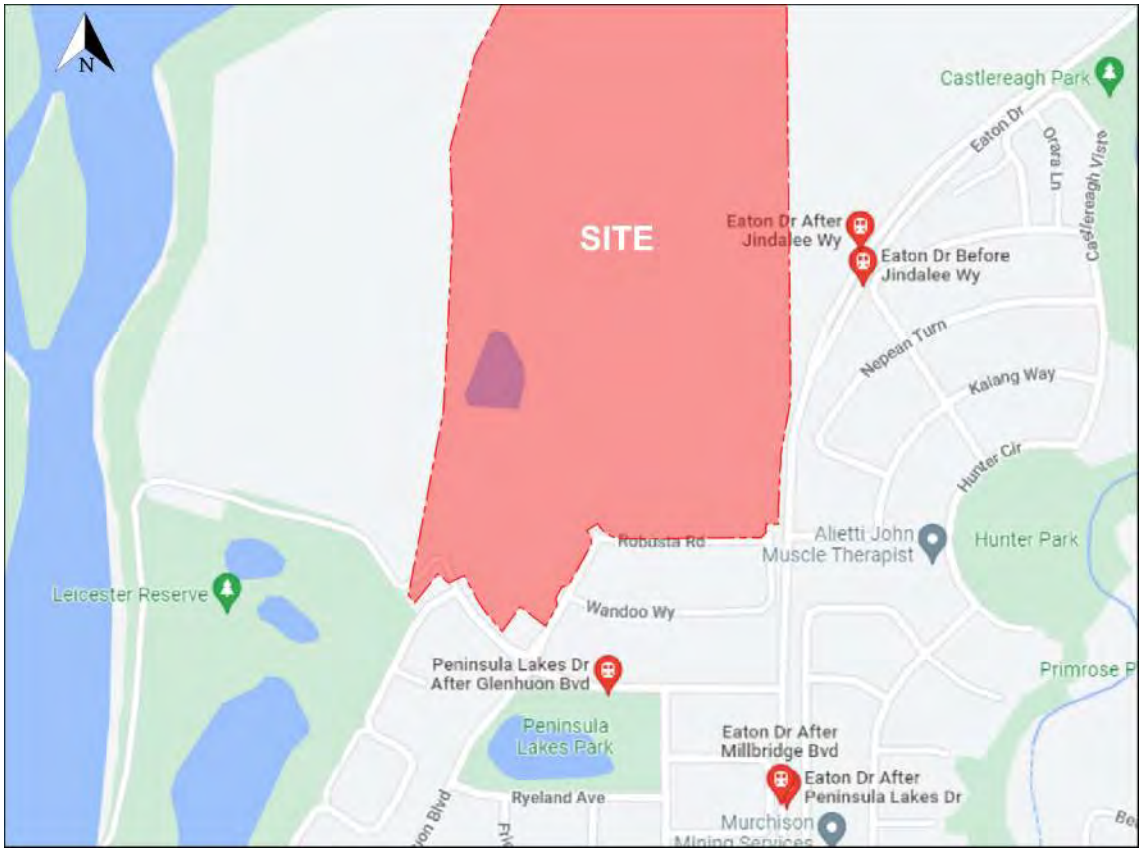
Table 3-3. Existing Bus Routes – Service Frequencies

Route Number	Direction	Service Frequency	
		Weekday	Saturday
Route 844	To Australind, Eaton and Millbridge	60 minutes	120 minutes
	To Bunbury Bus Station	60 minutes	120 minutes
Route 845	To Australind, Eaton and Millbridge	60 minutes	120 minutes
	To Bunbury Bus Station	60 minutes	120 minutes

Source: TransBunbury

The nearest bus stops are shown in **Figure 3-6** (in red pins) and includes two stops along Eaton Drive to the east and a stop on Peninsula Lakes Drive to the south. These stops are located approximately 200 metres from the nearest point of the proposed Parkridge Structure Plan area.

Figure 3-6. Surrounding Bus Stops



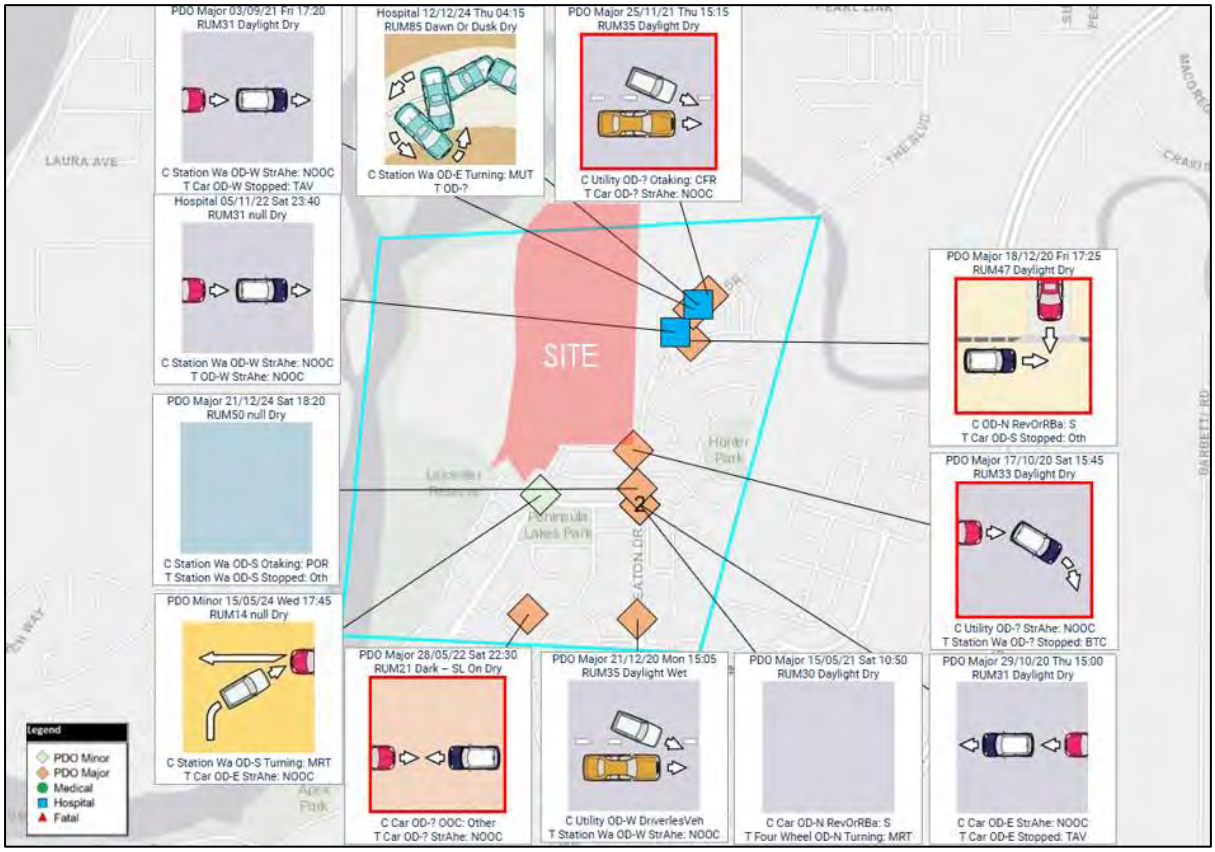
Source: Google Maps

Despite the close proximity of the bus stops and bus routes that operate near the Site, the bus trips on these routes are long, ranging between 1 to 2 hours. It is anticipated that few patrons will use the public transport due to its limited flexibility. Therefore, the existing public transport near the proposed Parkridge Structure Plan area can be considered to be poor and inadequate. No public transport networks and services currently operate within the Parkridge Structure Plan area.

3.8 Crash Assessment

A review of crashes that have been reported within the 5-year period from 2020 – 2024 has been undertaken using the Main Roads WA Crash Analysis Reporting System. **Table 3-4** to **Table 3-6** provides a summary of all crashes that occurred within the vicinity of the Site, with the location and severity of these crashes illustrated in **Figure 3-7**.

Figure 3-7. Crash Locations



Source: MRWA Crash Map

Table 3-4. Total Crashes

Type of Crash (RUM Code)	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Sideswipe Same Direction	-	-	-	2	-	2
Rear End	-	1	-	3	-	4
Hit Object	-	-	-	-	-	-
Head On	-	-	-	1	-	1
Right Angle	-	-	-	1	1	2
Unspecified	-	1	-	2	-	3
Total	-	2	-	9	1	12

Table 3-5. Intersection Crashes

Intersection Name	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Eaton Dr - Peninsula Lakes Dr	-	-	-	2	-	2
Wandoo Wy - Robusta Rd	-	-	-	1	-	1
Peninsula Lakes Dr – Glenhuon Bvd	-	-	-	-	1	1
Total	-	-	-	3	1	4

Table 3-6 Midblock Crashes

Intersection Name	Fatal	Hospital	Medical	Major Property Damage	Minor Property Damage	Total Crashes
Eaton Dr	-	2	-	4	-	6
Perendale Loop	-	-	-	1	-	1
Abercrombie Wy	-	-	-	1	-	1
Total	-	2	-	6	-	8

Results of the crash assessment are summarised as follows:

- A total of twelve (12) crashes were recorded
- Nine (9) PDO major crashes were recorded
- Two (2) hospital crashes were recorded
- Eight crashes occurred in midblock sections while four crashes occurred at intersections.

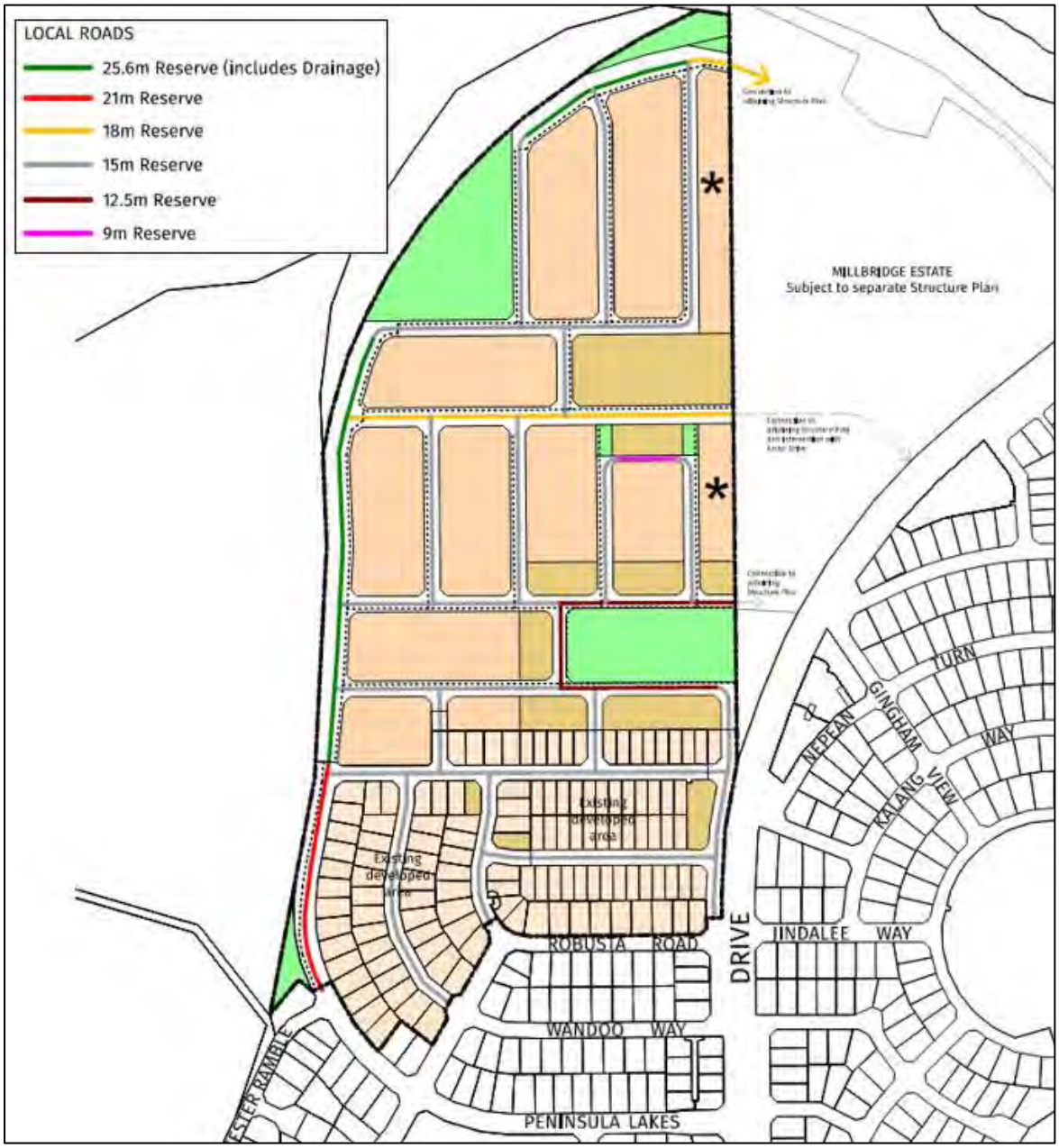
The low number of crashes within the surrounding area suggests that safety concerns are minimal. Overall, the proposed Parkridge Structure Plan is not anticipated to have a significant impact on traffic safety within the surrounding area.

4 Proposed Internal Transport Network

4.1 Changes/Additions to the Existing Road Network or Proposed New Road Network

The proposed local roads within the structure plan are shown in **Figure 4-1.** These roads are anticipated to carry local traffic only.

Figure 4-1. Internal Roads within the Structure Plan



Source: Harley Dykstra (August 2025)

4.2 Road Reservation Widths

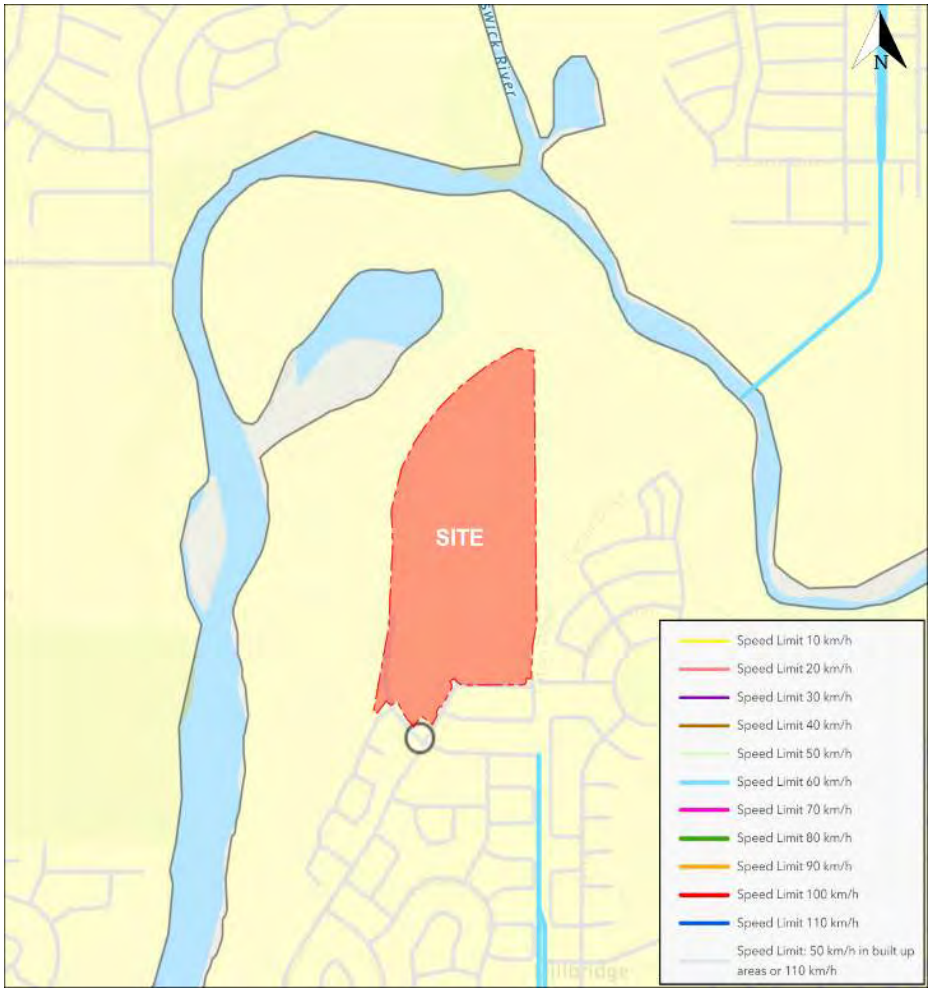
According to Liveable Neighbourhoods (2015), the road reserve widths for all access streets (Access Street B, C, or D) within the Parkridge Structure Plan area may range between 15.5m to 20.1m. The projected maximum volume for these streets may range between 1,000 to 3,000 vehicles per day.

In addition, the indicative road reserve widths for laneways/service lanes according to Liveable Neighbourhoods (2015) is 6m with a maximum of 300 vehicles per day. The other proposed road reserve widths within the structure plan that fall below the 'Access Street' category are expected to be sufficient in providing access to the side or rear of the lots, mainly for access to garages only.

4.3 Road Cross-Sections & Speed Limits

According to Liveable Neighbourhoods (2015), the speed limits for Access Streets B, C, and D may range from 20 km/h to 50 km/h. for laneways and service lanes, speed limits are anticipated to not exceed 15 km/h. It is expected that the speeds on the access roads within the Structure Plan area will be 50 km/h, similar to the speed limits on access roads to the south as shown in **Figure 4-2**.

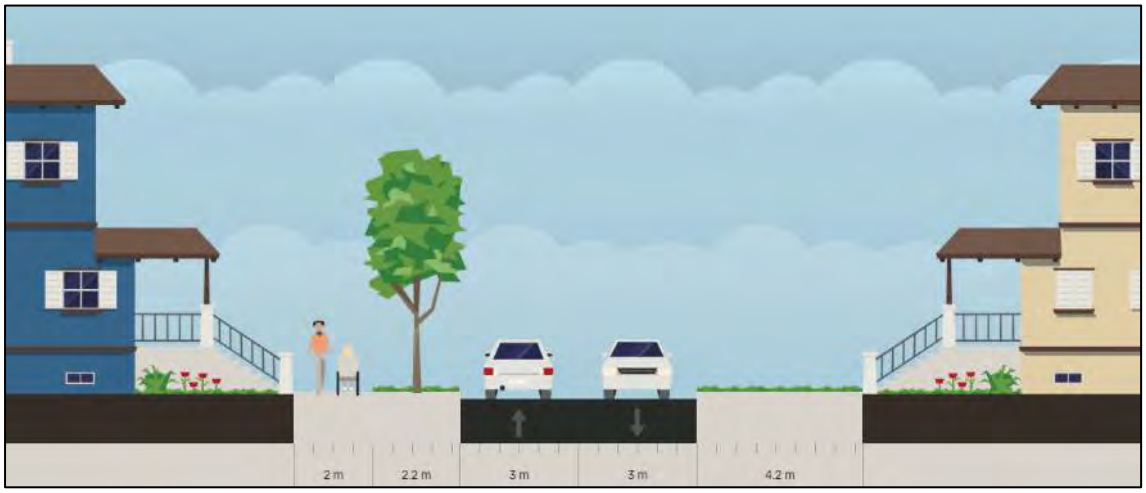
Figure 4-2. Speed Limits on Surrounding Roads



Source: MRWA Road Information Mapping System

The widths of the access roads within the proposed Parkridge Structure Plan area are anticipated to correlate with the widths in the developed areas of the original structure plan. Access streets in the developed section have widths of 6.0m, with a 2.2m-wide verge and a 2.0m-wide footpath on one side. Peninsula Lakes Drive is an exception and has a 7.2m-wide carriageway. The typical access road cross-section on the developed section of the original structure plan is shown in **Figure 4-3**.

Figure 4-3. Typical Access Street Cross-section



Source: StreetMix

4.4 Intersection Controls

According to Liveable Neighbourhoods (2015), intersections of two access roads are anticipated to be controlled by either stop/give-way signs or roundabouts (for very limited cases). It is anticipated that sign controls will be sufficient for all intersections within the proposed Parkridge Structure Plan area since there are only three-way intersections and the traffic volume is anticipated to be low. Similar intersection control measures as above are anticipated to be adequate for access street and laneway intersections.

4.5 Pedestrian/Cycle Networks and Crossing Facilities

A 2.0m-wide footpath is provided on one side of all access streets on the developed section of the original structure plan. Designated crossing points are also provided in the form of kerb ramps as shown in **Figure 4-4**. The same pedestrian and cycling facilities are anticipated to be provided within the internal access streets of the proposed Parkridge Structure Plan modification area.

Figure 4-4. Kerb Ramps at the Intersection of Robusta Road and Glenhuon Boulevard



Source: Metromap (2024)

4.6 Public Transport Routes

The Public Transport Authority (PTA) has advised that there are no immediate plans to modify the TransBunbury network within the area.

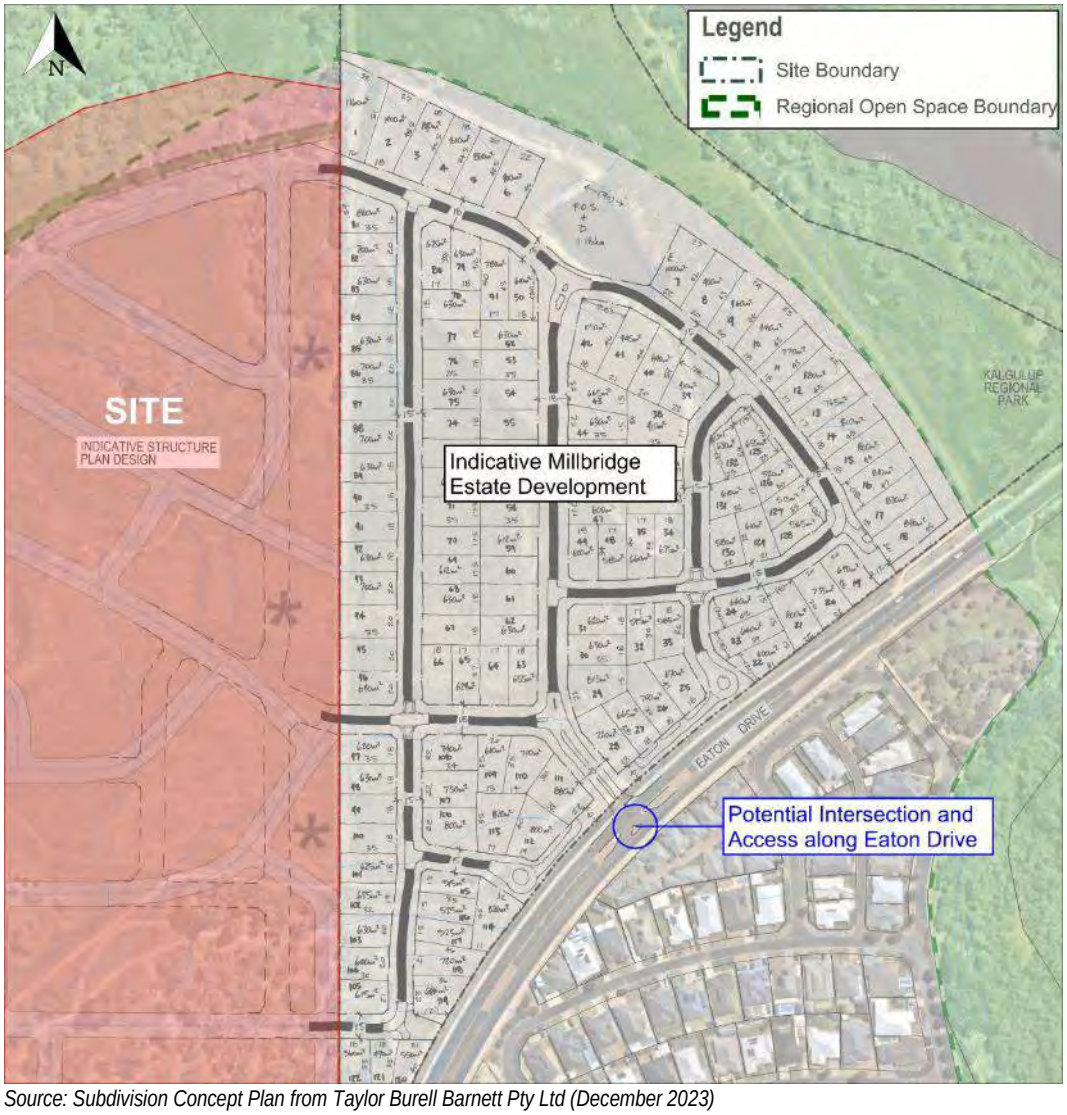
5 Changes to External Transport Network

5.1 Road Network

Stantec has contacted the Shire of Dardanup and was informed that no proposed changes to the road network are planned.

Referring to **Figure 5-1**, there appears to be a proposed intersection on Eaton Drive to the east of the proposed Parkridge Structure Plan area as part of the Millbridge Estate development (formerly 'Southbank @ Eaton). Details of the adjacent development are discussed in **Section 6.2**. This intersection may potentially be shared by residents of the Parkridge and Millbridge Estate developments in the future. However, the timeline for the construction of the Millbridge Estate development, including the future intersection is unknown.

Figure 5-1. Future Access to Millbridge Estate Development



Source: Subdivision Concept Plan from Taylor Burell Barnett Pty Ltd (December 2023)

5.2 Intersection Controls

Stantec has contacted the Shire of Dardanup and was informed that no proposed changes to the intersection controls outside of the structure plan area are planned.

5.3 Pedestrian/Cycle Networks and Crossing Facilities

Stantec has contacted the Shire of Dardanup and was informed that no proposed changes to existing footpaths and cycling facilities outside of the structure plan area are anticipated.

5.4 Public Transport Services

Stantec has contacted the Public Transport Authority and was informed that no proposed changes to the TransBunbury network outside of the structure plan area are planned.

6 Integration with Surrounding Area

6.1 Trip Attractors/Generators

Since the entire Parkridge Structure Plan Site is proposed to be residential, trips are anticipated to be from/to places of work, retail, and recreation. The main attractors/generators of traffic to/from the proposed Parkridge Structure Plan area are shown in **Figure 6-1**. These include the nearest commercial districts in the area: Treendale Shopping Centre and Eaton Fair Shopping Centre. It is also anticipated that several trips from the proposed Parkridge Structure Plan area will be arriving from or departing to the City of Bunbury which is situated approximately 9km to the west of the Proposed Parkridge Structure Plan area.

Figure 6-1. Major Trip Attractors / Generators

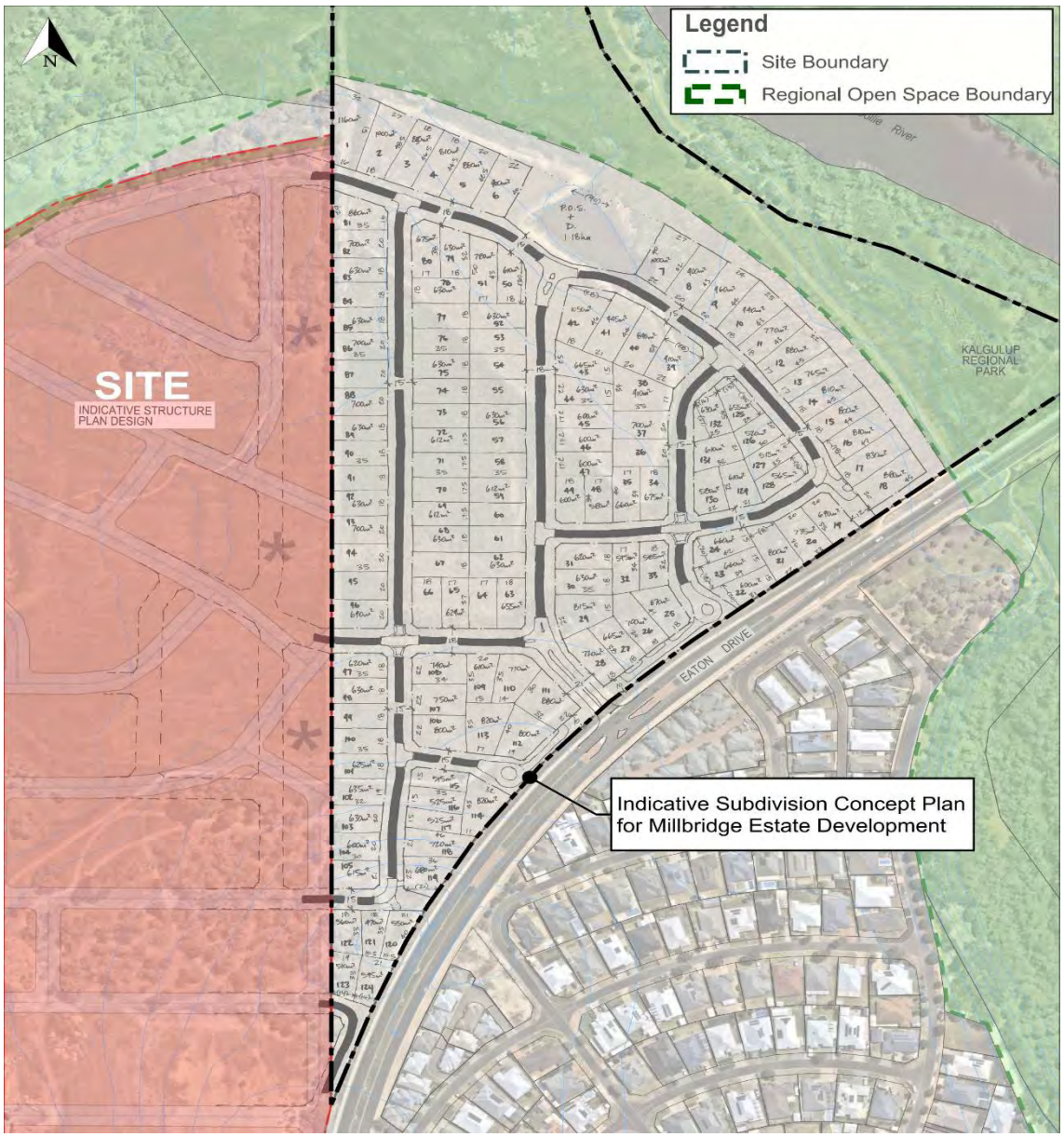


Source: Metromap (2024)

6.2 Proposed Changes to Land Uses within 800m

The indicative land uses at the Millbridge Estate development (formerly Southbank @ Eaton) located east of the proposed Parkridge Structure Plan area are shown in **Figure 6-2**. Only 'Residential' land uses are proposed in the area which is complimentary with the land uses within the proposed Parkridge Structure Plan. It is estimated that 132 residential lots will be available within this area. Due to the proximity of this future development to the proposed Parkridge Structure Plan area and the potential shared access between the two developments (as shown in **Figure 5-1**), the Millbridge Estate development was taken into consideration in the traffic analysis. A high-resolution version of the subdivision concept plan for the Millbridge Estate development is provided in **Appendix C**.

Figure 6-2. Proposed Land Uses to the East of the Parkridge Structure Plan



Source: Subdivision Concept Plan from Taylor Burell Barnett Pty Ltd (December 2023)

7 Analysis of Internal Transport Network

To identify the impact of the proposed development on the surrounding road network, the performance of the following intersections was assessed:

- Eaton Drive/Peninsula Lakes Drive intersection, and
- Eaton Drive/Millbridge Estate Access intersection

Although the intersection of Eaton Drive and Jindalee Way is located between the two identified intersections to be assessed, the trips generated by the development will only affect the through movements at this intersection. This is envisaged to have a minimal effect on the intersection performance; therefore, the intersection of Eaton Drive and Jindalee Way has been excluded from this analysis.

7.1 Assessment Years and Time Periods

The following scenarios were considered for assessment purposes:

- Scenario 1: 2025 Base Scenario;
- Scenario 2: 2030 future traffic with 50% Parkridge development (no Millbridge Estate); and
- Scenario 3: 2035 future traffic with 100% Parkridge development and 50% Millbridge Estate development
- Scenario 4: 2040 future traffic with 100% Parkridge development and 100% Millbridge Estate development

Note that the above years and percentage of development were assumed as the timeline of the implementation of the developments for the two structure plans are unknown.

The peak hour periods were derived from the traffic count data from the Main Roads Traffic Map. The peak periods are as follows:

- AM Peak: 7:45-8:45 AM
- PM Peak: 4:45-5:45 PM

7.2 Structure Plan Generated Traffic

The trip generation rate used for estimating development-generated trips for the proposed Parkridge Structure Plan Site was obtained from NSW's Guide to Transport Impact Assessment (2024). The trip generation rates from this guide comes from a 2022 survey on low-density residential developments around metropolitan Sydney area and regional NSW and 2013 surveys for medium-density residential development. The rates were selected due to its similarity to the Site in the following aspects:

- No traffic-generating developments within the area (e.g. childcare, etc.), and
- Significantly distant residential development from the CBD.

The proposed modification of the original structure plan area is anticipated to have a yield of at least 297 residential lots (including a grouped housing lot comprising of 47 dwelling units). This number was used to estimate the additional number of trips that the structure plan is expected to generate. The adopted trip generation rate is presented in **Table 7-1**. In addition, the anticipated trips to be generated by the proposed Millbridge Estate development (formerly Southbank), located east of the Site, was also considered.

Table 7-1. Adopted Trip Generation Rates

Land Use	Yield	Source	AM Peak	PM Peak	Daily
Residential Dwelling - Parkridge	296	TfNSW Guide to Transport Impact Assessment (2024) Trip Gen for Low-Density Residential Dwelling	0.68 per dwelling	0.77 per dwelling	8.12 per dwelling
Residential Grouped Dwelling – Parkridge	47	NSW Transport Impact Assessment (2024) Trip Gen for Medium density Residential Dwelling	0.39 per dwelling	0.37 per dwelling	2.72 per dwelling
Residential Dwelling - Millbridge Estate	132	NSW Guide to Transport Impact Assessment (2024) Trip Gen for Low-Density Residential Dwelling	0.68 per dwelling	0.77 per dwelling	8.12 per dwelling

In the absence of directional distribution data from the NSW reference, ITE 210 and ITE 220 directional distributions were used as illustrated in **Table 7-2** for estimating the inbound and outbound traffic proportions.

Table 7-2. Directional Distribution

	AM Peak		PM Peak		Daily	
Land Use	In	Out	In	Out	In	Out
Residential Dwellings (Single Family Detached Housing) ITE 210	26%	74%	64%	36%	50%	50%
Residential Dwellings (Multi Family Housing Low Rise) ITE 220	28%	72%	59%	41%	50%	50%

Using the above trip generation rates and distribution, the total estimated trips to be generated for the full build-out of the proposed Parkridge Structure Plan and Millbridge Estate developments are shown in **Table 7-3**.

Table 7-3. Estimated Total Trip Generation for 2040 Design Year

	AM Peak		PM Peak		Daily	
Land Use	In	Out	In	Out	In	Out
Residential Dwelling - Parkridge	52	149	146	82	1202	1202
Residential Grouped Dwelling – Parkridge	5	13	10	7	64	64
	219		245		2532	
Residential Dwelling - Millbridge Estate	23	66	65	37	536	536
	89		102		1072	
Sub Total	80	228	221	126	1802	1802
Total	308		347		3604	

The estimated total traffic to be generated by the proposed Parkridge Structure Plan and the Millbridge Estate development for the 2040 design year scenario is 308, 347, and 3,604 vehicle trips during the AM peak hour, PM peak hour and daily periods, respectively.

7.3 Extraneous (Through) Traffic

Through traffic at Eaton Drive/Peninsula Lakes Drive is already captured by the available traffic count at this intersection. However, additional through traffic is anticipated within the proposed Parkridge Structure Plan area due to the trips generated by the developed section of the structure plan.

The original TIA report, which was prepared in 2023, mentioned that out of the developed structure plan area, a total of 51 lots were considered to be ‘undeveloped’. To account for the development of the 51 ‘undeveloped’ lots, the estimated trip movements associated with these lots has been assumed to use the Eaton Drive/Peninsula Lakes Drive intersection. It is assumed that the traffic generated by the ‘developed’ lots is already incorporated in the background traffic data.

The estimated trip generation of the undeveloped lots was calculated using the same rates in **Table 7-1**, while the trip distribution was based on the percentage values indicated in **Table 7-2**. The estimated trips to be generated by the remaining undeveloped lots has been included in the base year background traffic as shown in **Figure 8-2**.

7.4 Design Traffic Flows

Based on the forecasted trip generation of the Proposed Parkridge Structure Plan in the ultimate 2040 scenario of around 2,500 vehicles daily as indicated in **Table 7-3** and the existing volumes on Peninsula Lakes Drive west of Eaton Drive of 1,200 daily vehicles as indicated in **Table 3-2**, the approximate daily traffic volumes on Peninsula Lakes Drive and Glenhuon Boulevard are shown in **Figure 7-1**.

Figure 7-1. Approximate Design Traffic Flows



Source: Metromap (base map)

The volumes on Glenhuon Boulevard (north of Peninsula Lakes Drive) and Peninsula Lakes Drive (west of Glenhuon Boulevard) are anticipated to remain under the maximum volume for an Access Street C from the *Liveable Neighbourhoods Guidelines,* which is 3,000vpd.

However, the volumes along Peninsula Lakes Drive, east of Glenhuon Boulevard, are anticipated to exceed the projected maximum volume for an Access Street. The next street type which can accommodate the volumes on Peninsula Lakes Drive is a Neighbourhood Connector A (7,000vpd max) with its function and characteristics detailed in **Table 7-4**. The pavement width for a Neighbourhood Connector A is 2 x 7.2m, while the existing pavement on Peninsula Lakes Drive is a single carriageway approximately 7.6m wide. This indicates that the road may not be able to accommodate the traffic volumes in the 2040 ultimate scenario.

The volume on Peninsula Lakes Drive is anticipated to exceed 3,000vpd at about **71%** completion (equivalent to about 211 lots) of the proposed Parkridge Structure Plan modification area. Since the improvement of Peninsula Lakes Drive does not appear to be possible due to constraints in the road reserve, the construction of the proposed intersection for the anticipated Millbridge Estate Access on Eaton Drive, which also links to the proposed Parkridge development will need to be considered to mitigate against the anticipated increase in traffic along Peninsula Lakes Drive.

Table 7-4. Function and Characteristics of Local Streets (Excerpt from Liveable Neighbourhoods)

Street type and function	Street name	Projected maximum volume (vehicles per day)	Indicative street reserve width (metres)	Maximum design/ target operating speed (km/hr)	Minimum street pavement width (metres)	Typical residential density
Neighbourhood connectors Streets with mostly residential frontage that typically provide the lower order sub-arterial network. These streets service and link neighbourhoods and activity centres.	**Neighbourhood connector A**	7,000	27.6	50 / 50	2 x 7.3 including parking, on-street bike lane, median plus shared path on one verge and footpath on the other side	R40 to R80
	Neighbourhood connector B	3,000	21.6	50 / 50	11.6 including parking, plus shared path on one verge.	R40 to R80
Access streets Access streets are to accommodate shared pedestrian, bike and vehicular movements. The requirements of adjacent land uses should be supported through street design.	**Access street A –** avenue	3,000	Overall width depends on design and function of central median	50 / 40	2 x 3.5 plus embayment parking.	Varies
	Access street B – wider street	3,000	20.1	50 / 40	10	Up to R40
	Access street C – yield or give way street	3,000	17.2	50 / 30	7.2 typical 7-7.5 range	Up to R35
	Access street D – narrow yield or give way street	1,000	15.5	50-20	5.5 typical 5.5-6 range	Less than R30

Source: WAPC Draft Liveable Neighbourhoods (2015)

7.5 Access Strategy

In the short term, the traffic generated by the proposed Parkridge Structure Plan area is anticipated to exclusively use the Peninsula Lakes Drive/Eaton Drive intersection to enter/exit the area. When the development of Millbridge Estate (formerly Southbank @ Eaton) commences, an additional intersection with Eaton Drive is proposed to the east of the proposed Parkridge Structure Plan Site, as discussed in **Section 5.1**. Although some traffic heading south may use Glenhuon Boulevard, this is considered unlikely due to the following:

- Lower speed limit on Glenhuon Boulevard.
- Presence of multiple roundabouts along the route, further increasing the travel time.
- Higher through volumes at the Eaton Drive/Glenhuon Boulevard intersection to the south, making right-turn movements from Glenhuon Drive more difficult.

As such, the analysis assumes that traffic from the proposed Parkridge Structure Plan area will only use Peninsula Lakes Drive and the future Millbridge Estate access in the longer term.

7.6 Safe Routes to School

The nearest school (Glen Huon Primary School) is located approximately 1.5km to the South of the proposed Parkridge Structure Plan area as shown in **Figure 7-2**. Students are not anticipated to walk to school due to the long distance. Some students may opt to ride their bikes to school and may take the route along Glenhuon Boulevard, as it has a lower posted speed and less vehicular traffic compared to Eaton Drive.

Figure 7-2. Potential Route from the Parkridge Structure Plan Area to Glen Huon Primary School



Source: Metromap (base map)

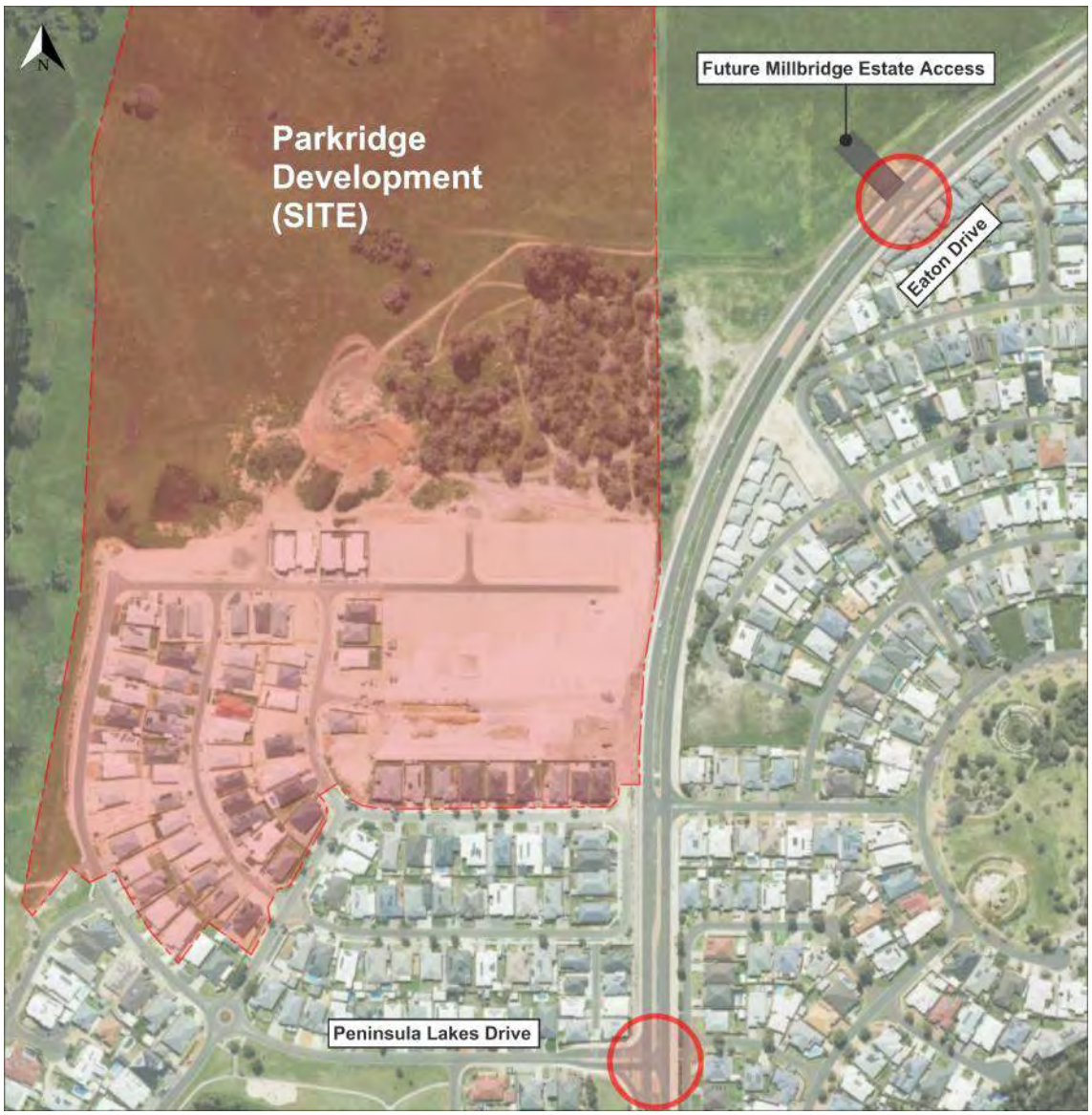
8 Analysis of External Transport Network

8.1 Extent of Analysis

As illustrated below in **Figure 8-1**, two intersections were assessed as part of the analysis:

- Eaton Drive/Peninsula Lakes Drive intersection, and
- Eaton Drive/ Millbridge Estate Access intersection.

Figure 8-1. Assessed Intersections



Source: Metromap (base map)

8.2 Key Assumptions

Assumptions used in undertaking the SIDRA analysis are detailed below:

- The 2025 base scenario and future scenario volumes were obtained by adding a background traffic growth rate to the 2022 volumes from the video survey at the intersection of Eaton Drive and Peninsula Lakes Drive (obtained from the MRWA Traffic Map).
- Growth rates used for different scenarios were based on population forecast for the Shire of Dardanup as summarised in **Table 8-1.**
- Heavy vehicle percentage used in the analysis is based on the surveyed traffic data. It is assumed that the distribution of vehicle classes will not change in future scenarios. The existing counts indicated that no Class 10, 11, and 12 vehicles are using the existing intersections.

8.3 Estimated Growth Rates

The forecast population growth for Eaton East, Shire of Dardanup was used in estimating the traffic growth rate on the surrounding roads. The growth rate is faster within the short/medium term but steadily slows down for the future years. Hence, different growth rates (from the base year) and associated with the future years as indicated in **Table 8-1** were used for the traffic analysis.

Table 8-1. Estimated Growth Rates

Analysis period (number of years from base year)	Growth Rate Per Annum
5	2.4%
10	2.0%
15	1.8%
20	1.5%

Source: Population and Household Forecasts by Informed Decisions (December 2021)

8.4 Trip Distribution

The trip distribution from the proposed structure plan was based on data from the Australian Bureau of Statistics (ABS) 2021 census. Data on the place of work of Eaton residents was extracted, and it was determined that approximately 80% of the residents head south, primarily to Bunbury and Dardanup centres, and 20% of the residents head north, primarily to Harvey and Collie centres. This directional distribution was used in estimating the turn volumes at the identified key intersections to be assessed.

Although the Base Scenario traffic data indicates a higher percentage of traffic heading to or approaching from the north, the ABS data distribution was used since this is considered to be more conservative since right-turn movements from the minor road have a greater impact on the intersection performance when compared to left-turn movements.

8.5 Traffic Volumes

The traffic volumes for the assessed intersections under different scenarios are presented in the following figures.

Figure 8-2 shows the 2025 base scenario volumes for the Peninsula Lakes Drive/Eaton Drive intersection. This volume was obtained by applying a growth rate of 2.4% for each year from the available 2022 traffic data. This does not include any traffic from the proposed Parkridge Structure Plan developments.

Figure 8-2. Scenario 1 – 2025: Base Year Scenario

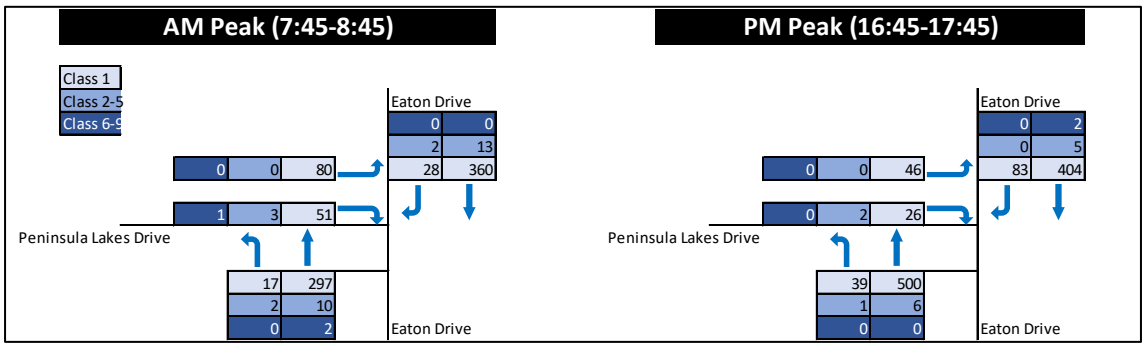


Figure 8-3 shows the Scenario 2 traffic volumes which assumes that 50% of the Parkridge development has been completed, while the Millbridge Estate development has not commenced yet. This scenario also assumes that the intersection of the future Millbridge Estate Access and Eaton Drive intersection is still not constructed.

Figure 8-3. Scenario 2 – 2030: 50% Parkridge without Millbridge Estate Development

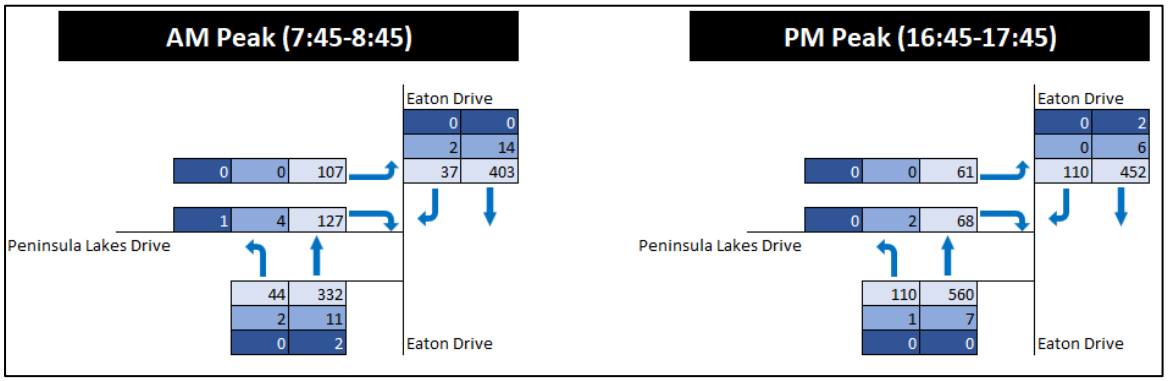


Figure 8-4 shows the Scenario 3 traffic volumes which assumes that the proposed Parkridge Structure Plan development has been fully completed, while the Millbridge Estate development is at 50% completion. This scenario also assumes that the intersection of Millbridge Estate Access and Eaton Drive has been constructed. In this scenario, it is assumed that 40% of the combined traffic from the two structure plan areas will use the proposed Millbridge Estate Access while the remaining 60% will still use the Peninsula Lakes Drive intersection.

Figure 8-4. Scenario 3 – 2035: 100% Parkridge with 50% Millbridge Estate Development

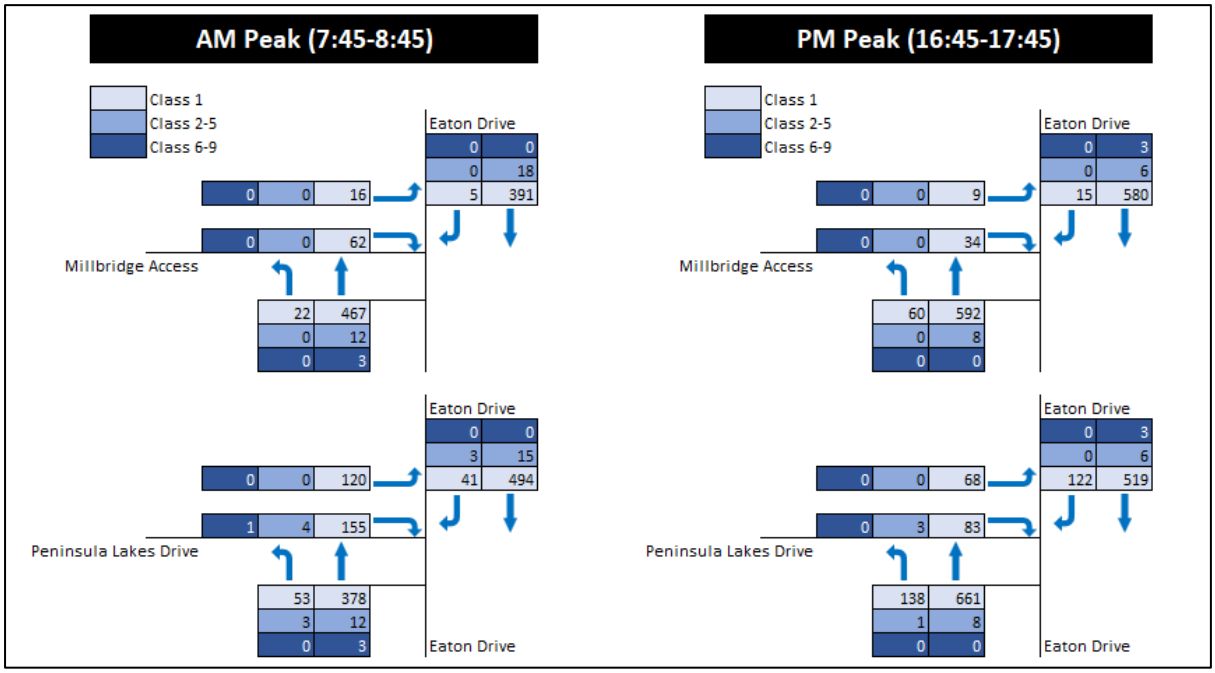
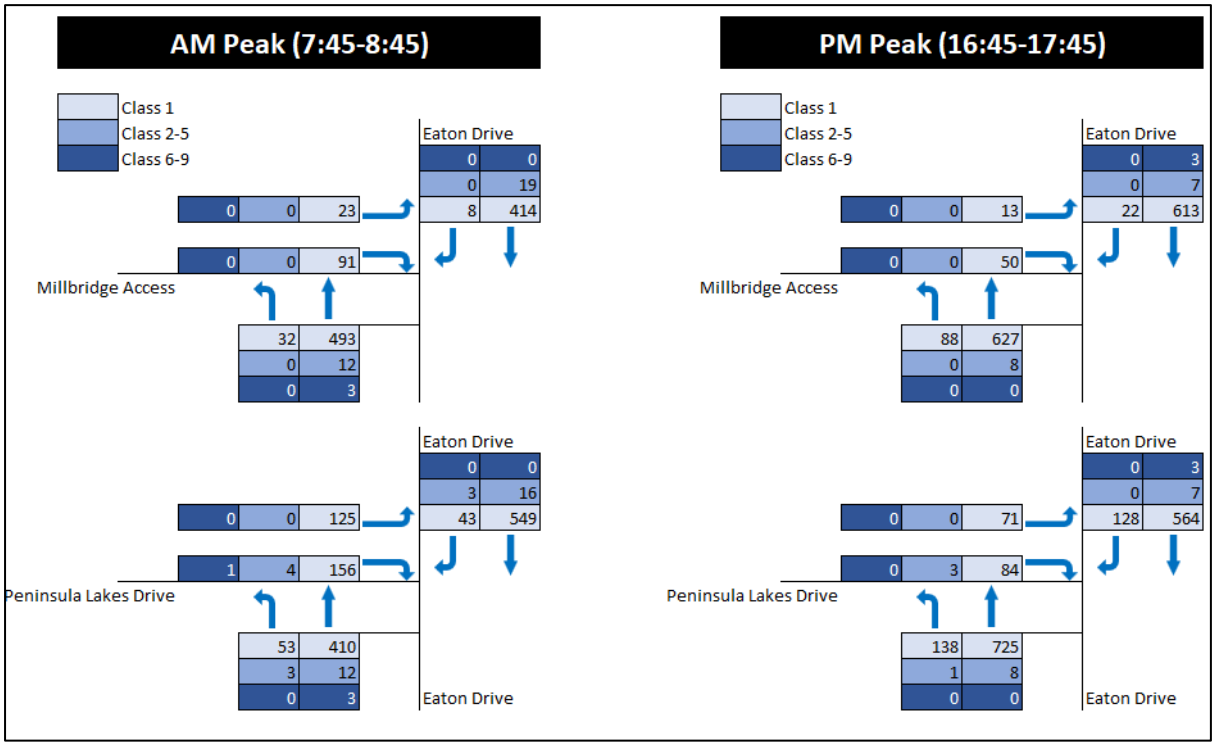


Figure 8-5 shows the Scenario 4 traffic volumes which assumes that both the Parkridge and Millbridge Estate developments have been fully developed. This assumes that the intersection of Millbridge Estate Access and Eaton Drive has also been constructed. In this scenario, it is assumed that 50% of the combined traffic from the two structure plan areas will use the proposed Millbridge Estate Access, while the remaining 50% will still use the Peninsula Lakes Drive intersection. The shift in distribution between the two accesses is based on the likelihood that drivers will avoid Peninsula Lakes Drive as it becomes busier during peak hour periods.

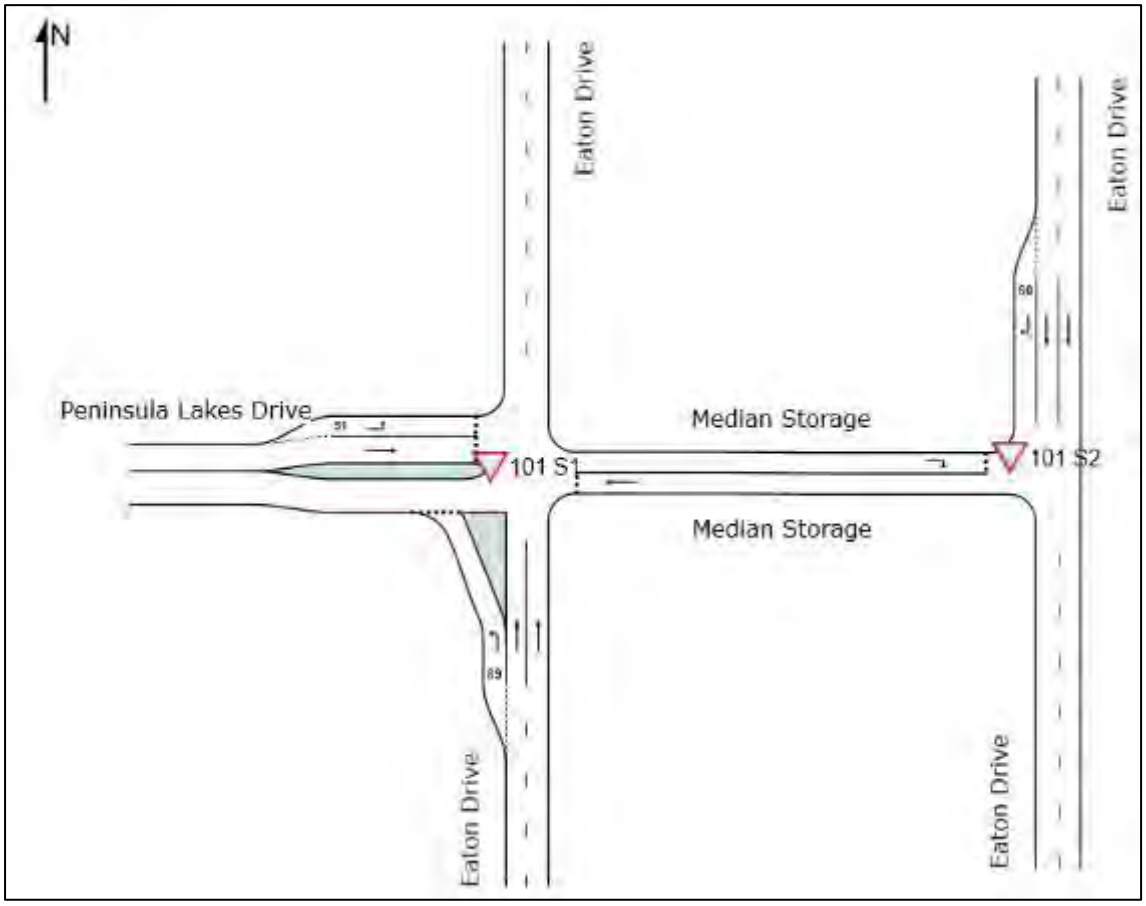
Figure 8-5. Scenario 4 – 2040: 100% both Parkridge and Millbridge Estate Developments



8.6 Intersection Layouts and Controls

The existing intersection of Peninsula Lakes Drive and Eaton Drive is a give-way sign-controlled intersection with a storage capacity for one (1) vehicle in the median area. The Main Roads WA Operational Modelling Guidelines prescribes that staged crossings are modelled as a network of two intersections to incorporate the effect of the median storage more accurately. The SIDRA model of the intersection is illustrated in **Figure 8-6**.

Figure 8-6. SIDRA Model: Peninsula Lakes Drive and Eaton Drive Intersection



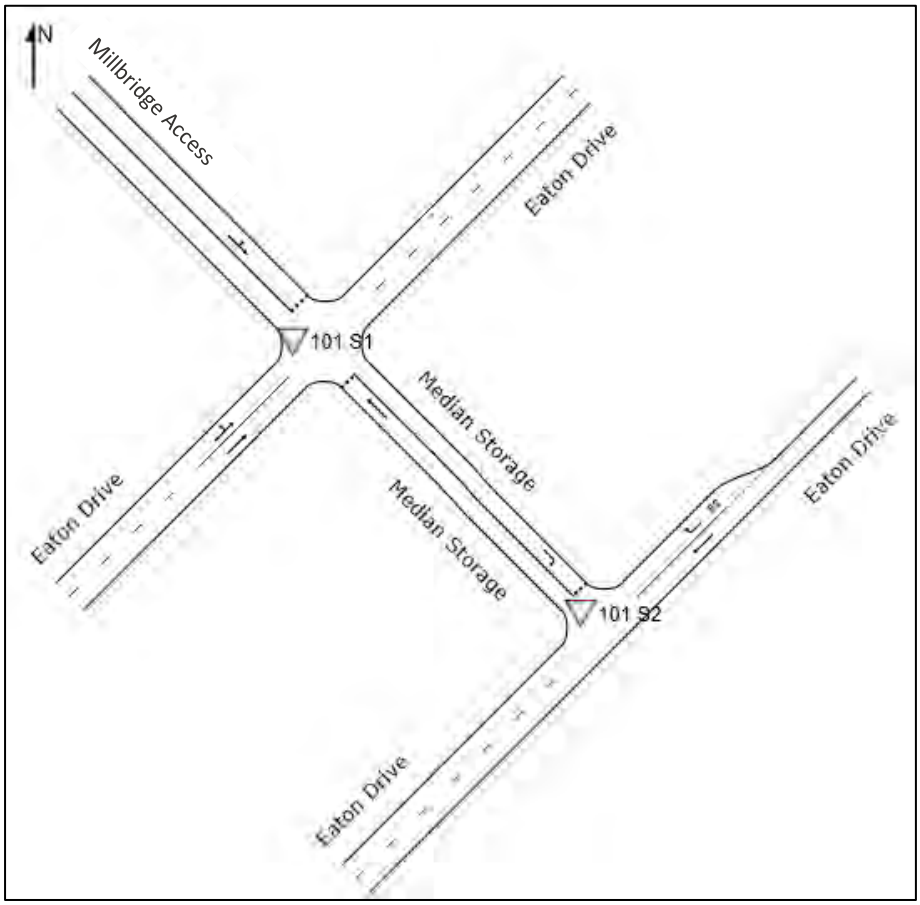
Based on the latest aerial image shown in **Figure 8-7**, the indicative future layout of the Millbridge Estate Access and Eaton Drive intersection appears to be a seagull crossing. This intersection also has a median storage and was modelled as a staged crossing as per the Main Roads WA Operational Modelling Guidelines. Assumptions were made regarding the controls (give-way sign-controlled) and the number of lanes on the proposed new access since its layout is currently unknown. The SIDRA intersection layout for the future Eaton Drive/ Millbridge Estate Access intersection is shown in **Figure 8-8**.

Figure 8-7. Aerial Image of the Future Millbridge Estate Access



Source: Metromap (2024)

Figure 8-8. SIDRA Model: Millbridge Estate Access and Eaton Drive Intersection



8.7 SIDRA Analysis

SIDRA results for each approach are presented below in the form of Degree of Saturation (DOS), Average Delay, Level of Service (LOS) and 95th Percentile Queue. These characteristics are defined as follows:

- **Degree of Saturation (DOS):** the ratio of the arrival traffic flow to the capacity of the approach during the same period. The theoretical intersection capacity is exceeded for an un-signalized intersection where DOS > 0.80;
- **95% Queue:** is the statistical estimate of the queue length up to or below which 95% of all observed queues would be expected;
- **Average Delay:** is the average of all travel time delays for vehicles through the intersection. An unsignalised intersection can be considered to be operated at capacity where the average delay exceeds 40 seconds for any movement; and
- **Level of Service (LOS):** is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. The different levels of service can generally be described as shown in **Table 8-2**.

Table 8-2 . Level of Service (LOS) Performance Criteria

LOS	Description	Signalised Intersection	Unsignalised Intersection
A	Free-flow operations (best condition)	≤10 sec	≤10 sec
B	Reasonable free-flow operations	10-20 sec	10-15 sec
C	At or near free-flow operations	20-35 sec	15-25 sec
D	Decreasing free-flow levels	35-55 sec	5-35 sec
E	Operations at capacity	55-80 sec	35-50 sec
F	A breakdown in vehicular flow (worst condition)	≥80 sec	≥50 sec

The results of the SIDRA analysis are discussed in the following subsections. Detailed results of the SIDRA analysis are provided in **Appendix D**.

8.7.1 Scenario 1 – 2025 Base Scenario

The performance of Eaton Drive/Peninsula Lakes Drive intersection for Scenario 1 (2025 base scenario) is summarised in **Table 8-3**. The analysis indicates that this intersection performs at an excellent LOS with minimal delays and queues.

Table 8-3. Scenario 1: Eaton Drive / Peninsula Lakes Drive Intersection

		AM Peak				PM Peak			
Intersection	Approach	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
South: Eaton Drive	L	0.013	5.9	A	0.4	0.028	5.9	A	0.8
	T	0.087	0	A	0	0.138	0	A	0
North: Eaton Drive	T	0.103	0	A	0	0.112	0	A	0
	R	0.018	6	A	0.3	0.047	6.1	A	0.9
West: Peninsula Lakes Drive	L	0.059	5.1	A	1.8	0.037	5.4	A	1.1
	R	0.071	8.8	A	3.5	0.052	11.3	B	2.2
All Vehicles		0.103	2.5	NA	3.5	0.138	2.1	NA	2.2

8.7.2 Scenario 2 – 50% Parkridge Development in 2030

The performance of Eaton Drive/Peninsula Lakes Drive intersection for Scenario 2, without any Millbridge Estate Development, is summarised in **Table 8-4**. It is anticipated that the additional traffic generated by the proposed Parkridge Structure Plan will not significantly affect the performance of this intersection. The average delay of all vehicles is anticipated to increase by less than 3 seconds, while queues are expected to be minimal.

Table 8-4. Scenario 2: Eaton Drive / Peninsula Lakes Drive Intersection

		AM Peak				PM Peak			
Intersection	Approach	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
South: Eaton Drive	L	0.031	5.8	A	1	0.082	6	A	2.5
	T	0.097	0	A	0	0.155	0	A	0
North: Eaton Drive	T	0.115	0	A	0	0.000	0		0
	R	0.023	6.1	A	0.4	0.126	0.5	A	1.3
West: Peninsula Lakes Drive	L	0.081	5.1	A	2.5	0.051	5.5	A	1.5
	R	0.181	9.7	A	9	0.152	10.6	B	4
All Vehicles		0.181	3.6	NA	9	0.155	4.4	NA	4

8.7.3 Scenario 3 – 100% Parkridge Development and 50% Millbridge Estate Development in 2035

The performance of Eaton Drive/Peninsula Lakes Drive intersection for Scenario 3 is summarised in **Table 8-5**. All movements at the intersection are still anticipated to operate at LOS A with minimal delays and short queue lengths.

Table 8-5. Scenario 3: Eaton Drive / Peninsula Lakes Drive Intersection

		AM Peak				PM Peak			
Intersection	Approach	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
South: Eaton Drive	L	0.041	5.8	A	1.3	0.106	6	A	3.3
	T	0.111	0	A	0	0.184	0	A	0
North: Eaton Drive	T	0.142	0	A	0	0.145	0	A	0
	R	0.027	6.1	A	0.5	0.070	6.3	A	1.5
West: Peninsula Lakes Drive	L	0.094	5.3	A	2.9	0.061	5.8	A	1.8
	R	0.247	11	B	12.5	0.241	16.4	C	9.3
All Vehicles		0.247	4.1	NA	12.5	0.241	3.7	NA	9.3

The performance of Eaton Drive/ Millbridge Estate Access intersection for Scenario 3 is summarised in **Table 8-6**. The results show that the future intersection is anticipated to operate at an excellent LOS, with minimal delays and queues.

Table 8-6. Scenario 3: Eaton Drive / Millbridge Estate Access Intersection

		AM Peak				PM Peak			
Intersection	Approach	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
South West: Eaton Drive	L	0.141	5.6	A	0	0.181	5.6	A	0
	T	0.141	0	A	0	0.181	0	A	0
North East: Eaton Drive	T	0.229	0.1	A	0	0.324	0.1	A	0
	R	0.003	6.1	A	0.1	0.009	6.3	A	0.2
North West: Millbridge Access	L	0.116	5.4	A	3.2	0.076	5.5	A	2
	R	0.116	9	A	4.2	0.076	10.7	B	2.6
All Vehicles		0.229	1.6	NA	4.2	0.324	1.5	NA	2.6

8.7.4 Scenario 4 – 100% both Parkridge and Millbridge Estate Developments in 2040

The performance of Eaton Drive/Peninsula Lakes Drive intersection for Scenario 4 is summarised in **Table 8-7**. The table shows that even at full buildout of the two developments, all movements at the intersection are still anticipated to operate at an acceptable level of service, with minimal delays and short queue lengths. The maximum delay (of 18.6 seconds) is anticipated to be experienced for vehicles turning right from the Peninsula Lakes Drive approach during the PM peak hour period.

Table 8-7. Scenario 4: Eaton Drive / Peninsula Lakes Drive Intersection

		AM Peak				PM Peak			
Intersection	Approach	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
South: Eaton Drive	L	0.041	5.8	A	1.3	0.107	6.1	A	3.3
	T	0.120	0	A	0	0.201	0.1	A	0
North: Eaton Drive	T	0.157	0	A	0	0.158	0	A	0
	R	0.028	6.1	A	0.5	0.073	6.4	A	1.7
West: Peninsula Lakes Drive	L	0.099	5.3	A	3	0.067	6	A	1.9
	R	0.258	11.8	B	13.4	0.271	18.6	C	10.3
All Vehicles		0.258	4.1	NA	13.4	0.271	3.7	NA	10.3

The performance of Eaton Drive/ Millbridge Estate Access intersection for Scenario 4 is summarised in **Table 8-8**. The results indicate that the future intersection is anticipated to operate at satisfactory LOS, with minimal delays and queueing during the AM and PM peak hour periods.

Table 8-8. Scenario 4: Eaton Drive / Millbridge Estate Access Intersection

		AM Peak				PM Peak			
Intersection	Approach	DOS	Delay (s)	LOS	95% Queue (m)	DOS	Delay (s)	LOS	95% Queue (m)
South West: Eaton Drive	L	0.151	5.6	A	0	0.199	5.6	A	0
	T	0.151	0	A	0	0.199	0.1	A	0
North East: Eaton Drive	T	0.243	0.1	A	0	0.343	0.1	A	0
	R	0.005	6.1	A	0.1	0.013	6.3	A	0.3
North West: Millbridge Access	L	0.174	5.4	A	4.9	0.120	5.5	A	3.2
	R	0.174	9.6	A	6.3	0.120	11.7	B	4.1
All Vehicles		0.243	2.1	NA	6.3	0.343	1.8	NA	4.1

In summary, the trips generated by the proposed modifications in the Parkridge Structure Plan will not significantly affect the performance of the existing intersection of Eaton Drive and Peninsula Lakes Drive. It is also anticipated that the future Eaton Drive and Millbridge Estate Access will perform at satisfactory levels of service and capacity.

9 Conclusions

This Transport Impact Assessment (TIA) outlines the transport aspects of the proposed modifications on the Parkridge Structure Plan, focusing on traffic operations, access and intersection performances. Included are discussions regarding pedestrian, cycle, and public transport considerations.

This report has been prepared in accordance with the *Western Australian Planning Commission (WAPC) Transport Impact Assessment Guidelines Volume 2 – Planning Schemes, Structure Plans and Activity Centre Zones (2016).*

The following conclusions have been made in regard to the proposed Structure plan modification:

- The proposed structure plan is expected to generate the following yields:
  - » Residential R30 – 253 lots
  - » Residential R40 – 44 lots (including one grouped housing lot comprising 47 dwellings)
  - » Public and Regional open spaces
- The proposed Parkridge Structure Plan area currently has poor/inadequate connectivity to public transportation due to the limited infrastructure and services in the surrounding area and the absence of any plans to modify the TransBunbury network.
- The active transport network is considered to be well-connected since adequate walking and cycling facilities are provided within the proposed Parkridge Structure Plan area and in the immediate surrounding areas.
- The proposed Parkridge Structure Plan area is considered to be adequately connected to the surrounding road network (The Boulevard to the north, and Forrest Highway in the east-west direction via Eaton Drive to the south),
- In terms of traffic generation, the proposed Parkridge Structure Plan is expected to generate a daily total of 2,532 trips, with 219 trips in the AM peak and 245 trips in the PM peak when the Site is fully developed.
- For a robust assessment, the adjacent Millbridge Estate development trip generation was included. The total traffic generation of both development at full build-out is 3,604 daily vehicle trips, with 308 trips in the AM peak hour and 347 trips in the PM peak hour period.
- The midblock traffic flow on Peninsula Lakes Drive between Glenhuon Boulevard and Eaton Drive is anticipated to reach 3,700vpd east of Glenhuon Boulevard. This exceeds the projected maximum volume for Access Streets of 3,000vpd. Improvements on Peninsula Lakes Drive or construction of the Millbridge Estate Access should be considered when the daily traffic volume reaches 3,000vpd at approximately at 71% completion of the proposed Parkridge development.
- The intersections of Eaton Drive/Peninsula Lakes Drive and Eaton Drive/ Millbridge Estate Access are anticipated to operate at satisfactory levels of service, with minimal queues and delays in the 2040 ultimate design year.

Overall, the proposed modification of the Parkridge Structure Plan will have minimal impact on the traffic operations and safety on the surrounding road network.

1.

Appendices.

Appendix A WAPC Checklist

Item	Section	Comments/Proposals
SUMMARY	Section 1	
INTRODUCTION/BACKGROUND	Section 1	
STRUCTURE PLAN PROPOSAL		
Regional context	Section 2	
Proposed land uses	Section 2	
Table of land uses and quantities	Section 2	
Major attractors/generators	Section 6	
Any specific issues	NA	
EXISTING SITUATION		
Existing land uses within structure plan	Section 3	
Existing land uses within 800m of Structure Plan area	Section 3	
Existing road network within Structure Plan area	Section 3	
Existing pedestrian/cycle networks within Structure Plan area	Section 3	
Existing public transport services within Structure Plan area	Section 3	
Existing road network within 2 (or 5) km of Structure Plan area	Section 3	
Traffic flows on roads within Structure Plan area (AM and PM Peak Hours)	Section 3	
Traffic flows on roads within 2 (or 5) km of Structure Plan area (AM and PM Peak Hours)	Section 3	
Existing pedestrian/cycle networks within 800m of the Structure Plan area	Section 3	
Existing public transport services within 800m of the Structure Plan area	Section 3	
PROPOSED INTERNAL TRANSPORT NETWORKS		
Changes/additions to existing road network or proposed new road network	Section 4	
Road reservation widths	Section 4	
Road cross-sections & speed limits	Section 4	
Intersection controls	Section 4	
Pedestrian/cycle networks and crossing facilities	Section 4	
Public transport routes	Section 4	
CHANGES TO EXTERNAL TRANSPORT NETWORKS		
Road network	Section 5	
Intersection controls	Section 5	
Pedestrian/cycle networks and crossing facilities	Section 5	
Public transport services	Section 5	
INTEGRATION WITH SURROUNDING AREA		

Trip attractors/generators within 800m	Section 6
Proposed changes to land uses within 800m	Section 6
Travel desire lines from Structure Plan to these attractors/generators	N/A
Adequacy of existing transport networks	N/A
Deficiencies in existing transport networks	N/A
Remedial measures to address deficiencies	N/A
ANALYSIS OF INTERNAL TRANSPORT	
Assessment years and time periods	Section 7
Structure Plan generated traffic	Section 7
Extraneous (through) traffic	Section 7
Design traffic flows	Section 7
Road cross-sections	Section 5
Intersection controls	Section 5
Access strategy	Section 7
Pedestrian/cycle networks	Section 4
Safe routes to schools	Section 7
Pedestrian permeability & efficiency	Section 4
Access to public transport	Section 4
ANALYSIS OF EXTERNAL TRANSPORT NETWORKS	
Extent of analysis	Section 8
Base flows for assessment years	Section 8
Total traffic flows	Section 8
Road cross-sections	Section 4
Intersection layouts & controls	Section 8
Pedestrian/cycle networks	Section 4
CONCLUSIONS	Section 9

Appendix B

Structure Plan Modification Area.

(Appendix ORD: 12.2.2C)

YIELD SUMMARY			
Size	No. Lots	% Total Lots	Avg. Lot Size
235m² - 319m²	6	2.02%	315m²
320m² - 449m²	237	79.80%	405m²
450m² - 499m²	42	14.14%	465m²
500m² - 549m²	5	1.68%	516m²
550m² - 599m²	3	1.01%	561m²
600m² - 699m²	1	0.34%	653m²
700m² - 799m²	2	0.67%	743m²
1 ha - 2 ha	1	0.34%	1.0517ha
Number of Proposed Lots	297		
Number of Existing Lots	131		
Total Number of Lots	428		
Public Open Space			3.0648ha

OVERALL CONCEPT SUBDIVISION PLAN
AMENDED STRUCTURE PLAN
PARKRIDGE ESTATE, EATON

Plan No.	22294-29
Date	27/08/25
Drawn	NP
Checked	KS
Revision	E
Scale	1:1500 @ A1 1:3000 @ A3

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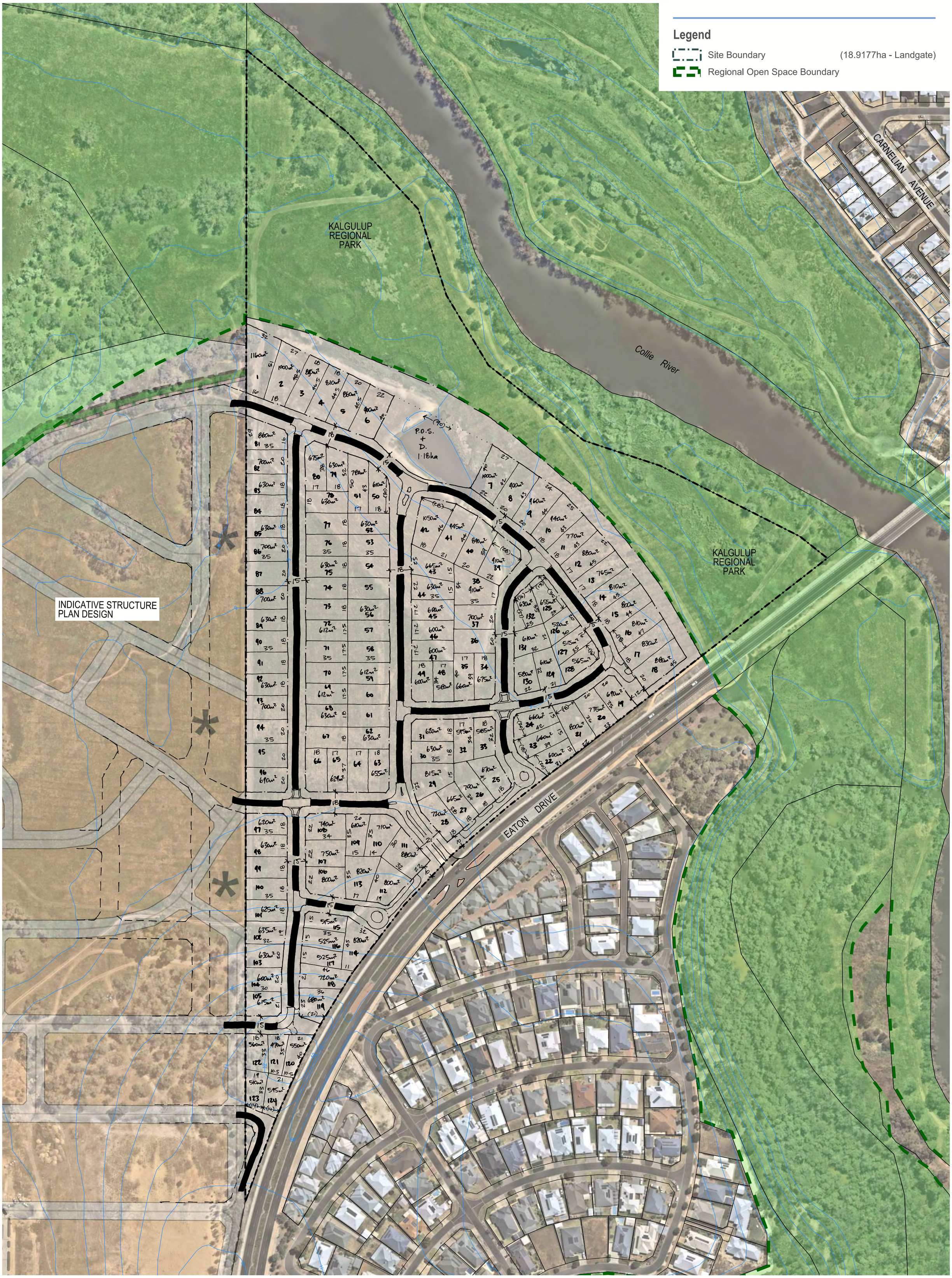
Harley Dykstra
PLANNING & SURVEY SOLUTIONS

LEGEND

- Structure Plan Area
- Existing Development
- Existing Cadastre
- Proposed Residential R40
- Proposed Residential R30
- Proposed Residential R20
- Public Open Space

Appendix C

Subdivision Concept Plan for Millbridge Estate Development.



Subdivision Concept Plan

LOT 3001 EATON DRIVE, EATON
MILLBRIDGE ESTATE
An Ardross Estates Project

scale:
1:2000@A2 | 1:1000@A0

0 20 40m

plan:
17/079/016

date:
12/12/2023

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Appendix D

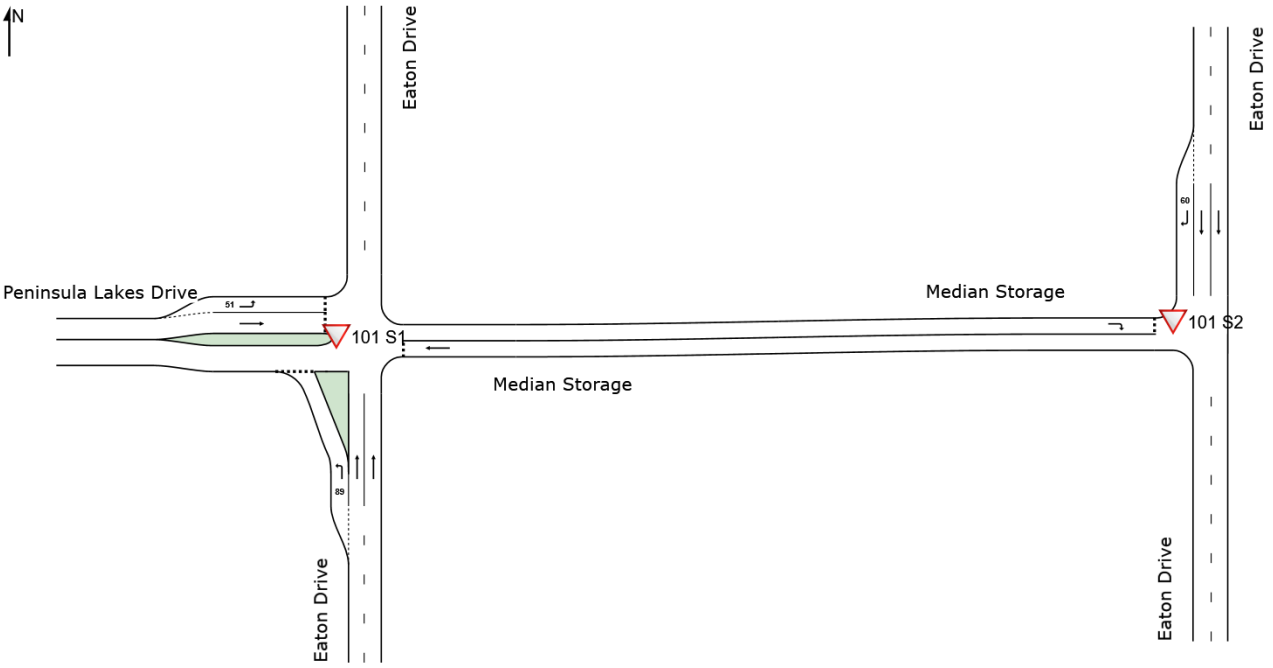
SIDRA Results.

NETWORK LAYOUT

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S1 Base 2025)]

New Network
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
▽101 S1	NA	Eaton Drive - Peninsula Lakes Drive AM S1
▽101 S2	NA	Eaton Drive - Peninsula Lakes Drive AM S2

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive AM S1 (Site Folder: S1 2025 Base)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S1 Base 2025)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	20	10.5	20	10.5	0.013	5.9	LOS A	0.1	0.4	0.10	0.51	0.10	48.7
2	T1	All MCs	325	3.9	325	3.9	0.087	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			345	4.3	345	4.3	0.087	0.4	LOS A	0.1	0.4	0.01	0.03	0.01	59.2
East: Median Storage															
5	T1	All MCs	32	6.7	32	6.7	0.010	0.2	LOS A	0.0	0.3	0.27	0.07	0.27	43.6
Approach			32	6.7	32	6.7	0.010	0.2	LOS A	0.0	0.3	0.27	0.07	0.27	43.6
West: Peninsula Lakes Drive															
10	L2	All MCs	84	0.0	84	0.0	0.059	5.1	LOS A	0.2	1.8	0.26	0.52	0.26	48.5
11	T1	All MCs	58	7.3	58	7.3	0.071	6.7	LOS A	0.3	2.0	0.45	0.63	0.45	42.4
Approach			142	3.0	142	3.0	0.071	5.7	LOS A	0.3	2.0	0.34	0.56	0.34	46.8
All Vehicles			519	4.1	519	4.1	0.087	1.8	NA	0.3	2.0	0.11	0.18	0.11	55.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive AM S2 (Site Folder: S1 2025 Base)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S1 Base 2025)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	393	3.5	393	3.5	0.103	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
9	R2	All MCs	32	6.7	32	6.7	0.018	5.8	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			424	3.7	424	3.7	0.103	0.5	NA	0.0	0.0	0.00	0.05	0.00	59.5
West: Median Storage															
12	R2	All MCs	58	7.3	58	7.3	0.059	2.1	LOS A	0.2	1.5	0.37	0.41	0.37	44.9
Approach			58	7.3	58	7.3	0.059	2.1	LOS A	0.2	1.5	0.37	0.41	0.37	44.9
All Vehicles			482	4.1	482	4.1	0.103	0.7	NA	0.2	1.5	0.04	0.09	0.04	58.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive PM S1 (Site Folder: S1 2025 Base)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S1 Base 2025)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	42	2.5	42	2.5	0.028	5.9	LOS A	0.1	0.8	0.17	0.52	0.17	48.8
2	T1	All MCs	533	1.2	533	1.2	0.138	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			575	1.3	575	1.3	0.138	0.5	LOS A	0.1	0.8	0.01	0.04	0.01	58.9
East: Median Storage															
5	T1	All MCs	87	0.0	87	0.0	0.031	0.4	LOS A	0.1	0.9	0.35	0.13	0.35	43.8
Approach			87	0.0	87	0.0	0.031	0.4	LOS A	0.1	0.9	0.35	0.13	0.35	43.8
West: Peninsula Lakes Drive															
10	L2	All MCs	48	0.0	48	0.0	0.037	5.4	LOS A	0.1	1.1	0.33	0.54	0.33	48.3
11	T1	All MCs	29	7.1	29	7.1	0.052	9.1	LOS A	0.2	1.4	0.57	0.73	0.57	40.2
Approach			78	2.7	78	2.7	0.052	6.8	LOS A	0.2	1.4	0.42	0.61	0.42	46.1
All Vehicles			740	1.3	740	1.3	0.138	1.1	NA	0.2	1.4	0.10	0.11	0.10	56.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive PM S2 (Site Folder: S1 2025 Base)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S1 Base 2025)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	433	1.7	433	1.7	0.112	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	87	0.0	87	0.0	0.047	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			520	1.4	520	1.4	0.112	1.0	NA	0.0	0.0	0.00	0.11	0.00	58.9
West: Median Storage															
12	R2	All MCs	29	7.1	29	7.1	0.031	2.2	LOS A	0.1	0.8	0.38	0.41	0.38	44.9
Approach			29	7.1	29	7.1	0.031	2.2	LOS A	0.1	0.8	0.38	0.41	0.38	44.9
All Vehicles			549	1.7	549	1.7	0.112	1.0	NA	0.1	0.8	0.02	0.12	0.02	58.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

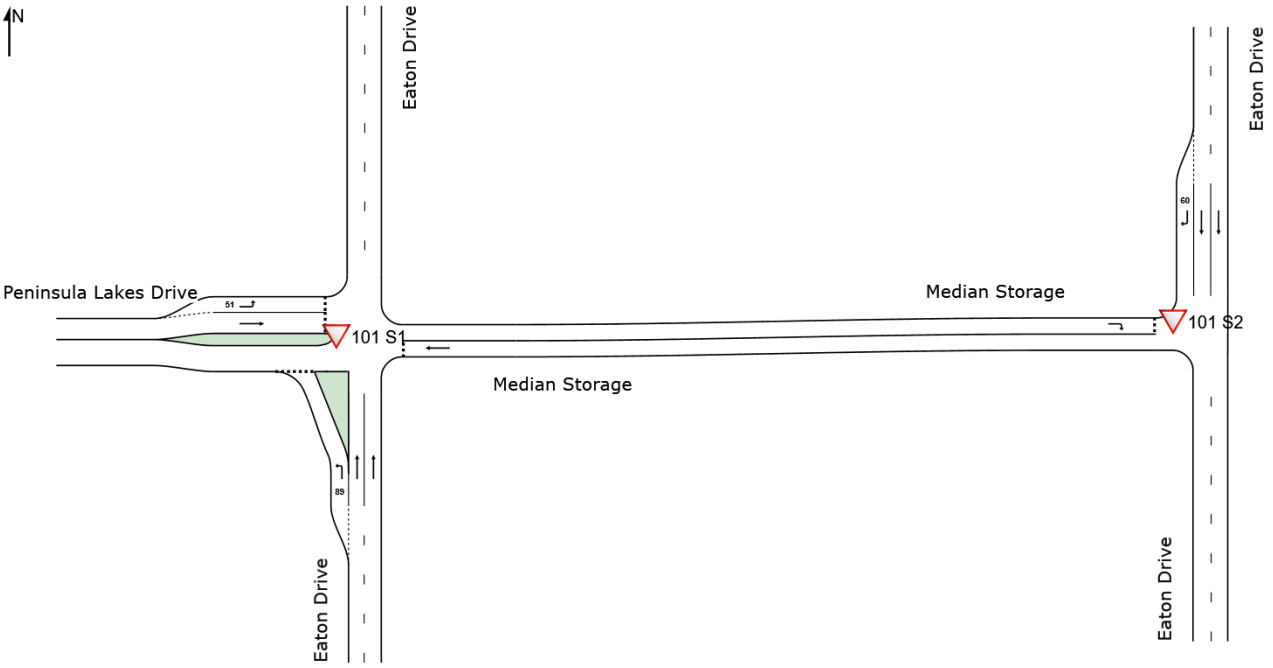
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NETWORK LAYOUT

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S2 2030 50% Parkridge)]

New Network
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
▽101 S1	NA	Eaton Drive - Peninsula Lakes Drive AM S1
▽101 S2	NA	Eaton Drive - Peninsula Lakes Drive AM S2

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive AM S1 (Site Folder: S2 2030 50% Parkridge)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S2 2030 50% Parkridge)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	48	4.3	48	4.3	0.031	5.8	LOS A	0.1	1.0	0.11	0.52	0.11	48.9
2	T1	All MCs	363	3.8	363	3.8	0.097	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	60.0
Approach			412	3.8	412	3.8	0.097	0.7	LOS A	0.1	1.0	0.01	0.06	0.01	58.4
East: Median Storage															
5	T1	All MCs	41	5.1	41	5.1	0.014	0.3	LOS A	0.1	0.4	0.28	0.08	0.28	43.7
Approach			41	5.1	41	5.1	0.014	0.3	LOS A	0.1	0.4	0.28	0.08	0.28	43.7
West: Peninsula Lakes Drive															
10	L2	All MCs	114	0.0	114	0.0	0.081	5.1	LOS A	0.3	2.5	0.28	0.53	0.28	48.4
11	T1	All MCs	140	3.8	140	3.8	0.181	7.3	LOS A	0.7	5.3	0.51	0.69	0.51	41.8
Approach			254	2.1	254	2.1	0.181	6.3	LOS A	0.7	5.3	0.41	0.62	0.41	45.7
All Vehicles			706	3.3	706	3.3	0.181	2.7	NA	0.7	5.3	0.17	0.26	0.17	53.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive AM S2 (Site Folder: S2 2030 50% Parkridge)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S2 2030 50% Parkridge)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	439	3.4	439	3.4	0.115	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	41	5.1	41	5.1	0.023	5.8	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			480	3.5	480	3.5	0.115	0.5	NA	0.0	0.0	0.00	0.05	0.00	59.4
West: Median Storage															
12	R2	All MCs	140	3.8	140	3.8	0.144	2.4	LOS A	0.5	3.7	0.41	0.47	0.41	46.3
Approach			140	3.8	140	3.8	0.144	2.4	LOS A	0.5	3.7	0.41	0.47	0.41	46.3
All Vehicles			620	3.6	620	3.6	0.144	0.9	NA	0.5	3.7	0.09	0.15	0.09	57.3

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive PM S1 (Site Folder: S2 2030 50% Parkridge)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S2 2030 50% Parkridge)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	121	0.9	121	0.9	0.082	6.0	LOS A	0.3	2.5	0.21	0.53	0.21	48.8
2	T1	All MCs	597	1.2	597	1.2	0.155	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			718	1.2	718	1.2	0.155	1.0	LOS A	0.3	2.5	0.04	0.09	0.04	57.7
East: Median Storage															
5	T1	All MCs	117	0.0	117	0.0	0.043	0.5	LOS A	0.2	1.3	0.38	0.15	0.38	43.8
Approach			117	0.0	117	0.0	0.043	0.5	LOS A	0.2	1.3	0.38	0.15	0.38	43.8
West: Peninsula Lakes Drive															
10	L2	All MCs	64	0.0	64	0.0	0.051	5.5	LOS A	0.2	1.5	0.36	0.56	0.36	48.2
11	T1	All MCs	75	2.8	75	2.8	0.152	10.6	LOS B	0.6	4.0	0.65	0.83	0.65	38.9
Approach			139	1.5	139	1.5	0.152	8.3	LOS A	0.6	4.0	0.51	0.71	0.51	44.3
All Vehicles			974	1.1	974	1.1	0.155	2.0	NA	0.6	4.0	0.15	0.18	0.15	54.6

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive PM S2 (Site Folder: S2 2030 50% Parkridge)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S2 2030 50% Parkridge)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	484	1.7	484	1.7	0.126	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	117	0.0	117	0.0	0.062	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			601	1.4	601	1.4	0.126	1.1	NA	0.0	0.0	0.00	0.12	0.00	58.8
West: Median Storage															
12	R2	All MCs	75	2.8	75	2.8	0.079	2.4	LOS A	0.3	1.9	0.41	0.46	0.41	46.7
Approach			75	2.8	75	2.8	0.079	2.4	LOS A	0.3	1.9	0.41	0.46	0.41	46.7
All Vehicles			676	1.6	676	1.6	0.126	1.3	NA	0.3	1.9	0.05	0.16	0.05	57.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

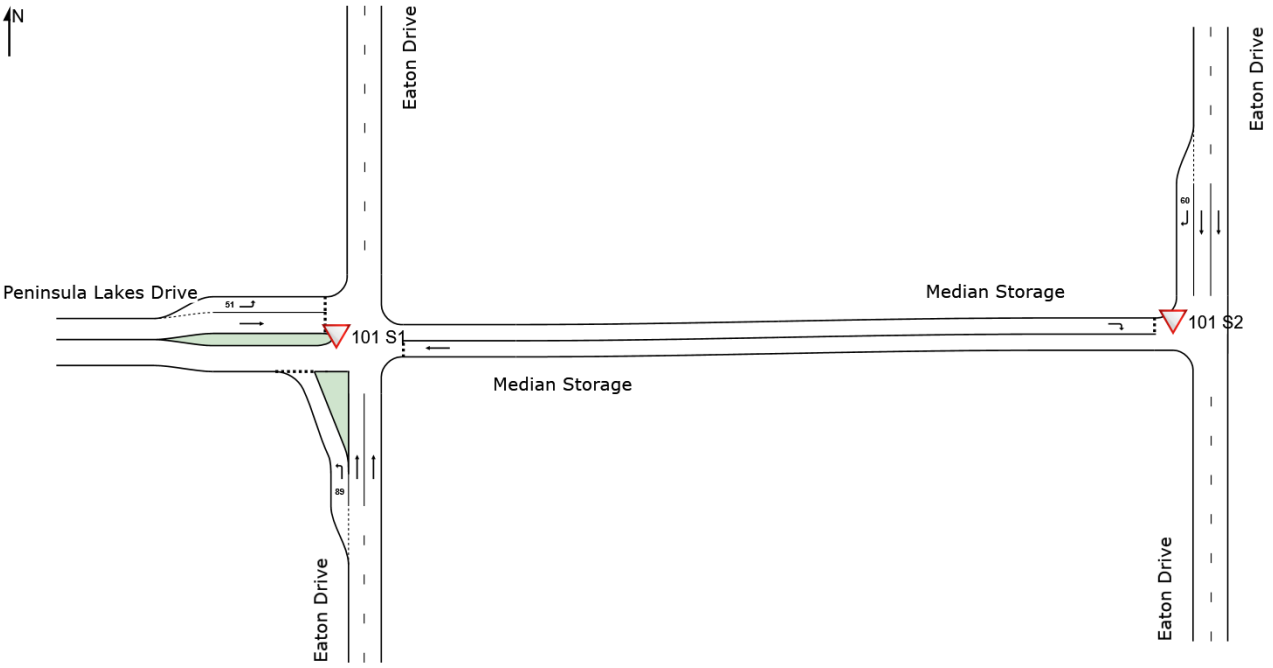
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NETWORK LAYOUT

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Network
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
▽101 S1	NA	Eaton Drive - Peninsula Lakes Drive AM S1
▽101 S2	NA	Eaton Drive - Peninsula Lakes Drive AM S2

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive AM S1 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	62	5.1	62	5.1	0.041	5.8	LOS A	0.2	1.3	0.13	0.52	0.13	48.9
2	T1	All MCs	416	3.8	416	3.8	0.111	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			478	4.0	478	4.0	0.111	0.8	LOS A	0.2	1.3	0.02	0.07	0.02	58.2
East: Median Storage															
5	T1	All MCs	47	6.7	47	6.7	0.016	0.3	LOS A	0.1	0.5	0.31	0.10	0.31	43.5
Approach			47	6.7	47	6.7	0.016	0.3	LOS A	0.1	0.5	0.31	0.10	0.31	43.5
West: Peninsula Lakes Drive															
10	L2	All MCs	128	0.0	128	0.0	0.094	5.3	LOS A	0.4	2.9	0.30	0.54	0.30	48.4
11	T1	All MCs	176	3.0	176	3.0	0.247	8.0	LOS A	1.0	7.3	0.56	0.73	0.56	41.1
Approach			304	1.7	304	1.7	0.247	6.8	LOS A	1.0	7.3	0.45	0.65	0.45	45.1
All Vehicles			829	3.3	829	3.3	0.247	3.0	NA	1.0	7.3	0.19	0.28	0.19	53.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive AM S2 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	542	2.9	542	2.9	0.142	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	47	6.7	47	6.7	0.027	5.8	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			589	3.2	589	3.2	0.142	0.5	NA	0.0	0.0	0.00	0.05	0.00	59.5
West: Median Storage															
12	R2	All MCs	176	3.0	176	3.0	0.198	3.0	LOS A	0.7	5.2	0.47	0.54	0.47	46.0
Approach			176	3.0	176	3.0	0.198	3.0	LOS A	0.7	5.2	0.47	0.54	0.47	46.0
All Vehicles			765	3.2	765	3.2	0.198	1.1	NA	0.7	5.2	0.11	0.16	0.11	57.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive PM S1 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	155	0.7	155	0.7	0.106	6.0	LOS A	0.4	3.3	0.23	0.53	0.23	48.7
2	T1	All MCs	709	1.2	709	1.2	0.184	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			864	1.1	864	1.1	0.184	1.1	LOS A	0.4	3.3	0.04	0.10	0.04	57.5
East: Median Storage															
5	T1	All MCs	132	0.0	132	0.0	0.051	0.6	LOS A	0.2	1.5	0.42	0.19	0.42	43.6
Approach			132	0.0	132	0.0	0.051	0.6	LOS A	0.2	1.5	0.42	0.19	0.42	43.6
West: Peninsula Lakes Drive															
10	L2	All MCs	73	0.0	73	0.0	0.061	5.8	LOS A	0.2	1.8	0.40	0.59	0.40	48.1
11	T1	All MCs	95	3.3	95	3.3	0.241	13.6	LOS B	0.9	6.6	0.74	0.90	0.81	36.6
Approach			167	1.9	167	1.9	0.241	10.2	LOS B	0.9	6.6	0.59	0.76	0.63	42.8
All Vehicles			1163	1.1	1163	1.1	0.241	2.4	NA	0.9	6.6	0.16	0.20	0.17	54.3

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive PM S2 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	559	1.7	559	1.7	0.145	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	132	0.0	132	0.0	0.070	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			691	1.4	691	1.4	0.145	1.1	NA	0.0	0.0	0.00	0.12	0.00	58.8
West: Median Storage															
12	R2	All MCs	95	3.3	95	3.3	0.108	2.8	LOS A	0.4	2.7	0.45	0.52	0.45	46.0
Approach			95	3.3	95	3.3	0.108	2.8	LOS A	0.4	2.7	0.45	0.52	0.45	46.0
All Vehicles			785	1.6	785	1.6	0.145	1.3	NA	0.4	2.7	0.05	0.17	0.05	57.6

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

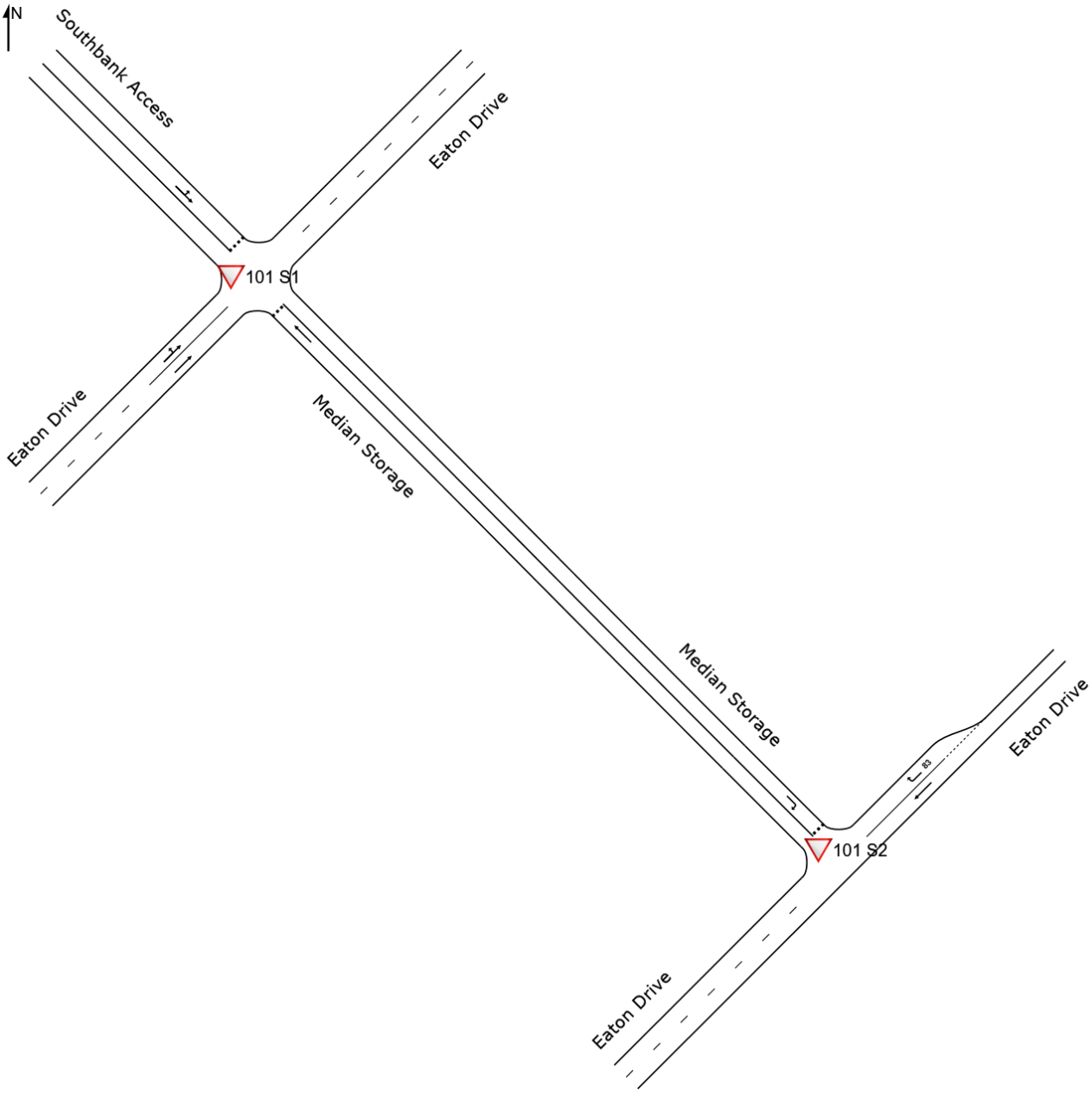
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NETWORK LAYOUT

Network: N101 [Eaton Drive - Southbank Access AM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Network
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
▽101 S1	NA	Eaton Drive - Southbank Access AM S1
▽101 S2	NA	Eaton Drive - Southbank Access AM S2

MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Southbank Access AM S1 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access AM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: Median Storage															
5	T1	All MCs	6	0.0	6	0.0	0.002	0.4	LOS A	0.0	0.1	0.35	0.13	0.35	44.3
Approach			6	0.0	6	0.0	0.002	0.4	LOS A	0.0	0.1	0.35	0.13	0.35	44.3
NorthWest: Southbank Access															
10	L2	All MCs	18	0.0	18	0.0	0.116	5.4	LOS A	0.5	3.2	0.51	0.67	0.51	47.6
11	T1	All MCs	72	0.0	72	0.0	0.116	7.5	LOS A	0.5	3.2	0.51	0.67	0.51	42.0
Approach			89	0.0	89	0.0	0.116	7.0	LOS A	0.5	3.2	0.51	0.67	0.51	43.7
SouthWest: Eaton Drive															
1	L2	All MCs	25	0.0	25	0.0	0.141	5.6	LOS A	0.0	0.0	0.00	0.06	0.00	57.0
2	T1	All MCs	508	3.1	508	3.1	0.141	0.0	LOS A	0.0	0.0	0.00	0.03	0.00	59.7
Approach			534	3.0	534	3.0	0.141	0.3	NA	0.0	0.0	0.00	0.03	0.00	59.5
All Vehicles			629	2.5	629	2.5	0.141	1.3	NA	0.5	3.2	0.08	0.12	0.08	57.5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Southbank Access AM S2 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access AM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
NorthEast: Eaton Drive															
8	T1	All MCs	431	4.4	431	4.4	0.229	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	6	0.0	6	0.0	0.003	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			437	4.3	437	4.3	0.229	0.1	NA	0.0	0.0	0.00	0.01	0.00	59.8
NorthWest: Median Storage															
12	R2	All MCs	72	0.0	72	0.0	0.058	1.5	LOS A	0.1	1.0	0.27	0.37	0.27	49.4
Approach			72	0.0	72	0.0	0.058	1.5	LOS A	0.1	1.0	0.27	0.37	0.27	49.4
All Vehicles			508	3.7	508	3.7	0.229	0.3	NA	0.1	1.0	0.04	0.06	0.04	58.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Southbank Access PM S1 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access PM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: Median Storage															
5	T1	All MCs	18	0.0	18	0.0	0.007	0.6	LOS A	0.0	0.2	0.41	0.18	0.41	44.1
Approach			18	0.0	18	0.0	0.007	0.6	LOS A	0.0	0.2	0.41	0.18	0.41	44.1
NorthWest: Southbank Access															
10	L2	All MCs	9	0.0	9	0.0	0.076	5.5	LOS A	0.3	2.0	0.56	0.71	0.56	46.9
11	T1	All MCs	39	0.0	39	0.0	0.076	8.8	LOS A	0.3	2.0	0.56	0.71	0.56	41.0
Approach			48	0.0	48	0.0	0.076	8.1	LOS A	0.3	2.0	0.56	0.71	0.56	42.7
SouthWest: Eaton Drive															
1	L2	All MCs	69	0.0	69	0.0	0.181	5.6	LOS A	0.0	0.0	0.00	0.12	0.00	56.4
2	T1	All MCs	632	1.2	632	1.2	0.181	0.0	LOS A	0.0	0.0	0.00	0.05	0.00	59.4
Approach			701	1.1	701	1.1	0.181	0.6	NA	0.0	0.0	0.00	0.06	0.00	59.1
All Vehicles			767	1.0	767	1.0	0.181	1.1	NA	0.3	2.0	0.04	0.10	0.04	58.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Southbank Access PM S2 (Site Folder: S3 2035 100% Parkridge 50% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access PM (Network Folder: S3 2035 100% Parkridge 50% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
NorthEast: Eaton Drive															
8	T1	All MCs	622	1.5	622	1.5	0.324	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
9	R2	All MCs	18	0.0	18	0.0	0.009	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			640	1.5	640	1.5	0.324	0.3	NA	0.0	0.0	0.00	0.02	0.00	59.6
NorthWest: Median Storage															
12	R2	All MCs	39	0.0	39	0.0	0.036	1.9	LOS A	0.1	0.6	0.34	0.43	0.34	48.8
Approach			39	0.0	39	0.0	0.036	1.9	LOS A	0.1	0.6	0.34	0.43	0.34	48.8
All Vehicles			679	1.4	679	1.4	0.324	0.4	NA	0.1	0.6	0.02	0.04	0.02	59.2

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

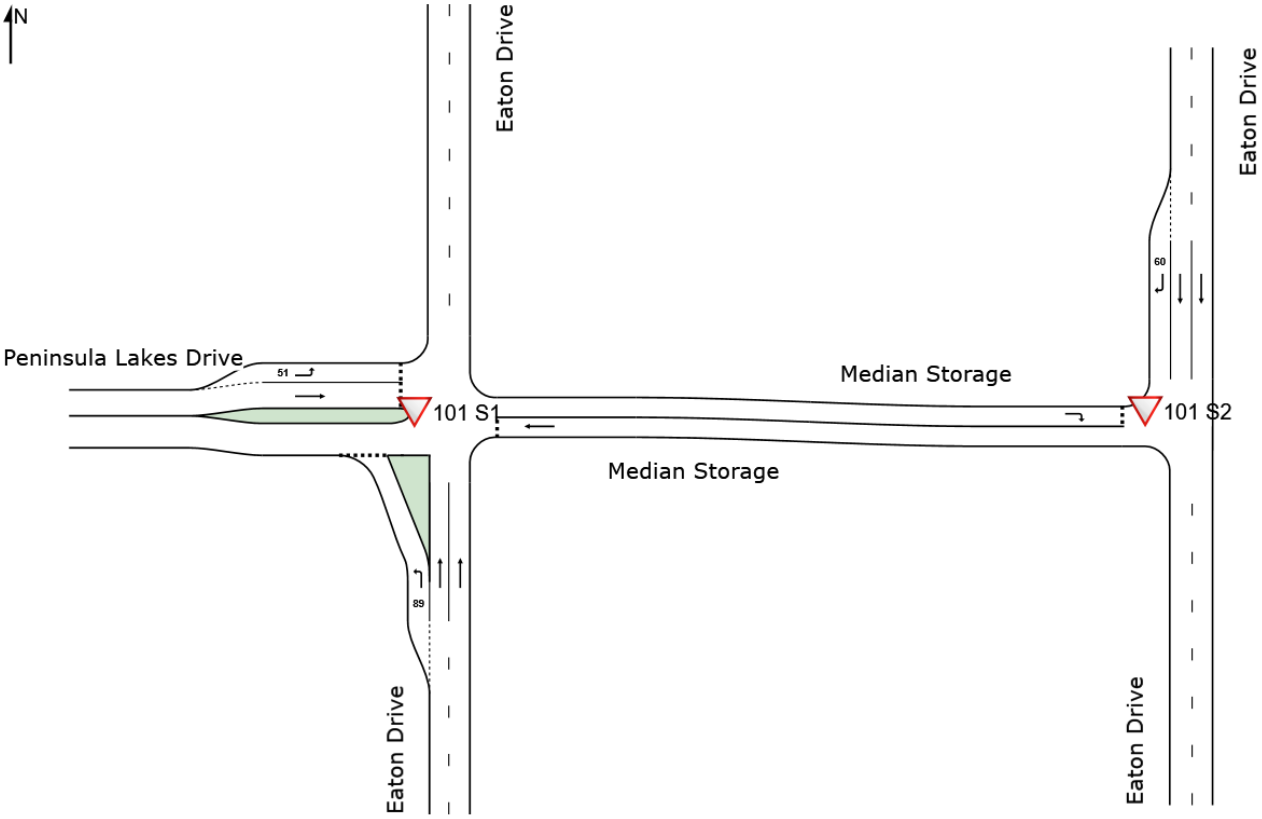
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NETWORK LAYOUT

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Network
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
▽101 S1	NA	Eaton Drive - Peninsula Lakes Drive AM S1
▽101 S2	NA	Eaton Drive - Peninsula Lakes Drive AM S2

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive AM S1 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	62	5.1	62	5.1	0.041	5.8	LOS A	0.2	1.3	0.13	0.52	0.13	48.9
2	T1	All MCs	449	3.5	449	3.5	0.120	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			512	3.7	512	3.7	0.120	0.7	LOS A	0.2	1.3	0.02	0.06	0.02	58.3
East: Median Storage															
5	T1	All MCs	49	6.4	49	6.4	0.017	0.3	LOS A	0.1	0.5	0.32	0.10	0.32	43.4
Approach			49	6.4	49	6.4	0.017	0.3	LOS A	0.1	0.5	0.32	0.10	0.32	43.4
West: Peninsula Lakes Drive															
10	L2	All MCs	133	0.0	133	0.0	0.099	5.3	LOS A	0.4	3.0	0.32	0.55	0.32	48.3
11	T1	All MCs	176	3.0	176	3.0	0.258	8.5	LOS A	1.1	7.9	0.58	0.76	0.61	40.7
Approach			308	1.7	308	1.7	0.258	7.1	LOS A	1.1	7.9	0.47	0.67	0.48	45.0
All Vehicles			869	3.1	869	3.1	0.258	3.0	NA	1.1	7.9	0.19	0.28	0.20	53.1

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive AM S2 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes AM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	602	2.8	602	2.8	0.157	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	49	6.4	49	6.4	0.028	5.8	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			652	3.1	652	3.1	0.157	0.5	NA	0.0	0.0	0.00	0.05	0.00	59.5
West: Median Storage															
12	R2	All MCs	176	3.0	176	3.0	0.211	3.3	LOS A	0.7	5.5	0.49	0.57	0.49	45.6
Approach			176	3.0	176	3.0	0.211	3.3	LOS A	0.7	5.5	0.49	0.57	0.49	45.6
All Vehicles			827	3.1	827	3.1	0.211	1.1	NA	0.7	5.5	0.11	0.16	0.11	57.3

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Peninsula Lakes Drive PM S1 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
South: Eaton Drive															
1	L2	All MCs	155	0.7	155	0.7	0.107	6.1	LOS A	0.4	3.3	0.24	0.54	0.24	48.7
2	T1	All MCs	779	1.1	779	1.1	0.201	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
Approach			934	1.0	934	1.0	0.201	1.0	LOS A	0.4	3.3	0.04	0.09	0.04	57.7
East: Median Storage															
5	T1	All MCs	137	0.0	137	0.0	0.056	0.7	LOS A	0.2	1.7	0.44	0.21	0.44	43.6
Approach			137	0.0	137	0.0	0.056	0.7	LOS A	0.2	1.7	0.44	0.21	0.44	43.6
West: Peninsula Lakes Drive															
10	L2	All MCs	76	0.0	76	0.0	0.067	6.0	LOS A	0.3	1.9	0.42	0.61	0.42	48.1
11	T1	All MCs	95	3.3	95	3.3	0.271	15.5	LOS C	1.0	7.5	0.78	0.93	0.89	35.3
Approach			171	1.9	171	1.9	0.271	11.2	LOS B	1.0	7.5	0.62	0.79	0.68	42.2
All Vehicles			1241	1.0	1241	1.0	0.271	2.4	NA	1.0	7.5	0.16	0.20	0.17	54.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Peninsula Lakes Drive PM S2 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Peninsula Lakes PM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
North: Eaton Drive															
8	T1	All MCs	608	1.7	608	1.7	0.158	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	137	0.0	137	0.0	0.073	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			745	1.4	745	1.4	0.158	1.1	NA	0.0	0.0	0.00	0.12	0.00	58.8
West: Median Storage															
12	R2	All MCs	95	3.3	95	3.3	0.114	3.1	LOS A	0.4	2.8	0.47	0.55	0.47	45.6
Approach			95	3.3	95	3.3	0.114	3.1	LOS A	0.4	2.8	0.47	0.55	0.47	45.6
All Vehicles			840	1.6	840	1.6	0.158	1.3	NA	0.4	2.8	0.05	0.17	0.05	57.7

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

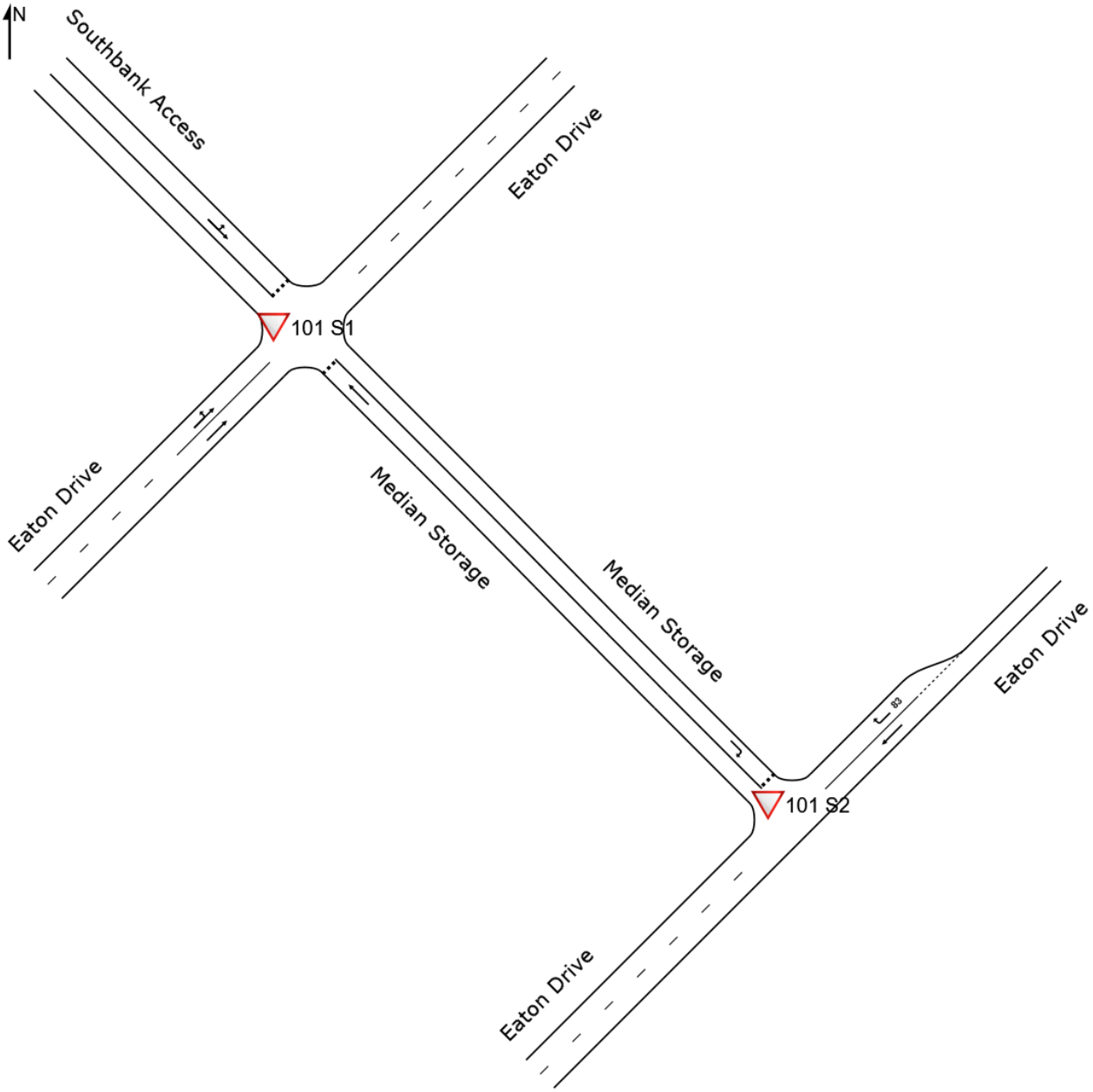
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NETWORK LAYOUT

Network: N101 [Eaton Drive - Southbank Access AM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Network
Network Category: (None)

Layout pictures are schematic functional drawings reflecting input data. They are not design drawings.



SITES IN NETWORK		
Site ID	**CCG ID**	**Site Name**
▽101 S1	NA	Eaton Drive - Southbank Access AM S1
▽101 S2	NA	Eaton Drive - Southbank Access AM S2

MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Southbank Access AM S1 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access AM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: Median Storage															
5	T1	All MCs	9	0.0	9	0.0	0.003	0.4	LOS A	0.0	0.1	0.36	0.14	0.36	44.3
Approach			9	0.0	9	0.0	0.003	0.4	LOS A	0.0	0.1	0.36	0.14	0.36	44.3
NorthWest: Southbank Access															
10	L2	All MCs	25	0.0	25	0.0	0.174	5.4	LOS A	0.7	4.9	0.54	0.70	0.54	47.3
11	T1	All MCs	103	0.0	103	0.0	0.174	8.0	LOS A	0.7	4.9	0.54	0.70	0.54	41.6
Approach			128	0.0	128	0.0	0.174	7.5	LOS A	0.7	4.9	0.54	0.70	0.54	43.3
SouthWest: Eaton Drive															
1	L2	All MCs	36	0.0	36	0.0	0.151	5.6	LOS A	0.0	0.0	0.00	0.07	0.00	56.8
2	T1	All MCs	536	2.9	536	2.9	0.151	0.0	LOS A	0.0	0.0	0.00	0.03	0.00	59.6
Approach			572	2.8	572	2.8	0.151	0.4	NA	0.0	0.0	0.00	0.04	0.00	59.4
All Vehicles			709	2.2	709	2.2	0.174	1.7	NA	0.7	4.9	0.10	0.16	0.10	56.8

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Southbank Access AM S2 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access AM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
NorthEast: Eaton Drive															
8	T1	All MCs	456	4.4	456	4.4	0.243	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.9
9	R2	All MCs	9	0.0	9	0.0	0.005	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			465	4.3	465	4.3	0.243	0.2	NA	0.0	0.0	0.00	0.01	0.00	59.8
NorthWest: Median Storage															
12	R2	All MCs	103	0.0	103	0.0	0.085	1.6	LOS A	0.2	1.4	0.29	0.39	0.29	49.2
Approach			103	0.0	103	0.0	0.085	1.6	LOS A	0.2	1.4	0.29	0.39	0.29	49.2
All Vehicles			568	3.5	568	3.5	0.243	0.4	NA	0.2	1.4	0.05	0.08	0.05	58.5

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S1 [Eaton Drive - Southbank Access PM S1 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access PM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
SouthEast: Median Storage															
5	T1	All MCs	25	0.0	25	0.0	0.010	0.6	LOS A	0.0	0.3	0.43	0.21	0.43	44.1
Approach			25	0.0	25	0.0	0.010	0.6	LOS A	0.0	0.3	0.43	0.21	0.43	44.1
NorthWest: Southbank Access															
10	L2	All MCs	15	0.0	15	0.0	0.120	5.5	LOS A	0.5	3.2	0.59	0.75	0.59	46.5
11	T1	All MCs	57	0.0	57	0.0	0.120	9.7	LOS A	0.5	3.2	0.59	0.75	0.59	40.3
Approach			72	0.0	72	0.0	0.120	8.8	LOS A	0.5	3.2	0.59	0.75	0.59	42.2
SouthWest: Eaton Drive															
1	L2	All MCs	101	0.0	101	0.0	0.199	5.6	LOS A	0.0	0.0	0.00	0.16	0.00	56.1
2	T1	All MCs	669	1.3	669	1.3	0.199	0.1	LOS A	0.0	0.0	0.00	0.07	0.00	59.3
Approach			771	1.1	771	1.1	0.199	0.8	NA	0.0	0.0	0.00	0.08	0.00	58.9
All Vehicles			867	1.0	867	1.0	0.199	1.4	NA	0.5	3.2	0.06	0.14	0.06	57.4

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).
Vehicle movement LOS values are based on average delay per movement.
Minor Road Approach LOS values are based on average delay for all vehicle movements.
NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).
Two-Way Sign Control Capacity Model: SIDRA Standard.
Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).
Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.
Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).
HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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MOVEMENT SUMMARY

Site: 101 S2 [Eaton Drive - Southbank Access PM S2 (Site Folder: S4 2040 100% Parkridge 100% Southbank)]

Output produced by SIDRA INTERSECTION Version: 9.1.6.228

Network: N101 [Eaton Drive - Southbank Access PM (Network Folder: S4 2040 100% Parkridge 100% Southbank)]

New Site
Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	Mov Class	Demand Flows [Total veh/h	HV] %	Arrival Flows [Total veh/h	HV] %	Deg. Satn v/c	Aver. Delay sec	Level of Service	95% Back Of Queue [Veh. veh	Dist] m	Prop. Que	Eff. Stop Rate	Aver. No. of Cycles	Aver. Speed km/h
NorthEast: Eaton Drive															
8	T1	All MCs	658	1.6	658	1.6	0.343	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	59.8
9	R2	All MCs	25	0.0	25	0.0	0.013	5.7	LOS A	0.0	0.0	0.00	0.63	0.00	50.5
Approach			683	1.5	683	1.5	0.343	0.3	NA	0.0	0.0	0.00	0.02	0.00	59.6
NorthWest: Median Storage															
12	R2	All MCs	57	0.0	57	0.0	0.054	2.0	LOS A	0.1	0.9	0.35	0.46	0.35	48.7
Approach			57	0.0	57	0.0	0.054	2.0	LOS A	0.1	0.9	0.35	0.46	0.35	48.7
All Vehicles			740	1.4	740	1.4	0.343	0.4	NA	0.1	0.9	0.03	0.06	0.03	59.0

Site Level of Service (LOS) Method: Delay (SIDRA). Site LOS Method is specified in the Network Data dialog (Override Site Data tab).

Vehicle movement LOS values are based on average delay per movement.

Minor Road Approach LOS values are based on average delay for all vehicle movements.

NA (TWSC): Level of Service is not defined for major road approaches or the intersection as a whole for Two-Way Sign Control (HCM LOS rule).

Two-Way Sign Control Capacity Model: SIDRA Standard.

Delay Model: SIDRA Standard (Control Delay: Geometric Delay is included).

Queue Model: SIDRA queue estimation methods are used for Back of Queue and Queue at Start of Gap.

Gap-Acceptance Capacity Formula: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

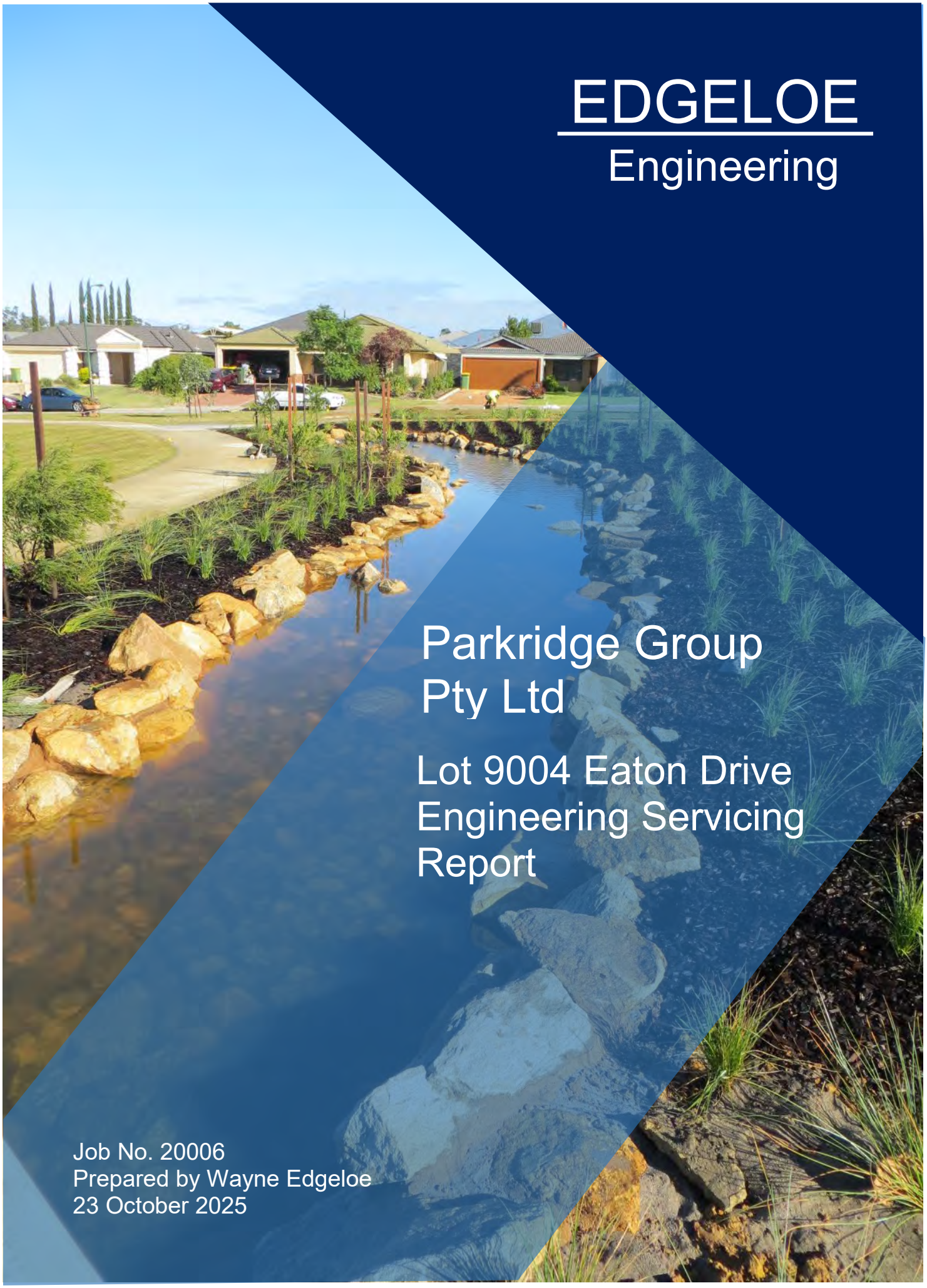
Arrival Flows used in performance calculations are adjusted to include any Initial Queued Demand and Upstream Capacity Constraint effects.

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With every community, we redefine what's possible.

Stantec is a global leader in sustainable engineering, architecture, and environmental consulting. The diverse perspectives of our partners and interested parties drive us to think beyond what's previously been done on critical issues like climate change, digital transformation, and future-proofing our cities and infrastructure. We innovate at the intersection of community, creativity, and client relationships to advance communities everywhere, so that together we can redefine what's possible.

APPENDIX G | SERVICING AND INFRASTRUCTURE



EDGELOE
Engineering

Parkridge Group Pty Ltd

Lot 9004 Eaton Drive Engineering Servicing Report

Job No. 20006
Prepared by Wayne Edgeloe
23 October 2025

EDGELOE
Engineering

Edgeloe Engineering Pty Ltd
ABN 31 639 695 088

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Ph 08 97 216 983
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Contact: Wayne Edgeloe – Director
Mobile 0429 220 608

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It is not intended for and should not be relied upon by any third party and no responsibility is taken to any third party.

Document Status

Rev No.	*Author*	*Issued for*	Signature	Date
1	W Edgeloe	Structure Plan approval		9 Sept 2025
2	W Edgeloe	Staging comment added		23 Oct 2025

EDGELOE
Engineering

1 Introduction

Parkridge Group Pty Ltd has engaged Edgeloe Engineering Pty Ltd to undertake the initial investigations and reporting on servicing constraints for the proposed development of Lot 9004 Eaton Drive, Eaton.

The site is a previously partially developed site which consists of Lot 9004. The previous developed portions are shown in Figure 1 with the new development areas to the north on the balance of the land.

This area of land sits approximately 2km upstream of the estuary along the Collie River flood plain.

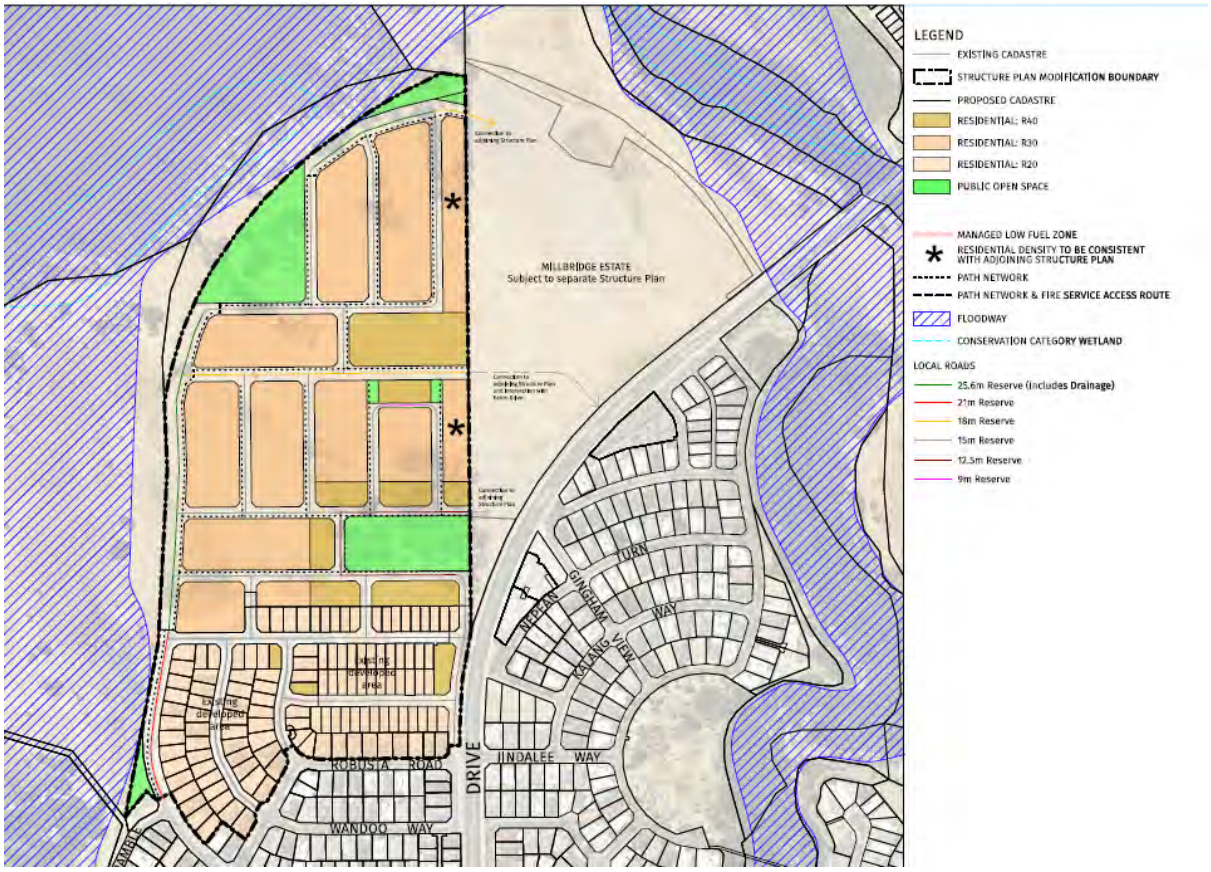


Figure 1 Proposed Structure Plan, Lot 9004

An historical aerial photograph of the site is shown below to depict the extent of the surrounding developments.

The residential developments to the south and east represent the extent of existing services.

EDGELOE
Engineering



Figure 2 **Aerial Imagery of Surrounding Area, Slip 2025**

2 Topography and Vegetation

The Site is located at the north end of Eaton and is bounded by the Collie River to the west and north, Guernsey Street to the south and Eaton Drive and vacant land to the east.

The land falls from RL 11m AHD in the south east to the west and north west at approximately RL 1.0m AHD as shown in Figure 3.

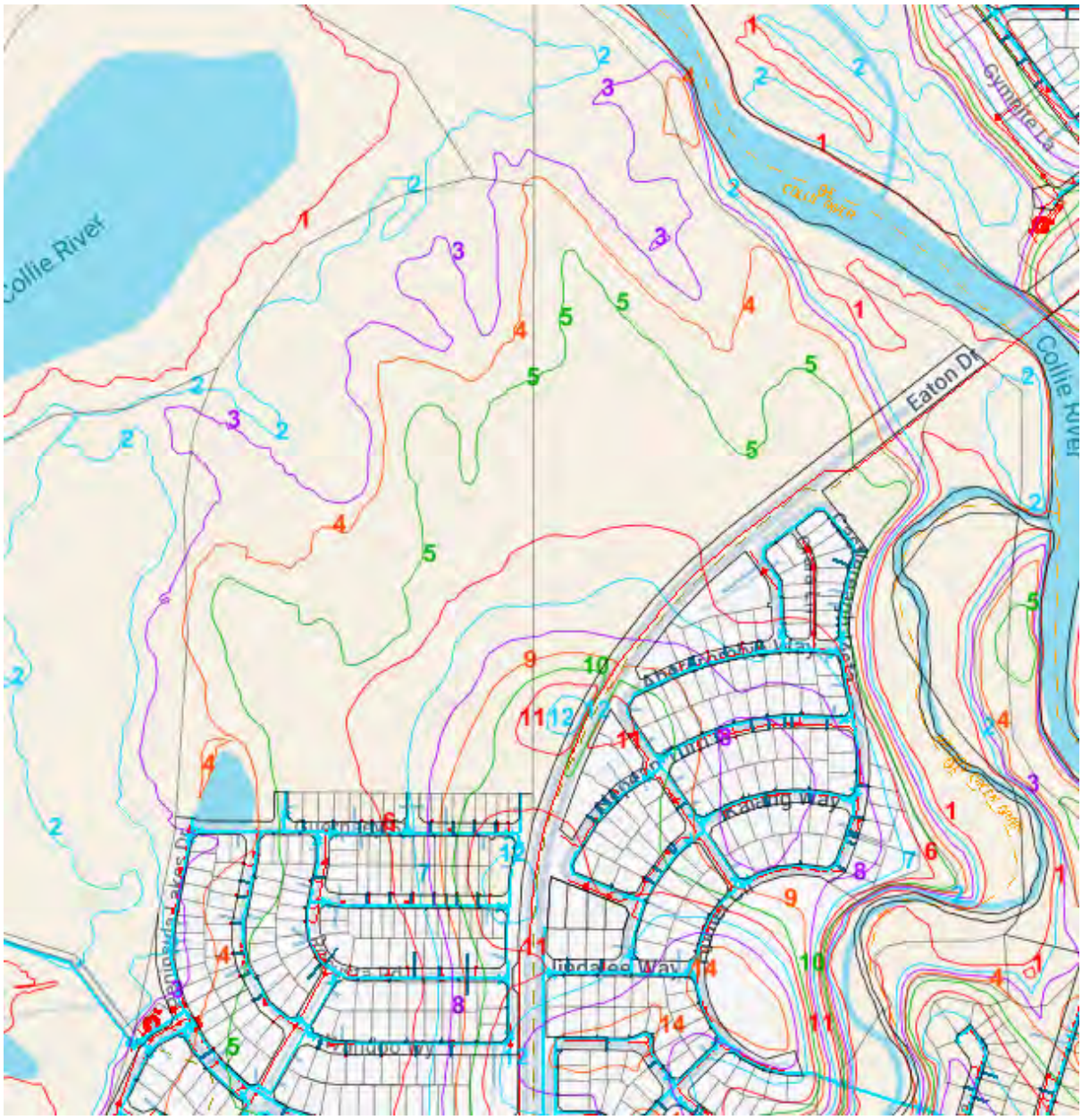


Figure 3 Contours of Site, Esinet Data, Water Corporation 2025

3 Geotechnical Review

3.1 General

GALT 2025) have undertaken a Geotechnical Investigation of the balance of the estate to determine requirements for development. This report is attached in Appendix A.

The extent of test holes undertaken are shown in Figure 4.



Figure 4 Test hole locations GALT (2025)

It was found most of the site was topsoil overlying Guilford Formation clayey soils with those clayey soils at shallow depth over much of the site.

3.2 Site Classification

Assuming that recommended earthworks are implemented across the Site, site classifications of Class A and Class M can be expected to be achieved.

Class A sites require sand at least 1.8m thick over the clayey soils and 0.6m thick for Class S sites.

3.3 Groundwater Assessment

The geotechnical review advises that the groundwater level is generally at the clay level across the site and so fill will be required to achieve groundwater clearances.

3.4 Acid Sulphate Soils

A preliminary assessment of acid sulphate soils (ASS) was conducted in December 2005 by Golder Associates (2005).

The results of this preliminary assessment showed that generally across the Site, actual ASS (AASS) can be expected to be encountered at depths of 3m or more. As shown in Figure 5, there is AASS at surface through to depths of 1.25m. Potential ASS has been encountered elsewhere throughout the geological profile.

Based on the geotechnical assessment, an Acid Sulphate Soils Management Plan will need to be prepared and implemented during any earthworks and construction.

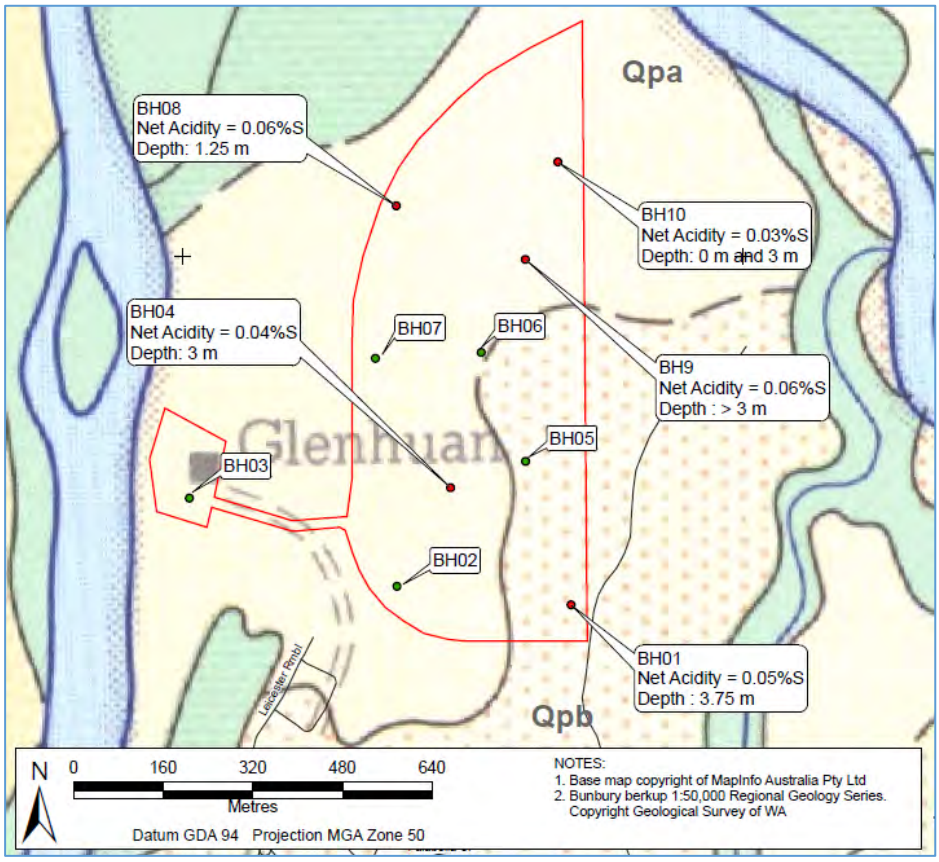


Figure 5 Results of ASS Testing, Golder Associates (2005)

4 Roads and Pavement

The development of the site will require new roads to be constructed to Shire of Dardanup Standards.

Roads will connect to the existing road network at the south and the exit to the north will be via a road link though the proposed Millbridge Development and onto the existing intersection location on Eaton Drive.

Paths will also be established on all roads to Shire of Dardanup requirements and standards.

5 Drainage Considerations

A Local Water Management Strategy has been prepared by Oversby Consulting (2025) for the balance of the Estate.

The water management strategies developed for this land are based on best practice water sensitive urban designs that integrate sustainability and the provision of attractive communities. The strategies will be achieved through the synthesis of planning and designs to manage, protect and conserve the total water cycle. The plans and designs for the development are appropriate for the subject land's residential development, surrounding environment and local drainage characteristics.

A summary of the WSUD elements that will be implemented within the development to achieve best management practices are outlined as follows:

Water Conservation and Servicing

- All houses are to be provided with a mains potable water managed by the Water Corporation
- Each lot is to be connected to a sewer system, managed by the Water Corporation.

Stormwater Management

- Stormwater detention systems, combined with treatment systems including a perimeter bioretention basin will capture and treat stormwater flows. All flows leaving the site up to the 20% AEP event match or are below the pre-development rate.
- Consistent with Shire policy CP060, soakage devices will be provided on lots where the aggregate impervious area including roofs, carparks, driveways, carports and patios exceeds 250m² or where the lot size is less than 400m².

Flood Protection

- All finished floor levels will be designed to maintain a clear separation of 300mm between the habitable floor level and the 1% Average Event Period (AEP) event flood level, generated on site;
- All finished floor levels will be designed to maintain a clear separation of 500mm between the habitable floor levels and the 1% Average Event Period (AEP) event flood level of the Collie River of 3.61mAHD.

Ecosystem Protection

- New habitat will be created within the perimeter bioretention basin, through the use of locally native plant species;
- The WSUD elements used on site will treat stormwater and groundwater, improving the water quality prior to it entering the downstream ecosystems of Collie River
- Flows to the Collie River will be managed to predevelopment rates for all events up to and including the 20% AEP, minimising changes to the current flows to this ecosystem.
- Existing habitat within the Collie River foreshore area will be retained as Regional Open Space (ROS) as part of the Kalgulup Regional Park and is subject to future planning. Any land use in this area will take into account the Collie River flood regime and need for ecological management.
- All drainage infrastructure is located more than 50m from the Eelup/Elbow Conservation Category Wetland within the foreshore area.
- The landscaping will utilise nutrient and waterwise practices to minimise contamination of the groundwater.

- Eelup Wetland is to be vested in the Conservation and Parks Commission to provide long term protection.

Groundwater Management

- Filling of building pads and roads will be used to manage groundwater so that adequate clearance is maintained between maximum estimated groundwater level and finished surface level.
- A subsoil drainage system will be used in roads to ensure adequate clearances to groundwater.
- Captured subsoil flows will be treated through the perimeter bioretention system.
- A change in land use from livestock grazing to sewered residential will reduce nutrient loading to groundwater.

Monitoring and Maintenance

- Monitoring is to be undertaken through the construction phase of each stage for surface water and potential groundwater in relation to possible contamination;
- Post development monitoring is to consider surface and groundwater quality, ecosystem enhancement and WSUD structural performance

Implementation and Governance

- Developers are to undertake detailed UWMP's to provide the necessary information for management of water across the subject land;
- Developers are to undertake detailed Foreshore Management Plans to provide guidance on land management within the Collie River foreshore area.
- The Shire of Dardanup, the Department of Biodiversity, Conservation and Attractions and the Department of Water and Environmental Regulation are to continue to provide guidance, direction and assistance so that the targets outlined in this report are able to be realised.

6 Earthworks Strategy and Considerations

All lot levels will be filled to achieve at least 1.5m above the clayey soils and groundwater levels on the site and also at least 500mm above the 1 in 100-year flood level.

Lots will be retained with limestone blockwork retaining walls to achieve level building lots.

7 Sewer

The Site is currently serviced from the south by a 150mm PVC sewers from Peninsula Lakes Drive and Guernsey Streets as shown in Figure 6.

The southern part of the proposed development will be directed to the existing sewer reticulation network via gravity sewer. This part of the catchment will be directed to the existing wastewater pump station located in the south-western area of the Site.

The remainder of the Site will be directed to the vacuum sewer that services this part of the Site via Millbridge. Current Water Corporation Planning is shown in Figure 7.

The Water Corporation has agreed that an additional portion of the land equating to 1.76 l/s of gravity flow (approximately 150 lots) can be connected to the gravity sewer to the south so as to reduce the amount of the site to be serviced by vacuum sewer.

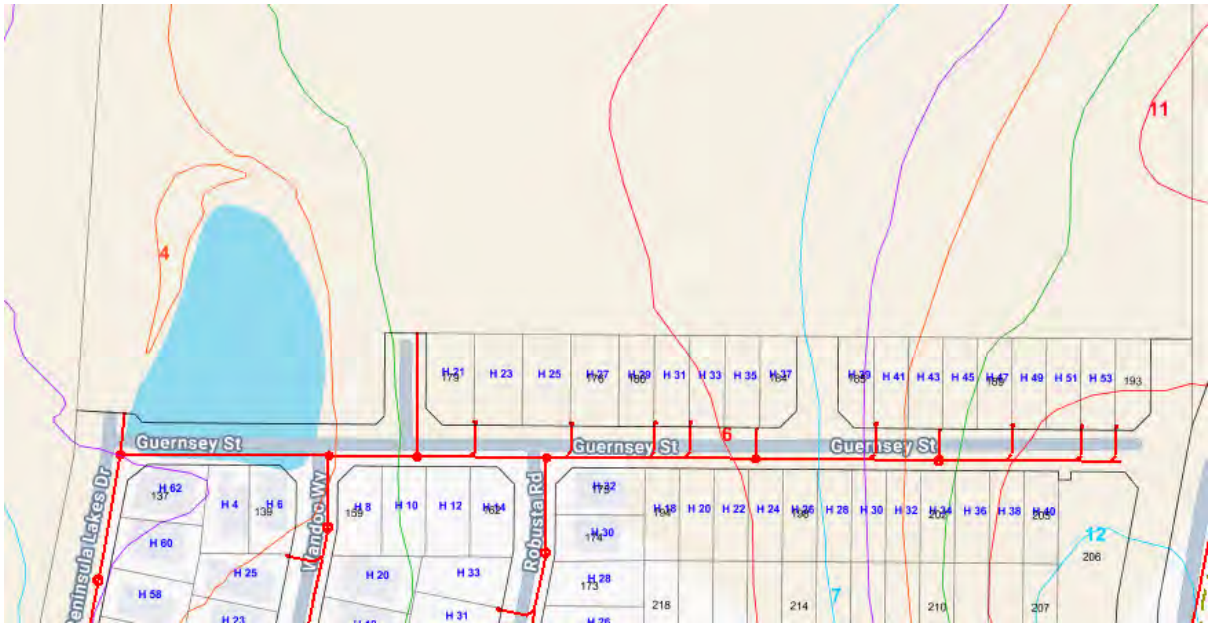


Figure 6 **Existing Sewer Reticulation, Esinet Data, Water Corporation 2018**

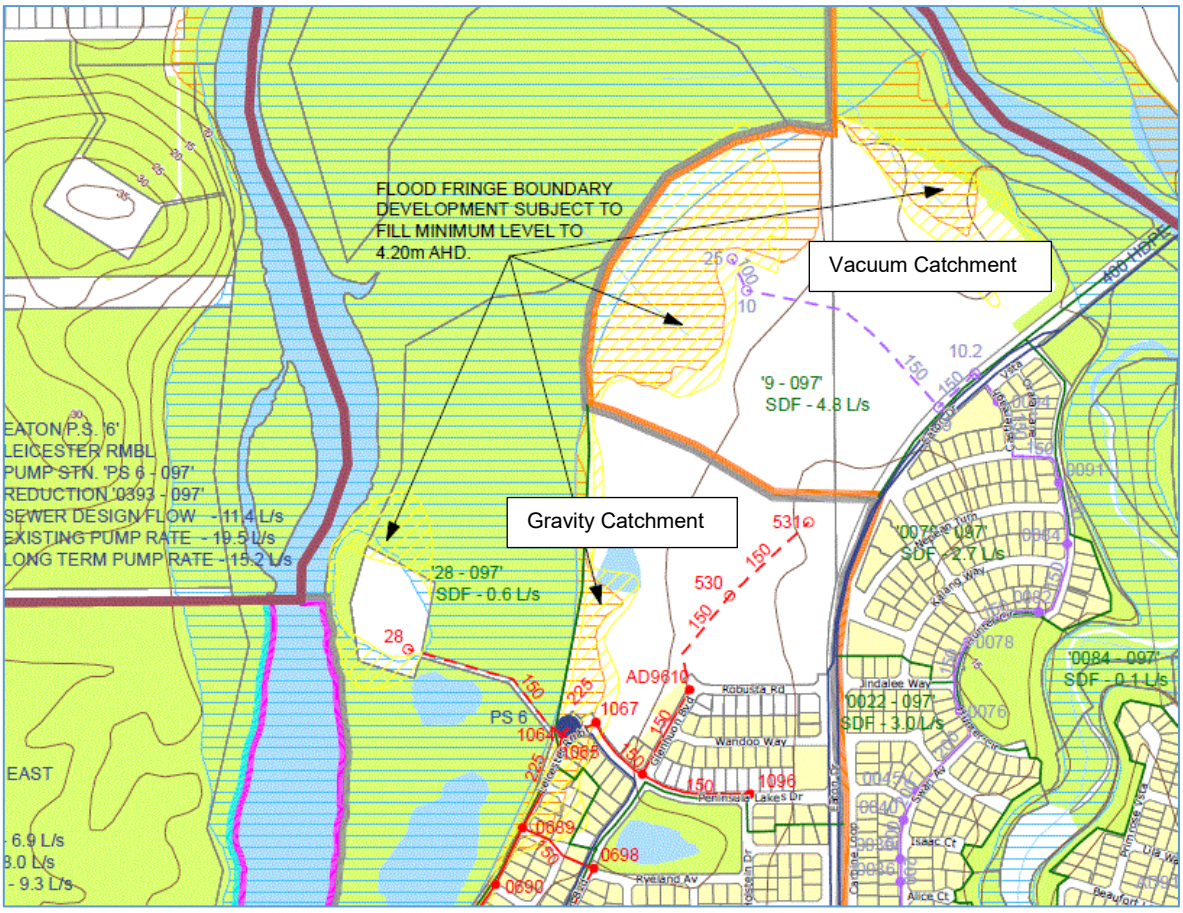


Figure 7 **Water Corporation Sewer Planning**

8 Water

The Water Corporation have confirmed the development can be connected to existing water mains to the south of the site and that critical main sizes shall be provided as shown in Figure 8.

This provides for extension of DN200 and DN150 mains north through the site to connect to existing mains on Eaton Drive via the adjacent proposed Millbridge development to the east.

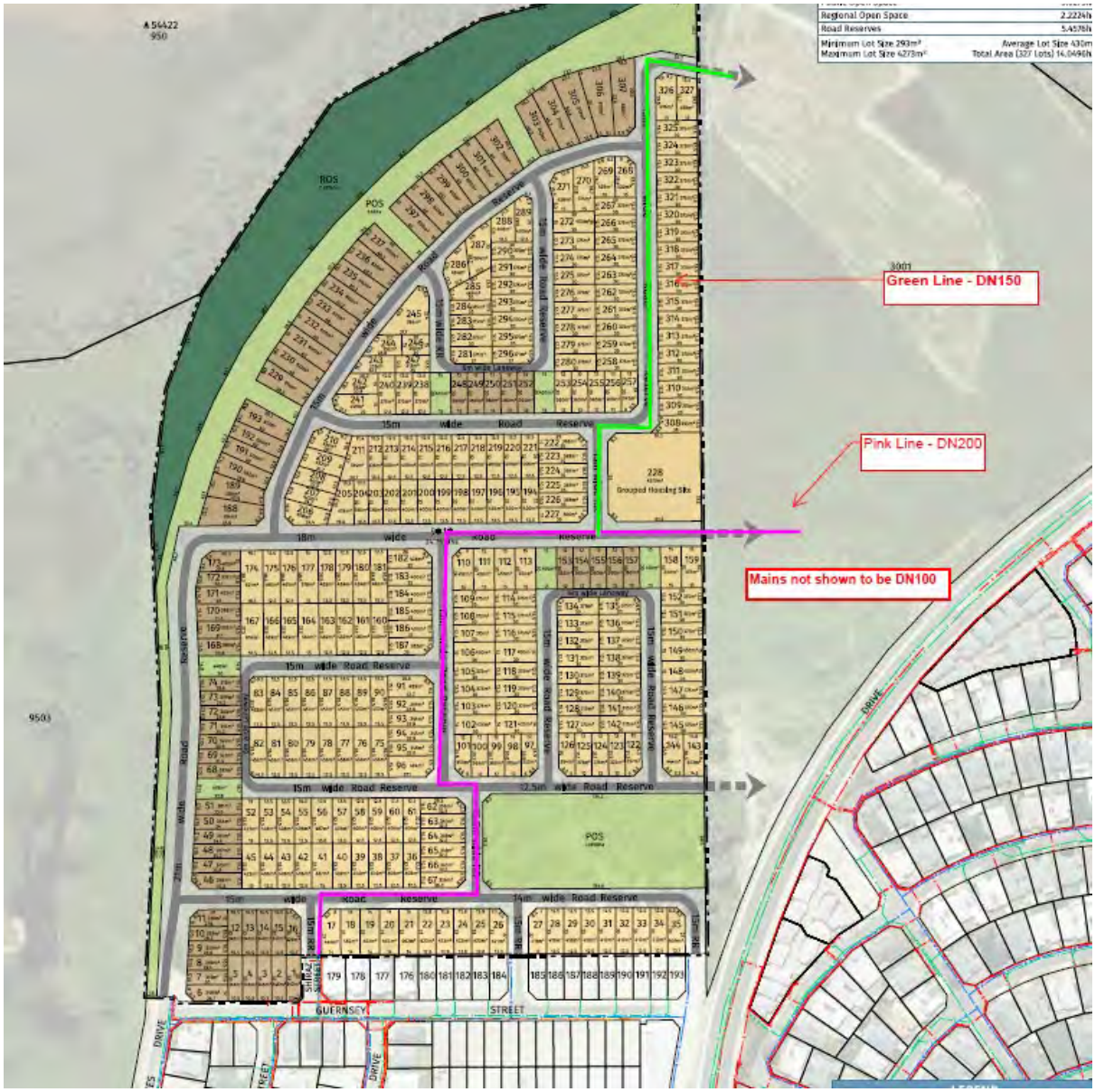


Figure 8 Existing Water Reticulation, Esinet Data, Water Corporation 2018

9 Gas Reticulation

Gas will be supplied to all new lots buy connection to ATCO gas mains at the southern end of the site.

Existing gas mains are shown in Figure 9.

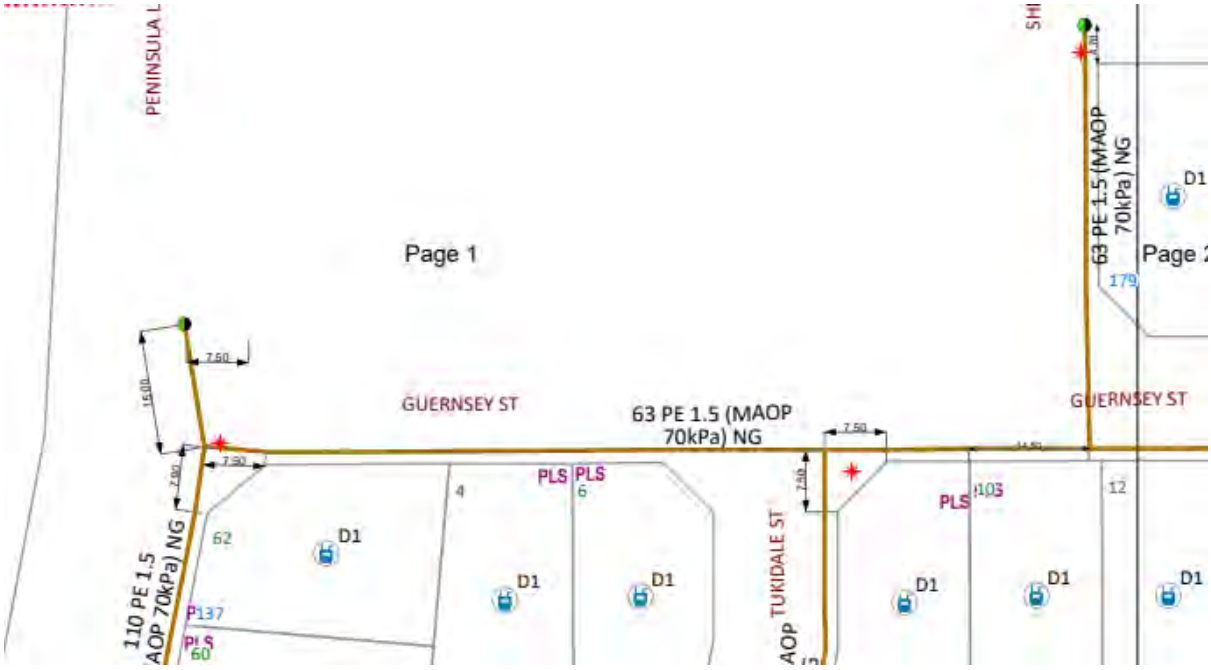


Figure 9 Existing Gas Reticulation, ATCO Gas 2025

10 Power

Western Power infrastructure will be extended from existing underground power services to the south to provide power services to all lots.

Any upgrades will be determined at time of development by application for a DIP with Western Power.

11 Telecommunications

Nbn services will be provided to all lots by a pit and pipe system extended from existing infrastructure in adjacent development at the southern end of the site.

12 Staging

As per the Stantec (2025) Traffic Impact Assessment the first 211 lots can be completed with a link to the south via Peninsula Lakes Drive.

To release lots in excess of this number will involve the construction of the link the rough the adjacent Millbridge Estate and linking to Eaton Drive. These works will be carried out in coordination with the adjoining landowner.

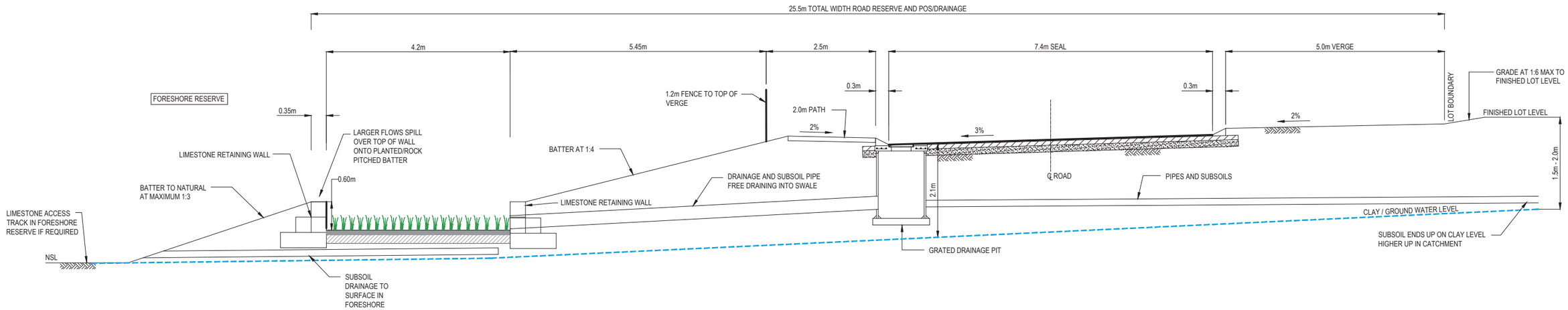
13 References

GALT (2025) Geotechnical Study Balance of Lot 9008 Parkridge Estate Eaton, Report no WAG190133-04 001 R Rev0

Golder Associates (2005) Geotechnical Investigation and Preliminary Acid Sulphate Soils Assessment Report 05642399- R01

Oversby Consulting (2025) Local Waster management Strategy Parkridge Estate

Stantec (2025) Parkridge Structure Plan Modification Transport Impact Assessment, Ref 300305774



TYPICAL ROAD CROSS SECTION - SIDE SWALE

1:50

EDGELOE
Engineering

Appendix A

GALT Geotechnical Report

(Appendix ORD: 12.2.2C)

Galt GEOTECHNICS

Report on:

GEOTECHNICAL STUDY
BALANCE OF LOT 9008 PARKRIDGE ESTATE
EATON WA

WAG190133-04 001 R Rev0

Submitted to:

Parkridge Group Pty Ltd
PO Box 8357 Angelo Street
SOUTH PERTH WA 6151

27 June 2025

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Figure 2B: Sand Thicknesses/Depth to Clay Layer

Appendix A: Site Photographs
Appendix B: Information Provided
Appendix C: Geotechnical Laboratory Test Results
Appendix D: Environmental Results Table and Laboratory Certificates

Standard Geotechnical Definitions, Recommendations, Requirements and Limitations

1. INTRODUCTION

This report presents the outcomes of Galt Geotechnics' (Galt's) geotechnical study for the proposed subdivision development, at Lot 9008, Parkridge Estate, Eaton WA ("the site", refer Figure 1).

This report is to be read in conjunction with the appended "Geotechnical Definitions, Recommendations, Requirements and Limitations". 'Clause GDR1', etc. refer to this Appendix, found at the back of this report.

2. KEY FINDINGS

We encountered Surficial topsoil over:

- **Most of site**: Guildford Formation (clayey soils)
- **South East part of site**: (Refer Figure 2B): Sand, over Guildford Formation (clayey soils)

Guildford Formation typically included zones of Clayey SAND, Sandy CLAY and CLAY.

Clay / clayey fill and rubbish stockpiles were encountered in the southern part of the site (refer Figure 1).

Groundwater was observed at the surface in parts of the site, and encountered at depths of 0.37 m to 2.70 m. Parts of the site are subject to flooding as discussed in Section 8.2.

The site is suitable for the proposed development. Significant filling is required to achieve adequate clearance from design flood / groundwater levels. The following AS2870 site classifications apply:

- Class A where sand at least 1.8 m thick is present over Guildford Formation;
- Class S where sand at least 0.6 m thick is present over Guildford Formation; and
- Class M where sand less than 0.6 m thick is present over Guildford Formation.

Subject to suitable subgrade preparation, the following CBR values are recommended:

- CBR of 3% for poorly drained clay subgrades;
- CBR of 5% Well drained clay subgrades (drainage may be difficult to achieve);
- CBR of 10% for subgrades where clay is overlain by no less than 0.4 m of compacted insitu sand (Refer Figure 2B) or compacted, approved sand fill.

Stormwater disposal is generally not suitable at the site in its current condition due to the typically clay/clayey subsurface profile. The sand encountered in most locations is not considered to be free draining. However, sand in BH118, BH128, BH129 and BH145 is judged to be free draining, with less than about 5 % fines. We recommend that in situ infiltration testing is done at finished cut level to confirm the design permeability of surficial sand / sand fill.

Material from the surface to a depth of 2.0 m within the northern ROS is classified as non-acid sulfate soils (NASS) and as such, no treatment or management is required if this material is reused. Material below 2.0 m is classified as acid sulfate soils (ASS) and as such, treatment with aglime would be needed if this material is reused.

3. SITE DESCRIPTION

Table 1: Summary of Site

Item	Comment
Site Extent	Refer to Figure 1
Site Area	About 24 ha.
Geomorphology and Current Site Surface Elevation[1]	The site is located within, and to the south of a bend in the Collie River. The site slopes down from about RL 10 m AHD in the south west, to about RL 2 m AHD to RL 3 m AHD in the north and west (near the river).
Current Site condition	Mostly vacant paddock (possibly pastoral land) vegetated with grass and some mature trees. Areas of rubbish stockpiles and soil stockpiles in the south east of the site (refer Figure 1). Some waterlogged areas, and areas of ponded water (refer Appendix A).
Site History[2]	**1970 to 2021**: Site has been relatively undeveloped. **2021**: Partial filling of pond in south west corner of site. Stockpiling of soil / rubbish in southern part of site commences. **2021 to present**: Site relatively unchanged. Some sporadic stockpiling of soil / rubbish in southern part of site.

NOTES: ***1.*** *Site elevation based on publicly available data (Landgate).*

2. *Site history based on aerial imagery (Landgate).*

4. PROPOSED DEVELOPMENT

Table 2: Summary of Proposed Development

Item	Comment
Proposed Development	Residential subdivision consisting of 327 Lots. POS areas proposed adjacent Collie River, and in south west corner of site.
Cut/Fill	We anticipate that filling is required to raise the northern and western parts of the site above design flood and groundwater levels. Mining of sand (from deep sand areas) followed by filling with clay stockpiled at the site is also being considered.
Assumed Stormwater Disposal	On site via soakwells
Assumed Sewage Disposal	Offsite via sewer network

NOTE: Proposed development details based on supplied information presented in Appendix B.

5. PROJECT OBJECTIVES

The objectives of the study were to:

- assess subsurface soil and groundwater conditions across the site;
- provide a site classification(s) in accordance with AS 2870-2011 “Residential Slabs and Footings”;
- provide recommendations and geotechnical design parameters for earth retaining structures, including temporary support;
- recommend appropriate site preparation procedures including compaction criteria and potential sourcing of excess sand from suitable areas of site and disposing of excess clay into POS areas;
- assess the permeability of the soils at the site for potential on-site disposal of stormwater by infiltration; and
- provide a subgrade California bearing ratio (CBR) value for pavement thickness design by others; and
- conduct a preliminary acid sulfate soils (ASS) study in POS area to help inform any material re-use from this area.

6. FIELDWORK

Fieldwork was carried out between 29 May and 4 June 2025 and is summarised below.

Table 3: Summary of Fieldwork

Type	Results Appendix / Table	Summary	GDR Clause	Equipment Used	No. Tests	Depth Range (m)
Site Plan	Figure 1	-	-	Hand held GPS[1]	-	-
Photographs	A	-	-	-	-	-
Machine Auger Boreholes (BH)	Table 8	Section 9	GDR3.3	EVH Scout on utility and Drillman GT on Utility	150	1.0 to 3.0
Monitoring Wells (MW)	Table 6	Section 8.2	GDR3.3		6	3.0

NOTES: ***1.*** *Hand held GPS is accurate to ±5 m.*

7. LABORATORY TESTING

Laboratory test results are presented in Appendix C and summarised in Attached Table 1.

8. SITE CONDITIONS

8.1. Geology

Table 4: Summary of Geology Mapping

Map Sheet	Map Scale	Mapped Soils
BUNBURY-BUREKUP	1:50 000	- **MOST OF SITE**: *Qpa; GUILDFORD FORMATION: mainly alluvial sandy clay*. - **SOUTH WEST PART OF SITE**: *Qpb: Qpb/Qpa Thin Bassendean Sand over Guildford Formation*. - **ADJACENT NORTH WEST SITE BOUNDARY**: *QHAY: Alluvium, younger terraces*. Areas of alluvium are likely to be present near the Collie River.

8.2. Groundwater and Surface Water

Table 5: Summary of Groundwater Levels

Item	Date	Depth Range (m)	Elevation Range (m AHD)	Comment
DWER[2] Floodplain Mapping	-	-	2.75 to 3.00 (Refer In-Line Image 1)[4]	Most of the site (excluding south east corner) is mapped as Floodplain Development Control Area. Northern and western parts of the site are in the DWER floodplain and flood fringe (refer In Line Image 1)[4].
DBCA[3] Mapped Geomorphic Wetlands	-	-	-	Most of the site (excluding south east corner) is mapped as a 'Palusplain' (defined as a seasonally waterlogged area).
Site Observations	June 2025	1.00 to 2.70 0.37 in MW01 2.60 in MW02	1.00 to 3.61[1] 3.39 in MW01[1] 3.85 in MW02[1]	Water ponding observed on site (Refer Appendix A). Groundwater encountered in boreholes are presented in Table 8. Groundwater in monitoring wells presented in Table 6.
Recommended Design	-	-	-	Design groundwater levels are subject to civil design and assessment by suitably qualified hydrogeologist. Groundwater could perch over clay/clayey soils at the site.

NOTES:

1. *Elevation range for site observations is inferred from survey information provided.*
2. *Where DWER is the Department of Water and Environmental Regulation.*
3. *Where DBCA is the Department of Biodiversity Conservation and Attractions.*
4. *DWER mapping represents the defined flood event (DFE) used to inform land use planning. In most cases, the DFE represents the 1 in 100 (1%) annual exceedance probability (AEP) flood event level. For proposed development located within the DFE floodplain, DWER provide advice on each proposal on a case-by-case basis. For proposed development located outside of the defined flood event (DFE) floodplain, DWER recommend a minimum building floor level of 0.50 metres above the adjacent DFE flood level.*

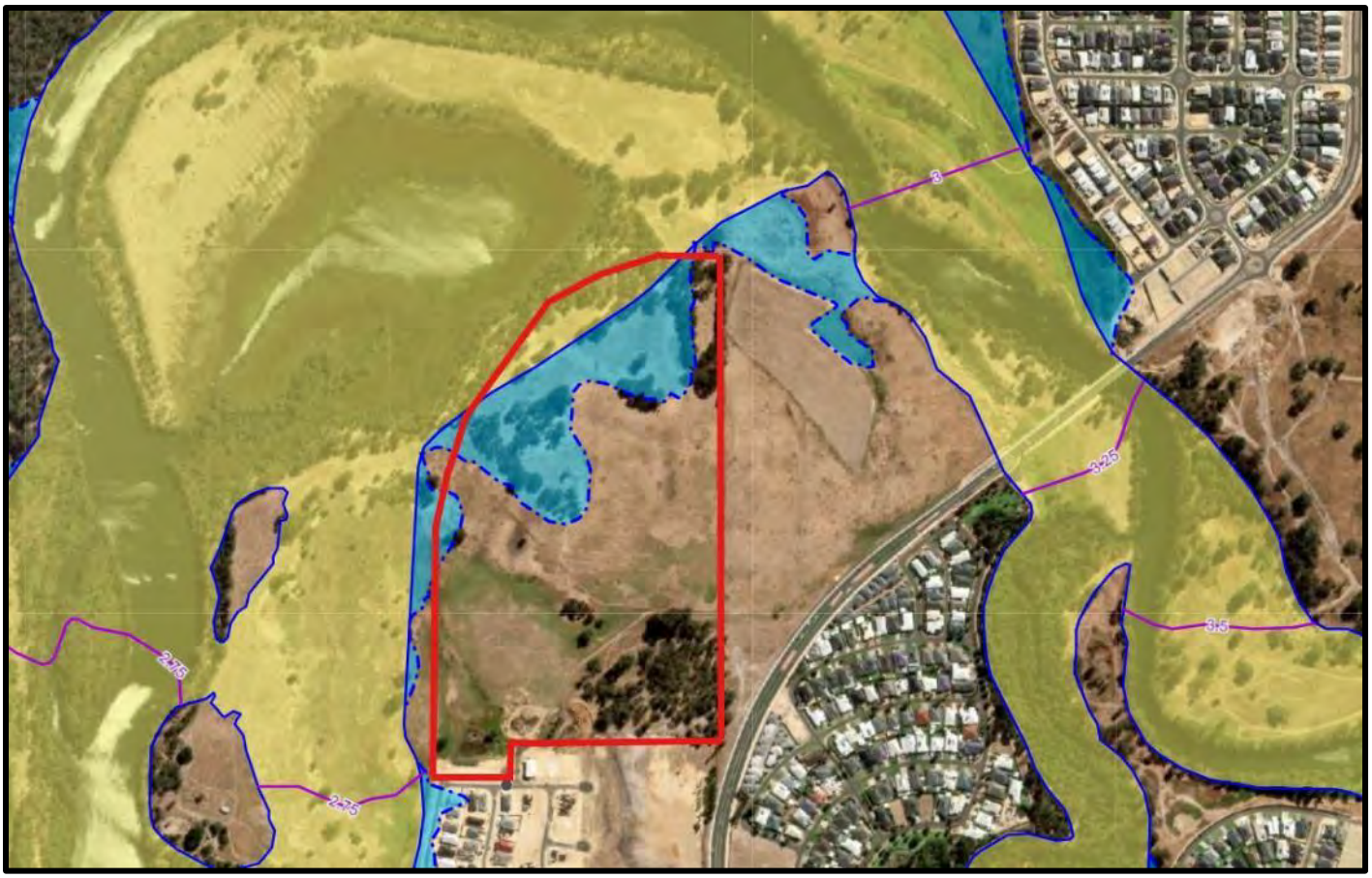
Table 6: Summary of Monitoring Wells

Monitoring Well	Surface RL (m AHD)	Depth to Groundwater (m BGL)	Groundwater Elevation (m AHD)
MW01 (BH140)	3.76	0.37	3.39
MW02 (BH127)	6.45	2.60	3.85
MW03 (BH89)	3.83	GNE	-
MW04 (BH53)	5.14	GNE	-
MW05 (BH05)	3.63	GNE	-
MW06 (BH01)	1.49	GNE	-

NOTES:

1. *Surface RL is inferred from feature survey provided.*
2. *Monitoring wells dipped about 1 week after installation.*

Inline Image 1 – DWER Flood mapping. Nominal Site boundary indicated in red.



9. GROUND MODEL

The subsurface surface conditions are summarised below:

- **Surficial TOPSOIL**, about 0.05 m to 0.2 m thick; overlying
- [South eastern corner of site only] **SAND (SP)**, fine to medium grained, grey / white/ yellow / brown, typically trace to with fines, extends to maximum investigated depth of 3.0 m in south east part of site (***Refer Table 8 and Figure 2B***).
- **GUILDFORD FORMATION: Clayey Sandy GRAVEL / Clayey SAND / Sandy CLAY / CLAY (GC/SC/SM/CH/CI/CL)**, low to medium plasticity clay, typically fine to medium grained sand and gravel, red / brown / orange, typically firm to hard, extends to maximum investigated depth of 3.0 m (Refer Table 8 and Figures 2A and 2B).

Notes:

1. Clay / clayey fill and rubbish stockpiles were encountered in southern parts of site (refer Figure 1).
2. Sand is likely to be present to depths greater than 3 m in localised parts of the southeast of the site (where the terrain is higher), however the maximum depth investigated was limited to 3 m. Due to the need to conform to site levels to the south and east, we do not expect more than ~2 m of cut in this area. The area where sand was still present at the maximum investigation depth is indicated in magenta hatching on Figures 2A and 2B.
3. Hence, clay elevations provided on Figure 2A are the current surface in most of the site and the base of sand, in the southeast corner, where sand was present. The clay elevation in the magenta hatched area is likely to be below the nominal elevation, since sand was still present at the maximum excavation depth. At this stage, we assume clay grading would not be done in that area of the site, therefore the specific elevation is not relevant. If additional data is needed, some deeper testing would be required.

Geotechnical parameters for the units above are presented below.

Table 7: Geotechnical Model Units and Design Parameters

Unit Name	γ_{bulk} (kN/m^3)	ϕ' (°)	c' (kPa)	S_u (kPa)	E_v (MPa)	ν	k_0	Wall Friction=0		Wall Friction=0.5ϕ	
								k_a	k_p	k_a	k_p
Approved Compacted Sand FILL Refer Table 9	18	36	-	-	50	0.3	0.41	0.26	3.85	0.22	6.54
Surficial SAND	18	33	-	-	20	0.3	0.46	0.29	3.39	0.26	5.30
Firm CLAY	18	30	5	25 to 50	6 to 10	0.45	Earth pressure coefficients can be calculated for undrained or drained conditions as outlined in GDR11.2.2.				
Stiff CLAY	18	30	5	50 to 100	10 to 20	0.45					
Very Stiff CLAY	18	30	5	100 to 200	20 to 40	0.45					
Hard CLAY	18	30	5	200	40	0.45					

NOTES:

1. *These units are a generalization of results from individual tests, which should be referred to for more information.*
2. *Topsoil is not included as a discrete unit.*
3. *For all earth pressure coefficients (retaining wall design) refer to clause GDR11.2 for more detail and interpretation. Unit weights for retaining structure design should be as per GDR11.2 or 1 kN/m^3 greater than the values in the table above.*

γ_{bulk} – bulk unit weight
ϕ' – effective friction angle
S_u – undrained shear strength
c'– effective cohesion
E_v – vertical elastic modulus
ν – Poisson's Ratio
k_a – coefficient of active earth pressure (Coulomb – AS4678-2002, Appendix E)
k_p – coefficient of passive earth pressure (Coulomb – AS4678-2002, Appendix E)
k_0 – coefficient of at-rest earth pressure (Jaky)

Table 8: Test location summary table

Borehole	Surface RL (m AHD)[5]	Thickness of Sand (m)[4]	RL of Guildford Formation	Depth to Ground water (m BGL)	Borehole	Surface RL (m AHD)[5]	Thickness of Sand (m)[4]	RL of Guildford Formation	Depth to Ground water (m BGL)	Borehole	Surface RL (m AHD)[5]	Thickness of Sand (m)[4]	RL of Guildford Formation	Depth to Ground water (m BGL)
BH001	1.49	0.0	1.40	GNE	BH031	3.37	0.0	3.30	GNE	BH061	4.90	0.0	4.80	GNE
BH002	1.89	0.0	0.90	GNE	BH032	3.01	0.0	3.00	GNE	BH062	4.98	0.0	4.90	GNE
BH003	2.63	0.0	2.60	GNE	BH033	3.75	0.0	3.70	GNE	BH063	5.34	0.0	5.30	GNE
BH004	2.56	0.0	2.50	GNE	BH034	4.50	0.0	4.40	GNE	BH064	2.35	0.0	1.65	GNE
BH005	3.63	0.0	3.60	GNE	BH035	2.01	0.0	2.00	GNE	BH065	2.57	0.0	2.50	GNE
BH006	2.09	0.0	1.20	GNE	BH036	2.12	0.0	2.10	GNE	BH066	3.07	0.0	3.00	GNE
BH007	2.52	0.0	1.50	GNE	BH037	3.47	0.0	3.40	GNE	BH067	3.13	0.0	2.00	GNE
BH008	2.74	0.0	2.70	GNE	BH038	4.16	0.0	4.10	GNE	BH068	2.77	0.0	2.70	GNE
BH009	2.71	0.0	2.70	GNE	BH039	4.21	0.0	4.20	GNE	BH069	2.16	0.0	2.10	GNE
BH010	2.41	0.0	2.40	GNE	BH040	3.94	0.0	3.90	GNE	BH070	3.37	0.0	2.80	GNE
BH011	3.67	0.0	3.60	GNE	BH041	4.38	0.0	4.30	GNE	BH071	4.61	0.0	4.60	GNE
BH012	1.99	0.0	0.90	GNE	BH042	0.00	0.0	0.00	GNE	BH072	4.83	0.0	4.80	GNE
BH013	2.24	0.0	2.20	GNE	BH043	0.00	0.0	0.00	GNE	BH073	4.87	0.0	4.80	GNE
BH014	2.60	0.0	2.50	GNE	BH044	2.53	0.0	2.50	GNE	BH074	5.15	0.0	3.70	GNE
BH015	2.67	0.0	2.60	GNE	BH045	1.52	0.0	0.80	GNE	BH075	3.04	0.0	2.50	GNE
BH016	2.66	0.0	2.60	GNE	BH046	2.17	0.0	2.10	GNE	BH076	3.26	0.0	3.20	GNE
BH017	2.96	0.0	2.90	GNE	BH047	2.34	0.0	2.30	GNE	BH077	3.19	0.0	2.70	GNE
BH018	3.58	0.0	3.50	GNE	BH048	3.11	0.0	3.10	GNE	BH078	3.46	0.0	3.40	GNE
BH019	1.77	0.0	0.10	GNE	BH049	4.09	0.0	4.00	GNE	BH079	3.74	0.0	3.70	GNE
BH020	2.10	0.0	1.00	GNE	BH050	4.90	0.0	4.90	GNE	BH080	4.32	0.0	3.30	GNE
BH021	2.25	0.0	2.20	GNE	BH051	4.58	0.0	4.50	GNE	BH081	4.63	0.0	3.80	GNE
BH022	2.88	0.0	2.80	GNE	BH052	5.02	0.0	5.00	GNE	BH082	5.07	0.0	3.70	GNE
BH023	2.99	0.0	2.90	GNE	BH053	5.14	0.0	5.10	GNE	BH083	5.38	0.0	3.60	GNE
BH024	2.60	0.0	2.60	GNE	BH054	3.17	0.0	3.10	GNE	BH084	5.45	0.0	3.70	GNE
BH025	2.79	0.0	2.70	GNE	BH055	2.97	0.0	2.90	GNE	BH085	1.80	0.0	1.40	GNE
BH026	3.12	0.0	3.10	GNE	BH056	2.51	0.0	1.00	GNE	BH086	3.11	0.0	2.80	1.7
BH027	2.10	0.0	1.00	GNE	BH057	2.42	0.0	0.80	GNE	BH087	3.89	0.0	0.80	2.3
BH028	2.04	0.0	2.00	GNE	BH058	2.38	0.0	1.90	GNE	BH088	4.32	0.0	1.30	2.4
BH029	3.08	0.0	3.00	GNE	BH059	3.60	0.0	3.50	GNE	BH089	3.83	0.0	3.80	2.5[6]
BH030	3.74	0.0	3.70	GNE	BH060	4.92	0.0	4.90	GNE	BH090	3.89	0.0	3.80	2.6

NOTES:

1. *Cells highlighted in green indicate areas where at least 0.5 m of sand is present.*
2. *GNE: Groundwater not encountered.*
3. *Topsoil is not included as a discrete unit.*
4. *Thickness of sand is also depth to Guildford Formation below ground.*
5. *Surface RL is inferred from feature survey provided.*
6. *Monitoring well installed at this location was dry when dipped one week later.*

Borehole	Surface RL (m AHD)[5]	Thickness of Sand (m)[4]	RL of Guildford Formation	Depth to Ground water (m BGL)	Borehole	Surface RL (m AHD)[5]	Thickness of Sand (m)[4]	RL of Guildford Formation	Depth to Ground water (m BGL)
BH091	4.08	0.0	3.50	GNE	BH121	4.46	0.0	3.10	2.2
BH092	4.36	0.0	3.30	GNE	BH122	5.31	0.0	2.30	1.8
BH093	4.80	0.0	4.20	GNE	BH123	5.02	0.0	4.00	1.5
BH094	5.16	0.0	4.00	GNE	BH124	5.05	0.0	2.00	1.7
BH095	5.57	0.0	4.40	GNE	BH125	5.74	0.0	2.70	GNE
BH096	5.68	0.0	3.70	GNE	BH126	6.30	0.5	4.40	GNE
BH097	2.50	0.0	0.00	1.2	BH127	6.45	0.0	3.40	2.60[7]
BH098	4.27	0.0	3.40	2.6	BH128	7.41	3.0	4.40	GNE
BH099	5.14	0.0	2.10	GNE	BH129	8.37	3.0	5.30	GNE
BH100	4.96	0.0	1.90	GNE	BH130	3.43	0.0	3.40	1.0
BH101	4.57	0.0	1.50	GNE	BH131	3.95	0.0	3.90	2.0
BH102	4.27	0.0	2.90	GNE	BH132	4.98	0.0	3.90	GNE
BH103	4.33	0.0	3.00	GNE	BH133	5.11	2.0	2.10	1.5
BH104	4.97	0.0	3.90	GNE	BH135	6.33	3.0	3.30	GNE
BH105	5.34	0.0	3.30	GNE	BH136	3.60	0.0	2.80	2.5
BH106	5.95	0.0	3.80	GNE	BH137	3.40	0.0	2.70	GNE
BH107	6.31	0.0	3.30	GNE	BH138	3.40	0.0	2.30	GNE
BH108	3.35	0.0	3.35	GNE	BH139	3.15	0.0	2.85	2.0
BH109	3.99	0.0	3.90	2.7	BH140	3.76	0.0	2.90	0.37[7]
BH110	5.06	0.0	2.00	2.2	BH141	5.64	0.0	2.60	GNE
BH111	5.45	0.0	2.40	2.2	BH142	7.99	3.0	4.90	GNE
BH112	5.29	0.0	2.20	2.3	BH143	6.05	3.0[6]	3.00	GNE
BH113	4.83	0.0	4.80	2.0	BH144	6.80	3.0	3.80	GNE
BH114	4.43	0.0	3.40	2.6	BH145	8.00	3.0	4.90	GNE
BH115	5.32	0.0	4.40	GNE	BH146	9.47	3.0	6.40	GNE
BH116	5.88	0.0	2.80	GNE	BH147	9.97	1.3	6.90	GNE
BH117	6.73	2.0	3.70	GNE	BH148	3.10	0.0	3.00	GNE
BH118	7.05	3.0	4.00	GNE	BH149	4.27	0.0	4.20	GNE
BH119	3.10	0.0	1.5	GNE	BH150	4.34	0.0	1.30	2.0
BH120	3.61	0.0	3.60	2.2	BH151	2.80	0.0	1.80	1.8

NOTES:
1. *Cells highlighted in green indicate areas where at least 0.5 m of sand is present.*
2. *GNE: Groundwater not encountered.*
3. *Topsoil is not included as a discrete unit.*
4. *Thickness of sand is also depth to Guildford Formation below ground. Sand thickness greater than 3 m not assessed (maximum depth of investigation: 3 m)*
5. *Surface RL is inferred from feature survey provided.*
6. *BH143 appears to have about 0.5 m of clayey fill at surface over sand.*
7. *Water level shown was observed in monitoring well 1 week after installation (refer Table 5)*

10. GEOTECHNICAL ASSESSMENT

10.1. Summary

Table 9: Summary of Geotechnical Assessment

Type	Clause	Parameter	Comment
Site Suitability	-	-	We consider the site to be geotechnically suitable for the proposed development. Standard site preparation measures will apply. Filling is required to raise the northern and western parts of the site above design flood and groundwater levels.
Site Classification (AS2870)	GDR5	A to M	Where thickness of sand fill and / insitu sand over Guildford Formation is: • No less than 1.8 m thick, Class A • No less than 0.6 m thick, Class S • Less than 0.6 m thick, Class M
Site Subsoil Class (AS1170.4)	-	Ce	-
Site Preparation	GDR6	-	**GDR6.2.1 Common Measures** followed by **GDR6.2.2 Sand Sites.** Where clayey soils are encountered and/or fill using stockpiled clayey soil is required, refer to **GDR6.2.4 Clayey Sites.** Attention is drawn to the need to control water during rain periods, as discussed in **GDR14 Drainage Control.** Further Construction recommendations are presented in Section 10.2.
Footing Preparation and Testing	GDR6.4	-	Refer to GDR6.4.2 Footings in Clay which specifies DCP testing is requirements at the base of footings founded within clay soils. A minimum DCP blow count of 2 blows per 100 mm will indicate that the clay has sufficient shear strength to support the proposed lightly loaded footings.
Topsoil Strip	GDR6.2.1	Thickness of 50 mm to 200 mm	-
Compaction Control	GDR7	-	A PSP may be used for compaction control on Sand with no more than 5% fines. Deemed to comply value for 'Bassendean' sand in GDR7.4 are applicable. In other areas where fines are greater than 5%, a nuclear density gauge shall be used GDR 7.3
Approved Fill	GDR8	-	Approved fill at this site is to comprise **either Permeable Sand, (**where stormwater disposal is required) **or General Sand** (if stormwater disposal is **not** required) as per GDR8 Approved Fill and Conformance Testing. Permeability, **site drainage and potential for perched groundwater must be considered when selecting fill materials**.
Stormwater Disposal	GDR13	-	Generally not suitable for the site in its current condition (Refer Section 10.2.3).
Earth Pressure Coefficients	GDR11	Refer parameters in Section 9	Earth pressure coefficients can be used for the generalised subsurface units presented in Table 7.
Excavations, batters and slopes	GDR12	1V:2H (temporary) 1V:3H (permanent)	Excavator (12 tonne or greater) generally suitable to remove in situ soils to be about 3 m depth. Presence of possible cemented layers and possible buried elements (soakwells, footings, etc.) must be considered when selecting earthmoving plant. The batter angles given are for slopes up to 2 m high which are above groundwater. Refer to **GDR12 Excavations, Batters and Slopes** for more information.
Pavement Subgrades	GDR16	-	Subject to subgrade preparation as stated above: - CBR of 3% for poorly drained clay subgrades; - CBR of 5% Well drained clay subgrades (***drainage may be difficult to achieve***); - CBR of 10% for subgrades overlain by no less than 0.4 m of insitu sand or approved sand fill.

NOTES: ***1.*** *q_{all} – allowable bearing pressure (maximum for all footings, refer to footing tables for further details)*

10.2. Construction Recommendations

10.2.1. Separation of soil during excavation

Based on the results of the investigation, the sand is likely to grade into clayey soils at least in some parts of the site. Care should be taken to not "mix" material from different depths during excavation.

On this basis, we recommend that bulk excavations are done using scrapers or loaders where possible, separating the sand into stockpiles of about 0.5 m stripped thickness. Geotechnical inspection and laboratory testing (percentage fines) must be done prior to re-use of this material.

Additionally, care should be taken to not mix visually different materials without testing (e.g, the grey sand and yellow sand, and clayey soils). All visually different material should be segregated during earthworks and assessed by a geotechnical engineer. Laboratory testing could also possibly be required.

10.2.2. Drainage control and clay grading

Underlying clay layers must be graded to drain and prevent perching or ponding of water (Refer **GDR14 Drainage Control).** We assume that clay grading will not be done in the southeast corner of the site and we note that the clay elevations indicated in Figure 2A are inaccurate in the magenta hatched area, because this represents the bottom of the test depth (3 m), where sand was still present and clay had not yet been encountered.

10.2.3. Stormwater Disposal

Stormwater disposal is generally not suitable at the site in its current condition due to the typically clay/clayey subsurface profile.

The sand encountered in most locations is not considered to be free draining. However, sand in BH118, BH128, BH129 and BH145 is judged to be free draining, with less than about 5 % fines. We recommend that in situ infiltration testing is done at finished cut level to confirm the design permeability of surficial sand / sand fill. All material described as 'sand' (not clayey sand) may be considered suitable to improve site classification to AS2870.

10.2.4. Potential for uncontrolled fill.

Area of scattered rubbish were observed on site, in the southeastern part of the site (refer Figure 1). There is a risk that some deleterious material have been buried in this area by vehicle traffic. Scattered rubbish must be removed from site.

10.2.5. Existing stockpiles

Various stockpiles of soil were observed to be present in the southern portion of the site (refer Figure 1). Stockpiles must be assessed to inform whether they can be reused at the site. From discussions with the civil engineer for the project, we understand that the soils contained in the stockpile are generally clayey and therefore should only be used as fill where improvement to site classification is not required.

10.2.6. Further Investigation of Potential Soft Soils

If earthworks uncover potential soft soils (nothing specific was noted during our study, although we did not assess soil consistency at depth), we recommend that delineation and testing be done to assess the potential impact for the finished development, in particular potential consolidation settlement of any weak, soft clayey soils.

11. PRELIMINARY ACID SULFATE SOIL ASSESSMENT FOR ROS AREA

11.1. Assessment Criteria

Soil samples for the ASS study were collected from the boreholes in accordance with the following guidelines and Australian Standards:

- Department of Environmental Regulation (DER) (2015) Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes.

A small portion of each soil sample was tested for pH before (pH_F) and after (pH_{FOX}) rapid oxidation with hydrogen peroxide (H_2O_2). The samples were then placed in an ice chilled cooler until submission to the laboratory for chromium reducible sulfur (CRS) analysis.

Samples with field pH values (pH_F) of <3 to 4 indicate the presence of ASS, thus indicating acids in the soil profile have oxidised.

The presence of unoxidized acids or potential acid sulfate soil (PASS) is indicated if:

- a strong reaction with hydrogen peroxide is observed;
- the pH_{FOX} is at least 1 pH unit below pH_F; or
- the pH_{FOX} is <3 to 4 and one or both of the above conditions apply.

The texture based net acidity action criteria presented in the DER (2015) *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* guideline document specifies a value of 0.03 %S based on the anticipated volume of soil to be disturbed being greater than 1,000 tonnes. This value has been adopted for the assessment of net acidity in soils across the site.

11.2. Results

The results are summarised in Table 10 below and field testing results are presented in Appendix D.

Table 10: Summary of Soil Field Results

Field pHf range	Field pHfox range	pH change	Maximum Net Acidity (%S)
5.0 – 8.1	2.5 – 6.4	-0.1 – 4.4	<0.02 – 0.14

During field testing 42 samples displayed a low reaction rate, 3 sample displayed a medium reaction rate, and 5 samples displayed a high reaction rate.

Confirmatory CRS analysis results indicate that the net acidity in all samples from the surface to a depth of 2.0 m are classified as non-acid sulfate soils (NASS). Samples from 2.0 m to the maximum depth of investigation had net acidity values ranging from <0.02 %S to 0.14 %S. As such, material from 2.0 m to the maximum depth of the investigation are classified as ASS.

All results and laboratory certificates of analysis are presented in Appendix D.

11.3. Summary

Based on the results of the preliminary ASS study, material from the surface to a depth of 2.0 m is classified as NASS and does not require any further treatment or management if this material is reused. Material from below 2.0 m is classified as ASS and will require treatment if it is reused. We do not anticipate any re-use of material from the ROS given that sufficiently sandy soils were not identified during the study.

We note that this preliminary ASS investigation aimed to characterise potential borrow material within the ROS only. As such, no assessment of areas requiring excavation for civil construction i.e. sewer has been undertaken. If excavation into natural soils is required for any aspect of construction, we recommend that a targeted ASS and groundwater study be undertaken.

12. CLOSURE

GALT GEOTECHNICS





Owen Woodland CPEng
Geotechnical Engineer

Tyrone Mardesic CPEng
Geotechnical Engineer

Attached Table 1: Summary of Geotechnical Index Test Results

Test Name	Sample Depth (m)	Soil Class (AS1726 2017)	Gravel (%)	Sand (%)	Fines (%)	LL (%)	PI (%)	LS (%)	MMDD (t/m^3)	OMC (%)	CBR (%)	CBR Swell (%)
BH003	0.15 – 0.50	Clayey SAND (SC)	4	62	34	29	13	7.5	-	-	-	-
BH010	0.20 – 0.60	Clayey SAND (SC)	25	52	23	19	4	2.0	2.09	9.0	25.0	0.0
BH045	0.30 – 0.65	Clayey SAND (SC)	5	64	31	-	-	-	-	-	-	-
BH051	1.10 – 1.60	Sandy CLAY (CI-CH)	5	53	42	-	-	-	-	-	-	-
BH057	0.40 – 0.70	Clayey SAND (SC)	8	69	23	-	-	-	-	-	-	-
BH073	0.10 – 0.60	Clayey SAND (SC)	23	47	30	33	18	8.5	1.94	13.0	3.5	0.5
BH075	0.60 – 1.00	Clayey SAND (SC)	13	56	31	-	-	-	-	-	-	-
BH076	0.10 – 0.60	Sandy CLAY (CH)	9	30	61	71	51	20.0	1.80	16.0	3.0[5]	2.0
BH081	0.30 – 0.50	Sandy CLAY (CI-CH)	6	59	35	-	-	-	-	-	-	-
BH083	0.30 – 0.50	Clayey SAND (SC)	4	67	29	-	-	-	-	-	-	-
BH095	0.50 – 0.70	Clayey SAND (SC)	7	77	16	-	-	-	-	-	-	-
BH096	0.10 – 0.50	Clayey SAND (SC)	0	66	34	23	8	4.0	1.90	12.0	15.0	0.0
BH101	1.00 – 1.30	Clayey SAND (SC)	0	80	20	-	-	-	-	-	-	-
BH102	0.10 – 0.60	Clayey SAND (SC)	7	59	34	41	26	12.0	2.01	10.0	6.0	0.5
BH107	1.50 – 2.00	Clayey SAND (SC)	0	81	19	-	-	-	-	-	-	-
BH109	1.00 – 1.30	Clayey SAND (SC)	5	63	32	44	25	11.5	-	-	-	-
BH116	0.80 – 1.10	Sandy CLAY (CI-CH)	1	58	41	-	-	-	-	-	-	-
BH118	1.00 – 1.30	SAND (SP)	0	95	5	-	-	-	-	-	-	-
BH123	2.50 – 3.00	Sandy CLAY (CI-CH)	4	61	35	35	20	10.0	-	-	-	-
BH127	1.50 – 1.70	Clayey SAND (SC)	3	77	20	-	-	-	-	-	-	-
BH131	0.50 – 0.80	Clayey SAND (SC)	5	61	34	-	-	-	-	-	-	-
BH133	1.00 – 1.30	SAND (SP-SC)	0	91	9	-	-	-	-	-	-	-
BH139	0.10 – 0.60	SAND (SP-SC)	0	89	11	NO	NP	0.5	1.85	13.5	25.0	0.0
BH142	1.50 – 1.70	SAND (SP-SC)	1	89	10	-	-	-	-	-	-	-
BH145	0.50 – 1.00	SAND (SP)	0	97	3	-	-	-	-	-	-	-
BH148	0.20 – 0.40	Clayey SAND (SC)	1	75	24	-	-	-	-	-	-	-
BH148	1.80 – 2.00	Clayey SAND (SC)	4	67	29	34	16	9.0	-	-	-	-

Notes

1. *Particle size distribution (by mass): Gravel: 2.36 mm to 63 mm, Sand: 0.075 mm to 2.36 mm, and Fines: <0.075 mm.*
2. *Atterberg Limits: LL: Liquid limit, PI: Plasticity index, LS: Linear shrinkage, NO: Not obtainable, and NP: Non-plastic.*
3. *Modified compaction: MMDD: Modified maximum dry density, and OMC: Optimum moisture content.*
4. *CBR: California bearing ratio: Remoulding dry density ratio typically 94% to 95% MMDD ([5]**92.5% of MMDD in BH076 due to higher swell**), Surcharge: 4.5 kg, and Soaking: 4-day soaked.*

Figures





Legend

- Site Boundary
- Lots and Roads: 198136.61 m²
- POS and ROS: 49227.04 m²
- Borehole
- Rubbish Present in these Areas
- Soil Stockpiles

N

0 40 80 120 160 200
Meters

NOTES

Aerial Imagery and Cadastre sourced from Landgate/SLIP

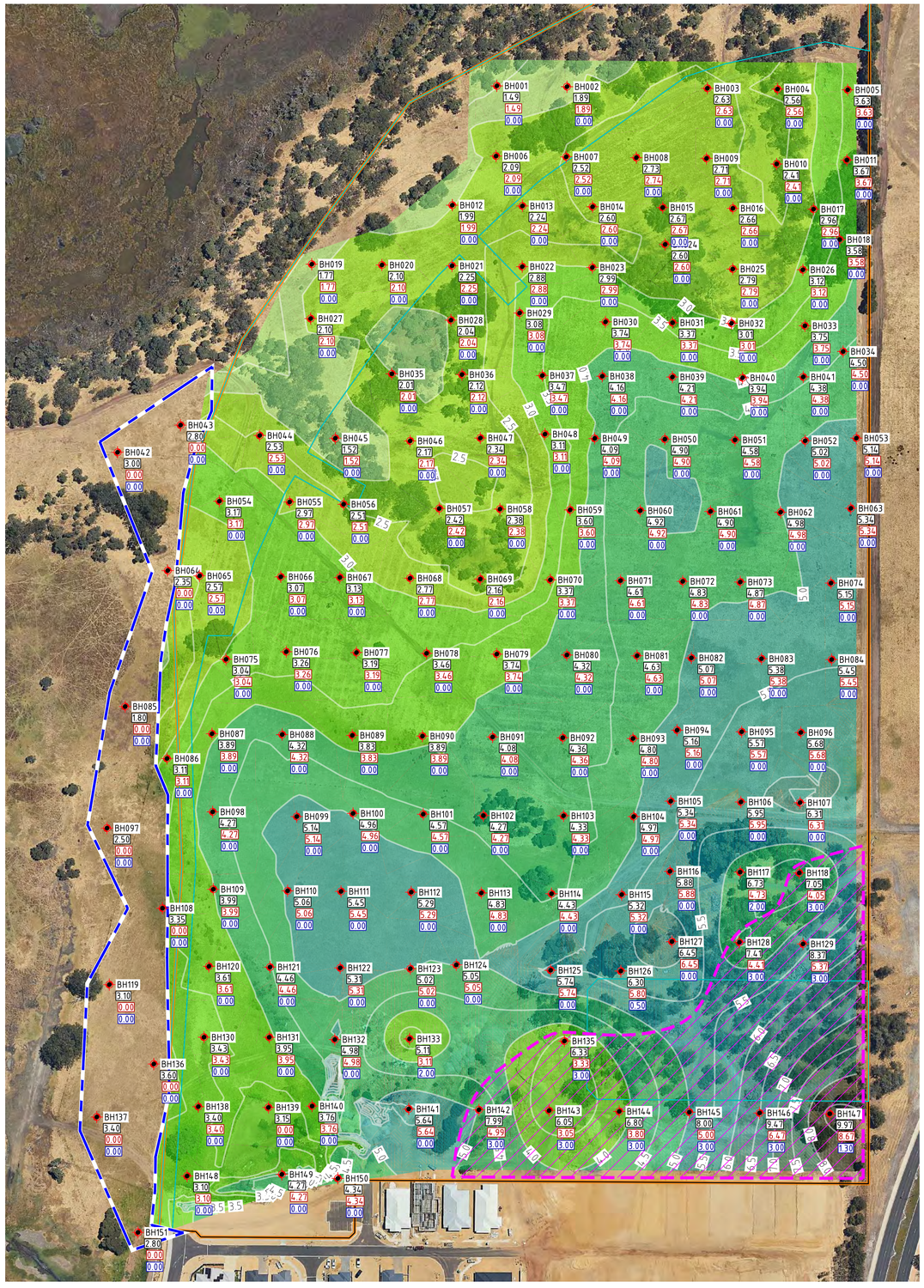


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DATE DRAWN	27/06/2025	
CHECKED	KS	
DATE CHECKED	27/06/2025	
PROJECTION	GDA 1994 MGA Zone 50	

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CLIENT	**EDGELOE ENGINEERING**
PROJECT	PARKRIDGE ESTATE
LOCATION	EATON
TITLE	SITE & LOCATION PLAN
Job No	WAG190133-04
Fig No	FIGURE 1
Rev	A



Borehole	PCG_E	PCG_N	RL	Thickness of Sand	Top of Clayey Soils
BH001	41668.8	114579.3	1.49	0.0	1.49
BH002	41700.0	114570.9	1.89	0.0	1.89
BH003	41788.8	114578.0	2.63	0.0	2.63
BH004	41828.9	114577.5	2.56	0.0	2.56
BH005	41868.9	114577.1	3.63	0.0	3.63
BH006	41668.4	114539.3	2.09	0.0	2.09
BH007	41708.4	114538.9	2.52	0.0	2.52
BH008	41748.4	114538.4	2.74	0.0	2.74
BH009	41788.4	114538.0	2.71	0.0	2.71
BH010	41828.4	114534.8	2.41	0.0	2.41
BH011	41868.4	114537.1	3.67	0.0	3.67
BH012	41643.4	114511.3	1.99	0.0	1.99
BH013	41683.4	114510.9	2.24	0.0	2.24
BH014	41723.4	114510.4	2.60	0.0	2.60
BH015	41763.4	114510.0	2.67	0.0	2.67
BH016	41803.4	114509.5	2.66	0.0	2.66
BH017	41849.4	114509.0	2.96	0.0	2.96
BH018	41864.3	114491.7	3.58	0.0	3.58
BH019	41563.3	114477.6	1.77	0.0	1.77
BH020	41603.3	114477.2	2.10	0.0	2.10
BH021	41643.3	114476.7	2.25	0.0	2.25
BH022	41683.3	114476.3	2.88	0.0	2.88
BH023	41723.3	114475.8	2.99	0.0	2.99
BH024	41764.8	114488.9	2.60	0.0	2.60
BH025	41803.3	114474.9	2.79	0.0	2.79
BH026	41843.3	114474.5	3.12	0.0	3.12
BH027	41562.6	114446.7	2.10	0.0	2.10
BH028	41642.6	114445.8	2.04	0.0	2.04
BH029	41681.8	114449.8	3.08	0.0	3.08
BH030	41730.8	114444.8	3.74	0.0	3.74
BH031	41769.0	114444.3	3.37	0.0	3.37
BH032	41802.7	114443.9	3.01	0.0	3.01
BH033	41844.5	114442.6	3.75	0.0	3.75
BH034	41866.3	114427.9	4.50	0.0	4.50
BH035	41608.9	114415.2	2.01	0.0	2.01
BH036	41648.9	114414.7	2.12	0.0	2.12
BH037	41694.7	114414.2	3.47	0.0	3.47
BH038	41728.9	114413.8	4.16	0.0	4.16
BH039	41768.9	114413.3	4.21	0.0	4.21
BH040	41808.9	114412.9	3.94	0.0	3.94
BH041	41843.5	114413.4	4.38	0.0	4.38
BH042	41452.5	114370.4	3.00	0.0	3.00
BH043	41488.4	114385.9	2.80	0.0	2.80
BH044	41533.6	114380.0	2.53	0.0	2.53
BH045	41576.7	114378.4	1.52	0.0	1.52
BH046	41619.4	114376.9	2.17	0.0	2.17
BH047	41659.4	114378.6	2.34	0.0	2.34
BH048	41696.3	114380.8	3.11	0.0	3.11
BH049	41724.6	114378.3	4.09	0.0	4.09
BH050	41764.6	114377.9	4.90	0.0	4.90

Borehole	PCG_E	PCG_N	RL	Thickness of Sand	Top of Clayey Soils
BH051	41804.6	114377.4	4.58	0.0	4.58
BH052	41844.6	114377.0	5.02	0.0	5.02
BH053	41873.8	114378.5	5.14	0.0	5.14
BH054	41510.6	114342.6	3.17	0.0	3.17
BH055	41550.6	114342.1	2.97	0.0	2.97
BH056	41581.4	114340.8	2.51	0.0	2.51
BH057	41636.0	114338.3	2.42	0.0	2.42
BH058	41670.6	114338.0	2.38	0.0	2.38
BH059	41710.6	114337.6	3.60	0.0	3.60
BH060	41750.6	114337.1	4.92	0.0	4.92
BH061	41790.6	114336.7	4.90	0.0	4.90
BH062	41830.6	114336.2	4.98	0.0	4.98
BH063	41870.7	114338.5	5.34	0.0	5.34
BH064	41481.1	114303.0	2.35	0.0	2.35
BH065	41499.3	114300.0	2.57	0.0	2.57
BH066	41545.6	114299.4	3.07	0.0	3.07
BH067	41579.3	114299.1	3.13	0.0	3.13
BH068	41619.3	114298.6	2.77	0.0	2.77
BH069	41659.3	114298.2	2.16	0.0	2.16
BH070	41699.3	114297.7	3.37	0.0	3.37
BH071	41739.3	114297.3	4.61	0.0	4.61
BH072	41774.8	114296.8	4.83	0.0	4.83
BH073	41807.6	114296.5	4.87	0.0	4.87
BH074	41859.4	114295.9	5.15	0.0	5.15
BH075	41514.4	114252.4	3.04	0.0	3.04
BH076	41548.7	114256.7	3.26	0.0	3.26
BH077	41588.7	114256.2	3.19	0.0	3.19
BH078	41628.8	114255.8	3.46	0.0	3.46
BH079	41668.8	114255.3	3.74	0.0	3.74
BH080	41708.8	114254.9	4.32	0.0	4.32
BH081	41748.8	114254.4	4.63	0.0	4.63
BH082	41779.7	114253.2	5.07	0.0	5.07
BH083	41819.8	114252.7	5.38	0.0	5.38
BH084	41859.8	114252.3	5.45	0.0	5.45
BH085	41456.8	114225.5	1.80	0.0	1.80
BH086	41480.7	114195.8	3.11	0.0	3.11
BH087	41506.4	114209.9	3.89	0.0	3.89
BH088	41546.4	114209.5	4.32	0.0	4.32
BH089	41586.4	114209.0	3.83	0.0	3.83
BH090	41626.4	114208.6	3.89	0.0	3.89
BH091	41666.4	114208.1	4.08	0.0	4.08
BH092	41706.4	114207.7	4.36	0.0	4.36
BH093	41746.4	114207.2	4.80	0.0	4.80
BH094	41771.6	114212.0	5.16	0.0	5.16
BH095	41808.5	114211.0	5.57	0.0	5.57
BH096	41842.1	114210.6	5.68	0.0	5.68
BH097	41446.5	114156.1	2.50	0.0	2.50
BH098	41506.8	114165.4	4.27	0.0	4.27
BH099	41554.7	114162.8	5.14	0.0	5.14
BH100	41586.8	114164.5	4.96	0.0	4.96

Borehole	PCG_E	PCG_N	RL	Thickness of Sand	Top of Clayey Soils
BH101	41626.8	114164.1	4.57	0.0	4.57
BH102	41661.1	114163.3	4.27	0.0	4.27
BH103	41706.8	114163.1	4.33	0.0	4.33
BH104	41746.8	114162.7	4.97	0.0	4.97
BH105	41768.0	114171.5	5.34	0.0	5.34
BH106	41808.0	114171.0	5.95	0.0	5.95
BH107	41841.7	114170.6	6.31	0.0	6.31
BH108	41478.2	114110.5	3.35	0.0	3.35
BH109	41507.1	114121.3	3.99	0.0	3.99
BH110	41549.5	114120.4	5.06	0.0	5.06
BH111	41580.0	114120.1	5.45	0.0	5.45
BH112	41620.0	114119.6	5.29	0.0	5.29
BH113	41660.0	114119.2	4.83	0.0	4.83
BH114	41700.0	114118.7	4.43	0.0	4.43
BH115	41740.0	114118.2	5.32	0.0	5.32
BH116	41767.5	114131.5	5.88	0.0	5.88
BH117	41807.5	114131.0	6.73	2.0	4.73
BH118	41841.2	114130.6	7.05	3.0	4.05
BH119	41447.8	114066.9	3.10	0.0	3.10
BH120	41504.6	114077.3	3.61	0.0	3.61
BH121	41539.5	114076.9	4.46	0.0	4.46
BH122	41579.5	114076.4	5.31	0.0	5.31
BH123	41619.5	114076.0	5.02	0.0	5.02
BH124	41645.7	114078.1	5.05	0.0	5.05
BH125	41699.5	114075.1	5.74	0.0	5.74
BH126	41739.5	114074.6	6.30	0.5	5.80
BH127	41768.7	114091.4	6.45	0.0	6.45
BH128	41807.1	114091.0	7.41	3.0	4.41
BH129	41843.4	114090.1	8.37	3.0	5.37
BH130	41501.8	114036.9	3.43	0.0	3.43
BH131	41539.0	114036.9	3.95	0.0	3.95
BH132	41576.4	114035.6	4.98	0.0	4.98
BH133	41619.0	114036.0	5.11	2.0	3.11
BH135	41707.3	114034.7	6.33	3.0	3.33
BH136	41473.2	114021.6	3.60	0.0	3.60
BH137	41440.7	113991.4	3.40	0.0	3.40
BH138	41498.6	113997.3	3.40	0.0	3.40
BH139	41538.6	113996.9	3.15	0.0	3.15
BH140	41563.5	113997.6	3.76	0.0	3.76
BH141	41618.6	113996.0	5.64	0.0	5.64
BH142	41658.6	113995.5	7.99	3.0	4.99
BH143	41698.6	113995.1	6.05	3.0	3.05
BH144	41738.6	113994.6	6.80	3.0	3.80
BH145	41778.6	113994.2	8.00	3.0	5.00
BH146	41818.6	113993.7	9.47	3.0	6.47
BH147	41858.6	113993.3	9.97	1.3	8.67
BH148	41492.2	113957.8	3.10	0.0	3.10
BH149	41546.2	113958.7	4.27	0.0	4.27
BH150	41578.1	113956.4	4.34	0.0	4.34
BH151	41464.2	113925.6	2.80	0.0	2.80

NOTE: SURFICIAL LAYER OF CLAYEY FILL ABOUT 0.5 m THICK OBSERVED AT BH143

LEGEND

- SITE BOUNDARY
- ZONE WHERE SAND ENCOUNTERED AT TERMINATION OF DRILLHOLE (>3m)
- ALL ELEVATIONS OF TEST LOCATIONS IN THIS AREA ARE ASSUMED (OUTSIDE PROVIDED SURVEY)
- POS AND ROS

BH045 BOREHOLE
1.52 ELEVATION (mAHD)
1.52 ELEVATION OF CLAY (mAHD)
0.00 DEPTH OF SAND (m)

CLAY ELEVATION CONTOURS (mAHD)	
Range	Colour
0.00 - 1.00	
1.00 - 2.00	
2.00 - 3.00	
3.00 - 4.00	
4.00 - 5.00	
5.00 - 6.00	
6.00 - 7.00	
7.00 - 8.00	
8.00 - 9.00	

0 20 40 50 75 100
HORIZONTAL SCALE (m)

REV	REVISION DESCRIPTION	DATE	CHK

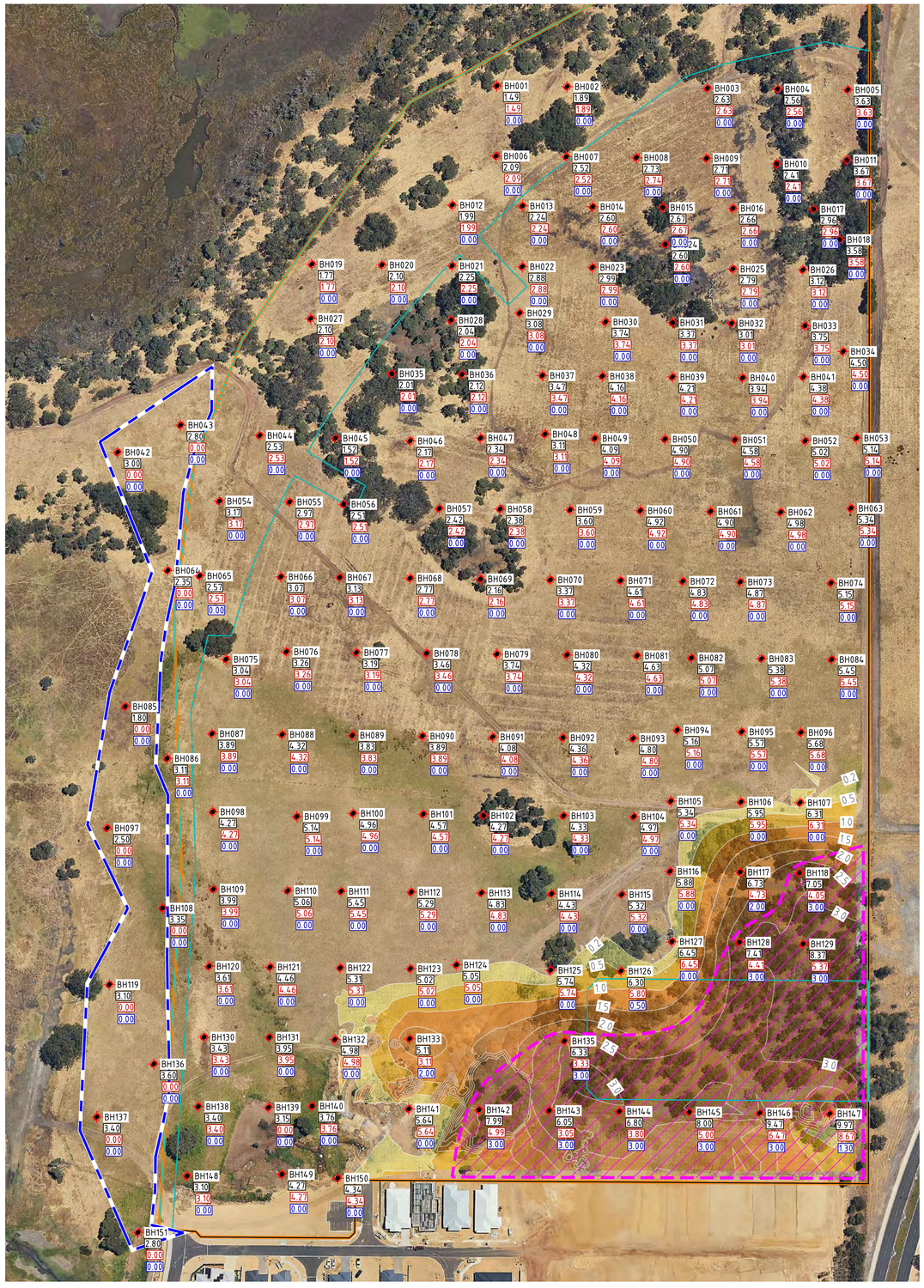
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DATE DRAWN 27/06/2025
CHECKED ORW
DATE CHECKED 27/06/2025

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CLIENT EDGELOE ENGINEERING
PROJECT PARKRIDGE ESTATE
LOCATION EATON
TITLE ELEVATION OF CLAY LAYER
JOB NO. WAG190133-04
FIGURE FIGURE 2A

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Borehole	PCG_E	PCG_N	RL	Thickness of Sand	Top of Clayey Soils
BH001	41668.8	114579.3	1.49	0.0	1.49
BH002	41700.0	114570.9	1.89	0.0	1.89
BH003	41788.8	114578.0	2.63	0.0	2.63
BH004	41828.9	114577.5	2.56	0.0	2.56
BH005	41868.9	114577.1	3.63	0.0	3.63
BH006	41668.4	114539.3	2.09	0.0	2.09
BH007	41708.4	114538.9	2.52	0.0	2.52
BH008	41748.4	114538.4	2.74	0.0	2.74
BH009	41788.4	114538.0	2.71	0.0	2.71
BH010	41828.4	114534.8	2.41	0.0	2.41
BH011	41868.4	114537.1	3.67	0.0	3.67
BH012	41643.4	114511.3	1.99	0.0	1.99
BH013	41683.4	114510.9	2.24	0.0	2.24
BH014	41723.4	114510.4	2.60	0.0	2.60
BH015	41763.4	114510.0	2.67	0.0	2.67
BH016	41803.4	114509.5	2.66	0.0	2.66
BH017	41849.4	114509.0	2.96	0.0	2.96
BH018	41864.3	114491.7	3.58	0.0	3.58
BH019	41563.3	114477.6	1.77	0.0	1.77
BH020	41603.3	114477.2	2.10	0.0	2.10
BH021	41643.3	114476.7	2.25	0.0	2.25
BH022	41683.3	114476.3	2.88	0.0	2.88
BH023	41723.3	114475.8	2.99	0.0	2.99
BH024	41764.8	114488.9	2.60	0.0	2.60
BH025	41803.3	114474.9	2.79	0.0	2.79
BH026	41843.3	114474.5	3.12	0.0	3.12
BH027	41562.6	114446.7	2.10	0.0	2.10
BH028	41642.6	114445.8	2.04	0.0	2.04
BH029	41681.8	114449.8	3.08	0.0	3.08
BH030	41730.8	114444.8	3.74	0.0	3.74
BH031	41769.0	114444.3	3.37	0.0	3.37
BH032	41802.7	114443.9	3.01	0.0	3.01
BH033	41844.5	114442.6	3.75	0.0	3.75
BH034	41866.3	114427.9	4.50	0.0	4.50
BH035	41608.9	114415.2	2.01	0.0	2.01
BH036	41648.9	114414.7	2.12	0.0	2.12
BH037	41694.7	114414.2	3.47	0.0	3.47
BH038	41728.9	114413.8	4.16	0.0	4.16
BH039	41768.9	114413.3	4.21	0.0	4.21
BH040	41808.9	114412.9	3.94	0.0	3.94
BH041	41843.5	114413.4	4.38	0.0	4.38
BH042	41452.5	114370.4	3.00	0.0	3.00
BH043	41488.4	114385.9	2.80	0.0	2.80
BH044	41533.6	114380.0	2.53	0.0	2.53
BH045	41576.7	114378.4	1.52	0.0	1.52
BH046	41619.4	114376.9	2.17	0.0	2.17
BH047	41659.4	114378.6	2.34	0.0	2.34
BH048	41696.3	114380.8	3.11	0.0	3.11
BH049	41724.6	114378.3	4.09	0.0	4.09
BH050	41764.6	114377.9	4.90	0.0	4.90

Borehole	PCG_E	PCG_N	RL	Thickness of Sand	Top of Clayey Soils
BH051	41804.6	114377.4	4.58	0.0	4.58
BH052	41844.6	114377.0	5.02	0.0	5.02
BH053	41873.8	114378.5	5.14	0.0	5.14
BH054	41510.6	114342.6	3.17	0.0	3.17
BH055	41550.6	114342.1	2.97	0.0	2.97
BH056	41581.4	114340.8	2.51	0.0	2.51
BH057	41636.0	114338.3	2.42	0.0	2.42
BH058	41670.6	114338.0	2.38	0.0	2.38
BH059	41710.6	114337.6	3.60	0.0	3.60
BH060	41750.6	114337.1	4.92	0.0	4.92
BH061	41790.6	114336.7	4.90	0.0	4.90
BH062	41830.6	114336.2	4.98	0.0	4.98
BH063	41870.7	114338.5	5.34	0.0	5.34
BH064	41481.1	114303.0	2.35	0.0	2.35
BH065	41499.3	114300.0	2.57	0.0	2.57
BH066	41545.6	114299.4	3.07	0.0	3.07
BH067	41579.3	114299.1	3.13	0.0	3.13
BH068	41619.3	114298.6	2.77	0.0	2.77
BH069	41659.3	114298.2	2.16	0.0	2.16
BH070	41699.3	114297.7	3.37	0.0	3.37
BH071	41739.3	114297.3	4.61	0.0	4.61
BH072	41774.8	114296.8	4.83	0.0	4.83
BH073	41807.6	114296.5	4.87	0.0	4.87
BH074	41859.4	114295.9	5.15	0.0	5.15
BH075	41514.4	114252.4	3.04	0.0	3.04
BH076	41548.7	114256.7	3.26	0.0	3.26
BH077	41588.7	114256.2	3.19	0.0	3.19
BH078	41628.8	114255.8	3.46	0.0	3.46
BH079	41668.8	114255.3	3.74	0.0	3.74
BH080	41708.8	114254.9	4.32	0.0	4.32
BH081	41748.8	114254.4	4.63	0.0	4.63
BH082	41779.7	114253.2	5.07	0.0	5.07
BH083	41819.8	114252.7	5.38	0.0	5.38
BH084	41859.8	114252.3	5.45	0.0	5.45
BH085	41456.8	114225.5	1.80	0.0	1.80
BH086	41480.7	114195.8	3.11	0.0	3.11
BH087	41506.4	114209.9	3.89	0.0	3.89
BH088	41546.4	114209.5	4.32	0.0	4.32
BH089	41586.4	114209.0	3.83	0.0	3.83
BH090	41626.4	114208.6	3.89	0.0	3.89
BH091	41666.4	114208.1	4.08	0.0	4.08
BH092	41706.4	114207.7	4.36	0.0	4.36
BH093	41746.4	114207.2	4.80	0.0	4.80
BH094	41771.6	114212.0	5.16	0.0	5.16
BH095	41808.5	114211.0	5.57	0.0	5.57
BH096	41842.1	114210.6	5.68	0.0	5.68
BH097	41446.5	114156.1	2.50	0.0	2.50
BH098	41506.8	114165.4	4.27	0.0	4.27
BH099	41554.7	114162.8	5.14	0.0	5.14
BH100	41586.8	114164.5	4.96	0.0	4.96

Borehole	PCG_E	PCG_N	RL	Thickness of Sand	Top of Clayey Soils
BH101	41626.8	114164.1	4.57	0.0	4.57
BH102	41661.1	114163.3	4.27	0.0	4.27
BH103	41706.8	114163.1	4.33	0.0	4.33
BH104	41746.8	114162.7	4.97	0.0	4.97
BH105	41768.0	114171.5	5.34	0.0	5.34
BH106	41808.0	114171.0	5.95	0.0	5.95
BH107	41841.7	114170.6	6.31	0.0	6.31
BH108	41478.2	114110.5	3.35	0.0	3.35
BH109	41507.1	114121.3	3.99	0.0	3.99
BH110	41549.5	114120.4	5.06	0.0	5.06
BH111	41580.0	114120.1	5.45	0.0	5.45
BH112	41620.0	114119.6	5.29	0.0	5.29
BH113	41660.0	114119.2	4.83	0.0	4.83
BH114	41700.0	114118.7	4.43	0.0	4.43
BH115	41740.0	114118.2	5.32	0.0	5.32
BH116	41767.5	114131.5	5.88	0.0	5.88
BH117	41807.5	114131.0	6.73	2.0	4.73
BH118	41841.2	114130.6	7.05	3.0	4.05
BH119	41447.8	114066.9	3.10	0.0	3.10
BH120	41504.6	114077.3	3.61	0.0	3.61
BH121	41539.5	114076.9	4.46	0.0	4.46
BH122	41579.5	114076.4	5.31	0.0	5.31
BH123	41619.5	114076.0	5.02	0.0	5.02
BH124	41645.7	114078.1	5.05	0.0	5.05
BH125	41699.5	114075.1	5.74	0.0	5.74
BH126	41739.5	114074.6	6.30	0.5	5.80
BH127	41768.7	114091.4	6.45	0.0	6.45
BH128	41807.1	114091.0	7.41	3.0	4.41
BH129	41843.4	114090.1	8.37	3.0	5.37
BH130	41501.8	114036.9	3.43	0.0	3.43
BH131	41539.0	114036.9	3.95	0.0	3.95
BH132	41576.4	114035.6	4.98	0.0	4.98
BH133	41619.0	114036.0	5.11	2.0	3.11
BH135	41707.3	114034.7	6.33	3.0	3.33
BH136	41473.2	114021.6	3.60	0.0	3.60
BH137	41440.7	113991.4	3.40	0.0	3.40
BH138	41498.6	113997.3	3.40	0.0	3.40
BH139	41538.6	113996.9	3.15	0.0	3.15
BH140	41563.5	113997.6	3.76	0.0	3.76
BH141	41618.6	113996.0	5.64	0.0	5.64
BH142	41658.6	113995.5	7.99	3.0	4.99
BH143	41698.6	113995.1	6.05	3.0	3.05
BH144	41738.6	113994.6	6.80	3.0	3.80
BH145	41778.6	113994.2	8.00	3.0	5.00
BH146	41818.6	113993.7	9.47	3.0	6.47
BH147	41858.6	113993.3	9.97	1.3	8.67
BH148	41492.2	113957.8	3.10	0.0	3.10
BH149	41546.2	113958.7	4.27	0.0	4.27
BH150	41578.1	113956.4	4.34	0.0	4.34
BH151	41464.2	113925.6	2.80	0.0	2.80

NOTE: SURFICIAL LAYER OF CLAYEY FILL ABOUT 0.5 m THICK OBSERVED AT BH143

LEGEND

- SITE BOUNDARY
- ZONE WHERE SAND ENCOUNTERED AT TERMINATION OF DRILLHOLE (>3m)
- ALL ELEVATIONS OF TEST LOCATIONS IN THIS AREA ARE ASSUMED (OUTSIDE PROVIDED SURVEY)
- POS AND ROS

BH045 BOREHOLE
1.52 ELEVATION (mAHD)
1.52 ELEVATION OF CLAY (mAHD)
0.00 DEPTH OF SAND (m)

DEPTH TO CLAY CONTOURS (mAHD)	
Range	Colour
0.20 - 0.50	
0.50 - 1.00	
1.00 - 1.50	
1.50 - 2.00	
2.00 - 2.50	
2.50 - 3.00	
3.00 - 7.00	

0 20 40 50 75 100
HORIZONTAL SCALE (m)

REV	REVISION DESCRIPTION	DATE	CHK

SCALE 1:1500 (@A1)
DRAWN DAC
DATE DRAWN 27/06/2025
CHECKED ORW
DATE CHECKED 27/06/2025

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CLIENT EDGELOE ENGINEERING
PROJECT PARKRIDGE ESTATE
LOCATION EATON
TITLE SAND THICKNESSES / DEPTH TO CLAY LAYER
JOB NO. WAG190133-04
FIGURE FIGURE 2B

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Appendices

Appendix A: Site Photographs

Photograph 1: Water ponding near BH50



Photograph 2: Stockpiles of soil.



Photograph 3: Illegal rubbish



Photograph 4: Machine Auger testing at BH127.



Photograph 5: POS Area around BH20.



Photograph 6: Testing at BH117.



Photograph 7: Water ponding near BH67.



Photograph 8: Water ponding near BH81.



Photograph 9: Area near BH63 facing South.



Appendix B: Information Provided

YIELD SUMMARY

Size	No. Lots	% Total Lots	Avg. Lot Size
235m² - 319m²	15	4.59%	309m²
320m² - 449m²	222	67.89%	380m²
450m² - 499m²	55	16.82%	464m²
500m² - 549m²	4	1.22%	507m²
550m² - 599m²	5	1.53%	570m²
600m² - 699m²	18	5.50%	614m²
700m² - 799m²	4	1.22%	766m²
800m² - 899m²	2	0.61%	861m²
900m² - 999m²	1	0.31%	902m²
4000m² - 4999m²	1	0.31%	4273m²
Number of Lots	**327**		
Public Open Space			3.0275ha
Regional Open Space			2.2224ha
Road Reserves			5.4576ha
Minimum Lot Size 293m²			Average Lot Size 430m²
Maximum Lot Size 4273m²			Total Area (327 Lots) 14.0496ha

54422
950

3001

9503

ROS
2.2224ha

POS
1.66ha

POS
1.0950ha

228
4273m²
Grouped Housing Site

9010
24.7571ha

6m wide Laneway

15m wide Road Reserve

12.5m wide Road Reserve

18m wide Road Reserve

21m wide Road Reserve

14m wide Road Reserve

15m RR

12.5m wide RR

SHIRAZ STREET

GUERNSEY STREET

CAMARGUE STREET

DRIVE

LAKES DRIVE

PENINSULA

TUKIDALE STREET

ROBUSTA DRIVE

EATON DRIVE

LEGEND

- Subject Area (24.7571ha)
- Existing Cadastre
- Proposed Residential R40
- Proposed Residential R30 - R40
- Public Open Space
- Regional Open Space
- E — Underground Electricity (BYDA)
- AE — Overhead Electricity (BYDA)
- W — Reticulated Water (BYDA)
- S — Reticulated Sewer (BYDA)
- PM — Sewer Pressure Main (BYDA)
- T — Telecommunications (BYDA)
- G — Reticulated Gas (BYDA)

OVERALL CONCEPT SUBDIVISION PLAN

PARKRIDGE ESTATE
Lot 9010 on DP428930, EATON

Plan No. | 22294-29
Date | 04/04/25
Drawn | NP
Checked | KS
Revision | A

Scale | 1:1500 @ A1
1:3000 @ A3

0 20m 40m

NOTE: This plan has been prepared for planning purposes. Areas, Contours and Dimensions shown are subject to survey

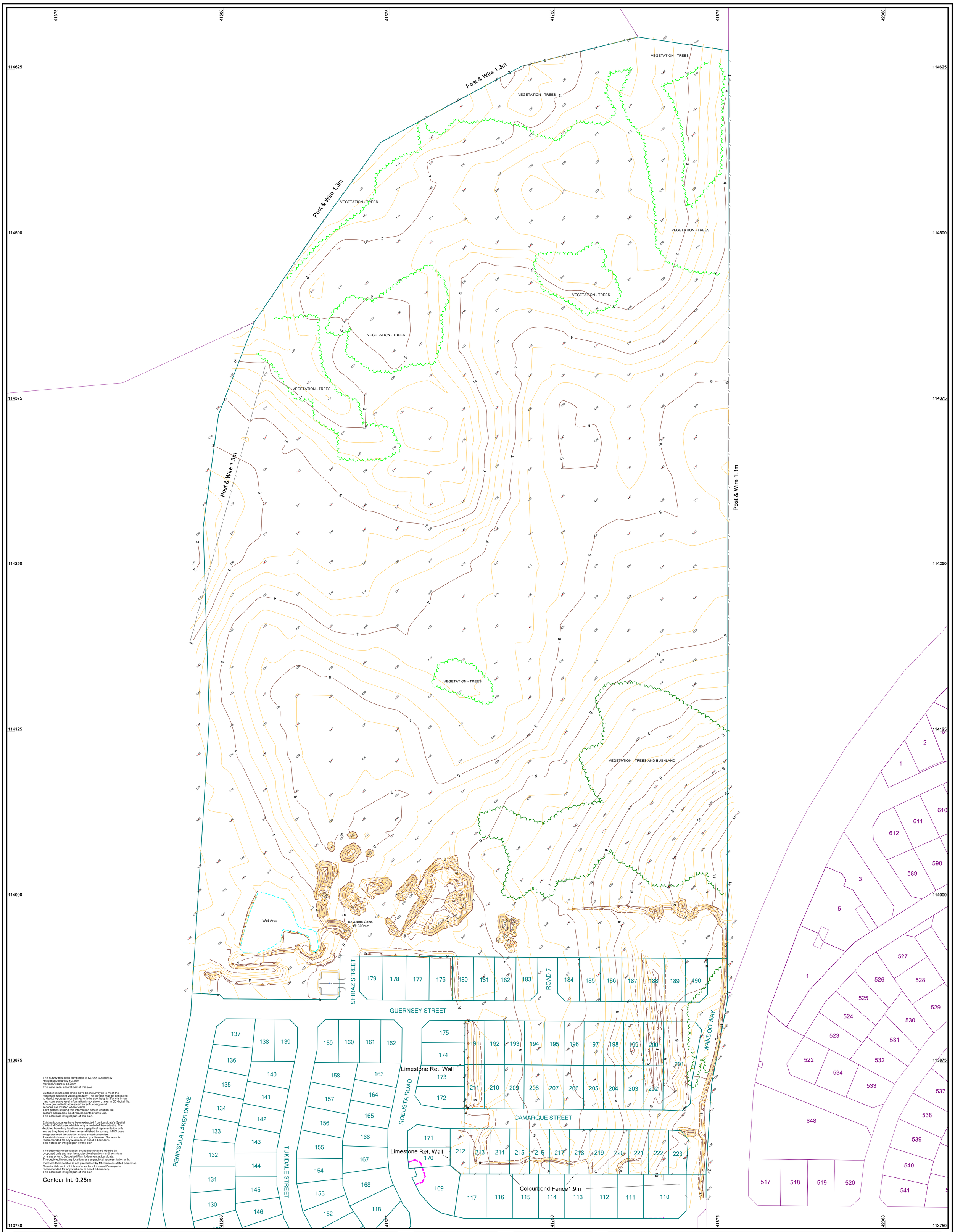
BUNBURY OFFICE:
21 Spencer Street,
BUNBURY WA 6230
T: 08 9792 6000
E: bunbury@harleydykstra.com.au
W: www.harleydykstra.com.au
ALBANY | BUNBURY | BUSSELTON | FORRESTDALE | PERTH

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(Appendix ORD: 12.2.2C)



This survey has been completed to CLASS 3 Accuracy
Horizontal Accuracy ± 30mm
Vertical Accuracy ± 50mm
This note is an integral part of this plan

Surface features and levels have been surveyed to meet the requested scope of works accuracy. The surface may be contoured to depict topography or defined only by spot heights. For clarity on hard copy some level information is not shown, refer to 3D digital file. Above ground indicators (markers) of underground services are located where visible.
Third parties utilising this information should confirm the capture accuracies meet requirements prior to use.
This note is an integral part of this plan.

Existing boundaries have been extracted from Landgate's Spatial Cadastral Database, which is only a model of the cadastre. The depicted boundary locations are a graphical representation only and as they have not been re-established by survey. MNG does not guaranteed the position unless stated otherwise.
Re-establishment of lot boundaries by a Licensed Surveyor is recommended for any works on or about a boundary.
This note is an integral part of this plan

The depicted Precalculated boundaries shall be treated as proposed only and may be subject to alterations in dimensions or areas prior to Deposited Plan lodgement at Landgate.
The depicted boundary locations are a graphical representation only, therefore their position is not guaranteed by MNG unless stated otherwise.
Re-establishment of lot boundaries by a Licensed Surveyor is recommended for any works on or about a boundary.
This note is an integral part of this plan

Contour Int. 0.25m

Rev.	Description	Drawn	Date	Checked
A	Initial Issue	BR	13/12/2022	CPO

ISO 9001 - AS/NZS 4801 - ISO45001
Global-Mark.com.au®

Surveyor:- BR
Survey Date:- 12/12/2022
Precal/Cad:- 13/12/2022

N

TOPOGRAPHIC SURVEY
LOT 9008
PARKRIDGE ESTATE - EATON

CLIENT:
Parkridge Group Pty Ltd

The contents of this plan are current and correct as of the date stated within the revision panel. All consultants and persons wishing to utilise this data should satisfy themselves of this plans currency by contacting the McMullen Nolan Group.

SCALE 1:1250 @ A1
0 10 20 30 40 50 100
ALL DISTANCES ARE IN METRES
For a true to scale reproduction of this plan, plot it to A1 with the Paging Scaling set to None.

The boundaries shown on this plan were not re-established as part of this survey, therefore this plan does not guarantee their accuracy. Existing easements, encumbrance or interest are not depicted and a title search is recommended to obtain this information. Re-establishment of the cadastral boundaries is recommended for any proposed works on or near existing boundaries.

MNG
MCMULLEN NOLAN GROUP - SOUTH WEST
177 Spencer Street
South Bunbury, W.A. 6230
PO Box 1233, Bunbury
W.A. 6231, Australia
Offices in: Perth | Melbourne | Kimberley| South West WA
Tel: (08) 6316 2120
Fax: (08) 6436 1500
info@mngsurvey.com.au
www.mngsurvey.com.au
ABN 90 009 363 311

Project Mngr.	Casey Oliver	Datum	PCG94 / AHD

102389 - DE - 029 - A
Job Number | Type | Plan Number | Revision

Appendix C: Geotechnical Laboratory Test Results

WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

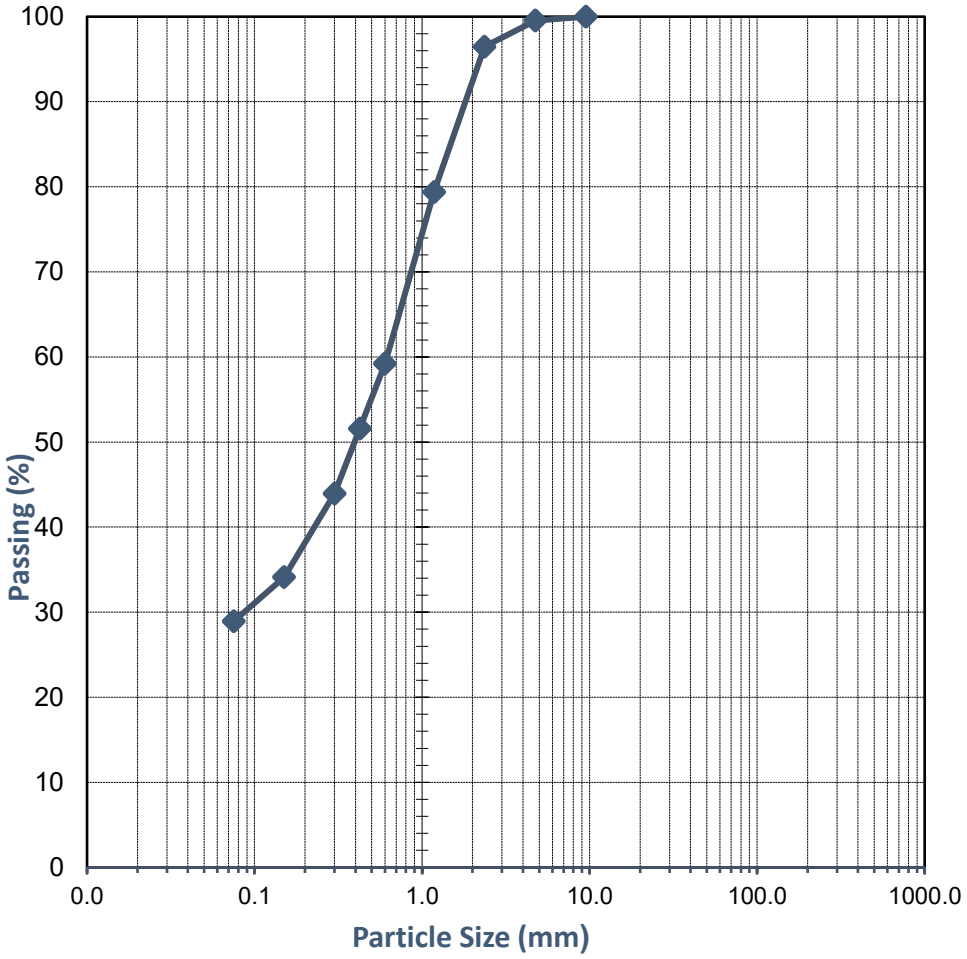
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10709_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10709
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH148 (1.8-2m)	*Date Tested:*	18/06-20/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	96
1.18	79
0.600	59
0.425	52
0.300	44
0.150	34
0.075	29



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

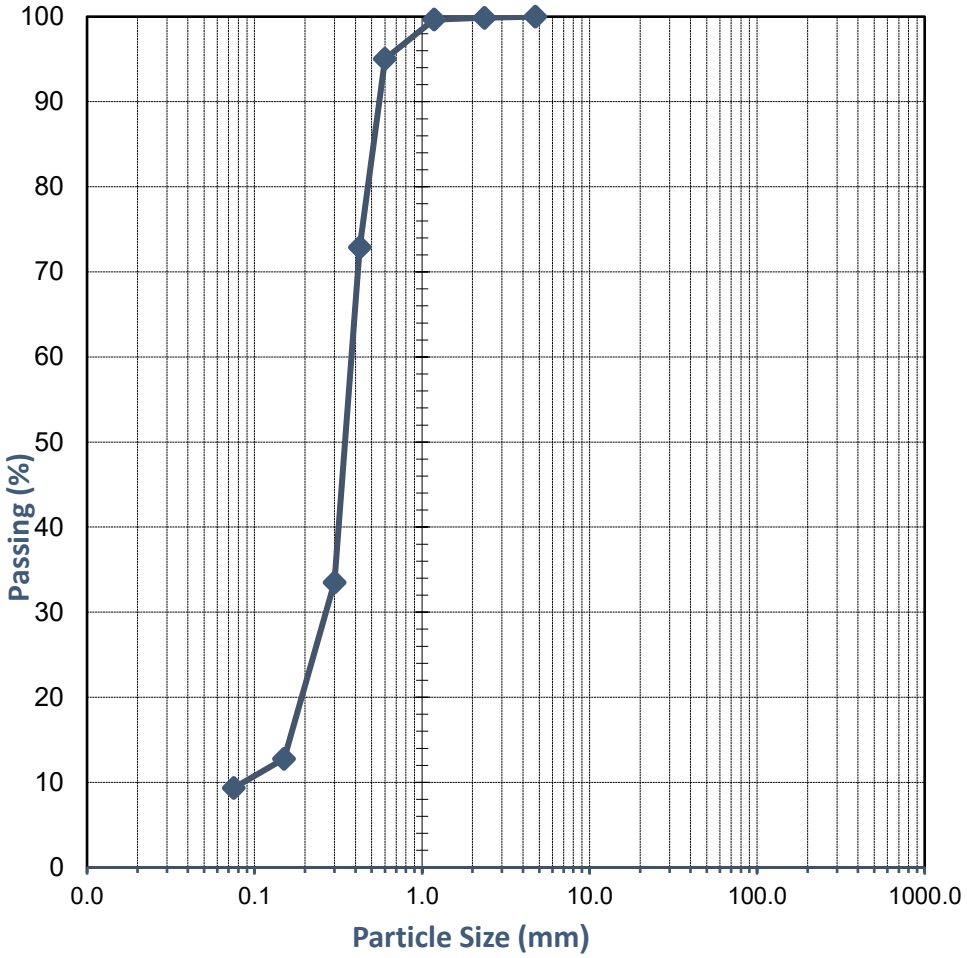
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10770_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10770
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH133 (1-1.3m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	95
0.425	73
0.300	33
0.150	13
0.075	9



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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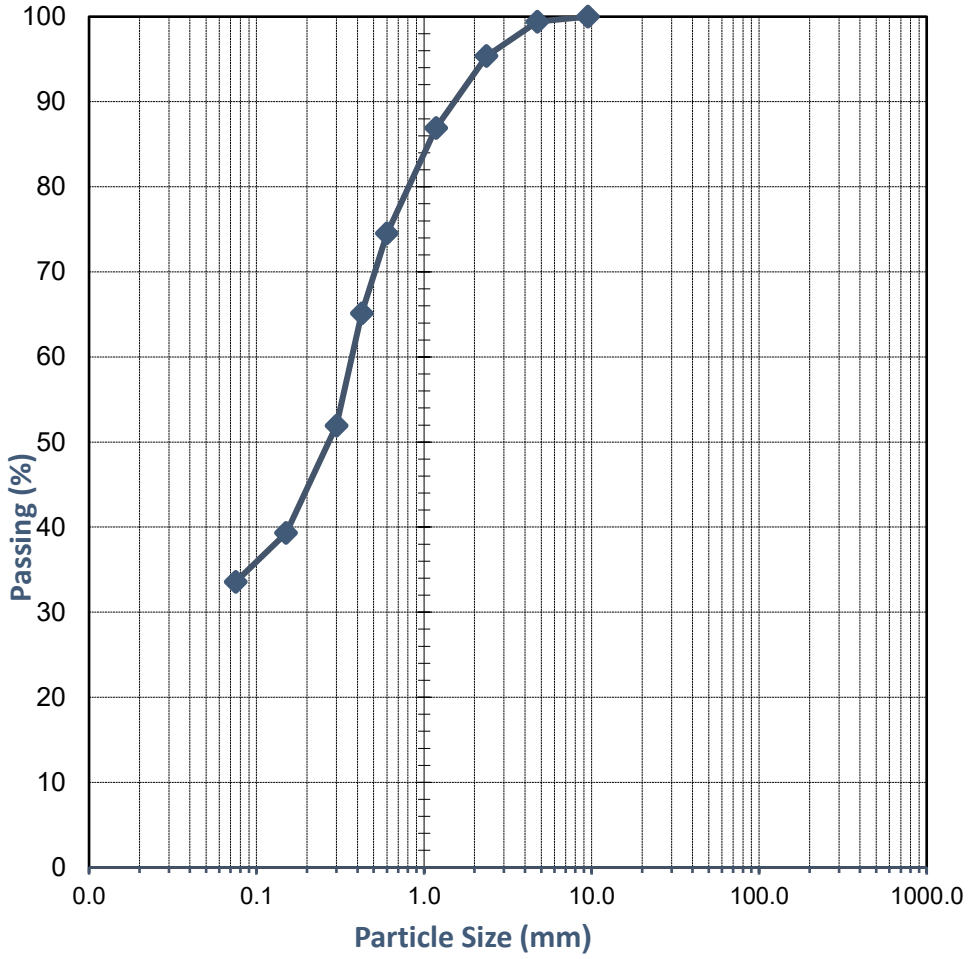
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10707_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10707
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH131 (0.5-0.8m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	95
1.18	87
0.600	75
0.425	65
0.300	52
0.150	39
0.075	34



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

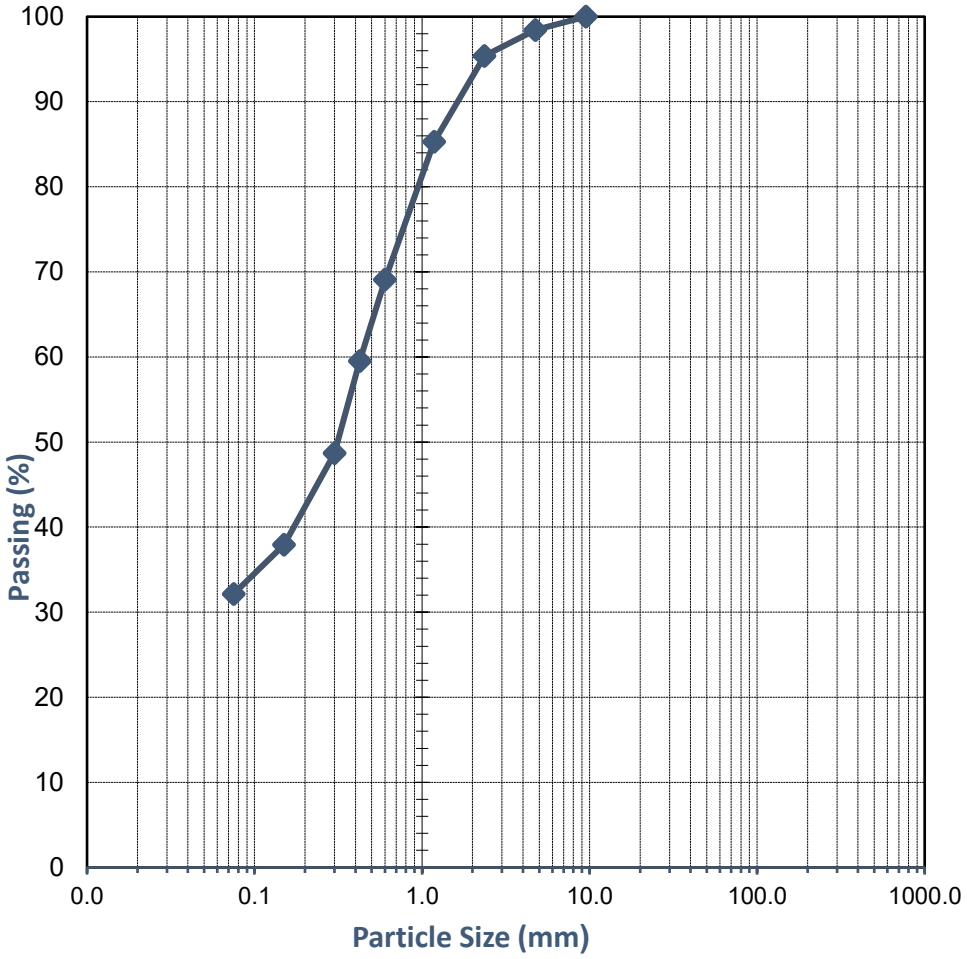
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10705_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10705
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH109 (1-1.3m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	98
2.36	95
1.18	85
0.600	69
0.425	60
0.300	49
0.150	38
0.075	32



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

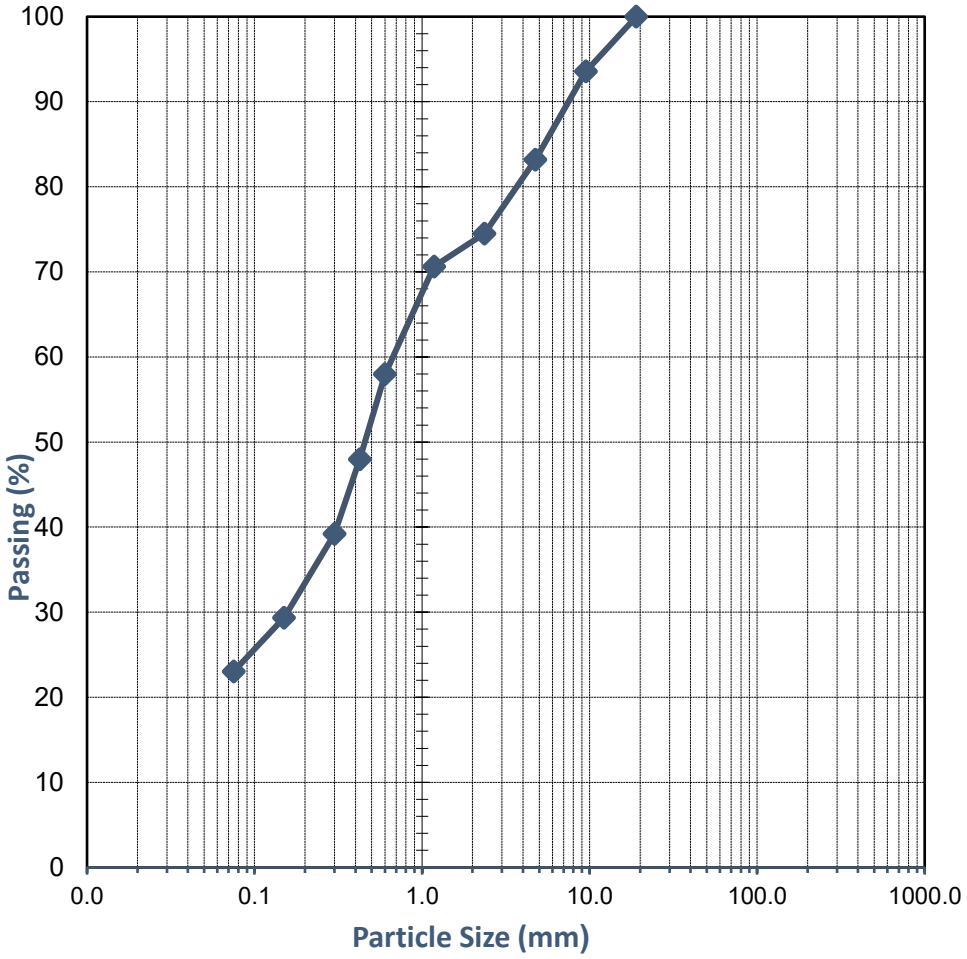
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10696_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10696
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH10 (0.2-0.6m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	94
4.75	83
2.36	75
1.18	71
0.600	58
0.425	48
0.300	39
0.150	29
0.075	23



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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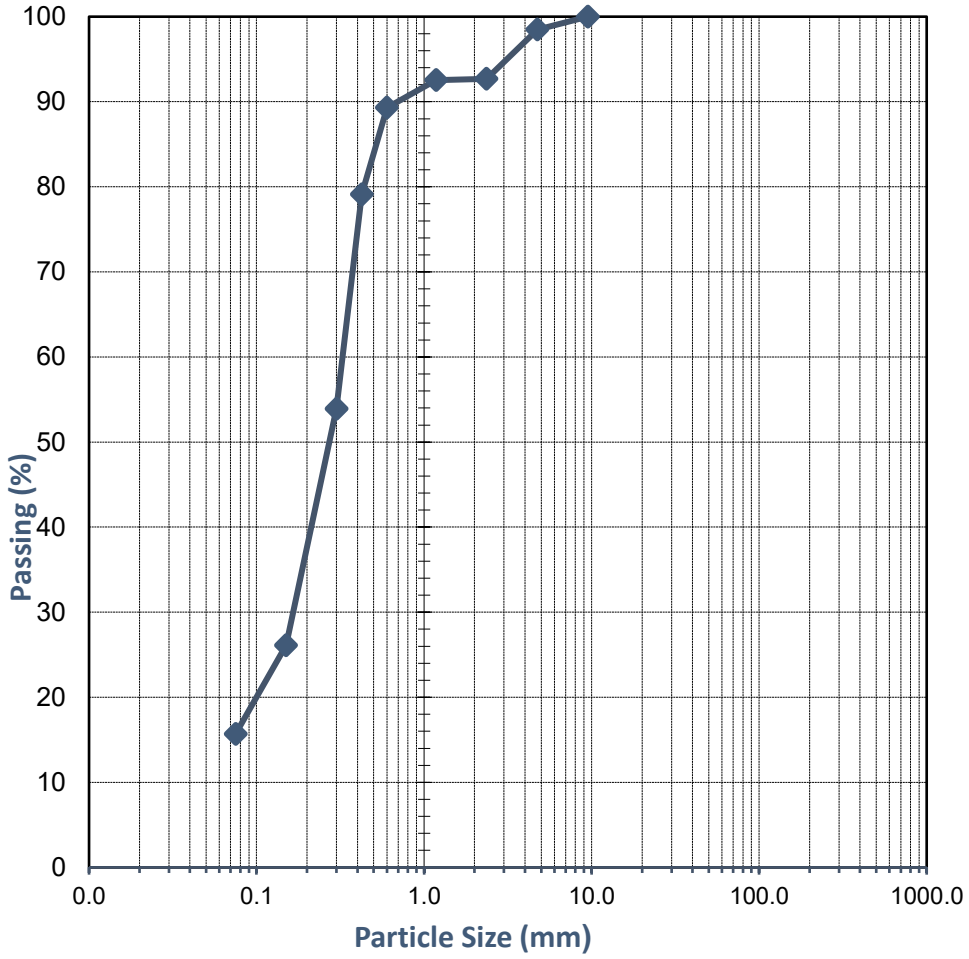
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10704_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10704
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH095 (0.5-0.7m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	98
2.36	93
1.18	93
0.600	89
0.425	79
0.300	54
0.150	26
0.075	16



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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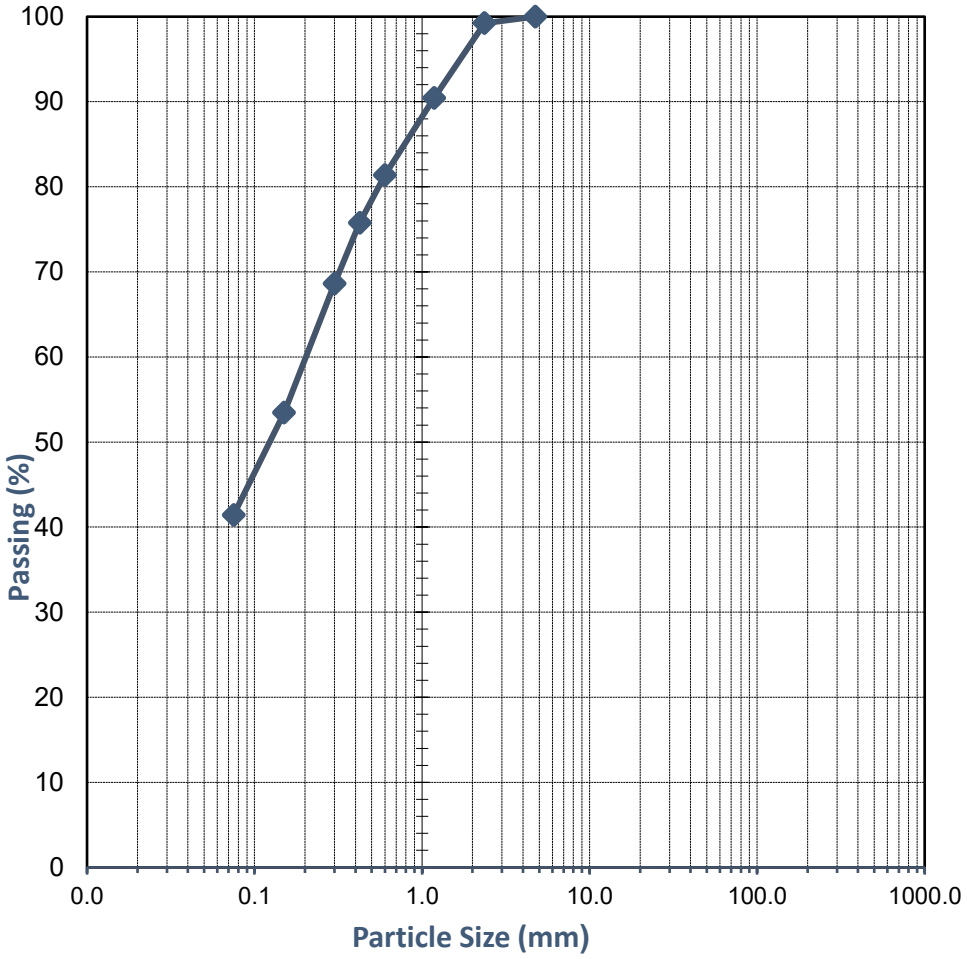
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10767_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10767
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH116 (0.8-1.1m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	90
0.600	81
0.425	76
0.300	69
0.150	53
0.075	41



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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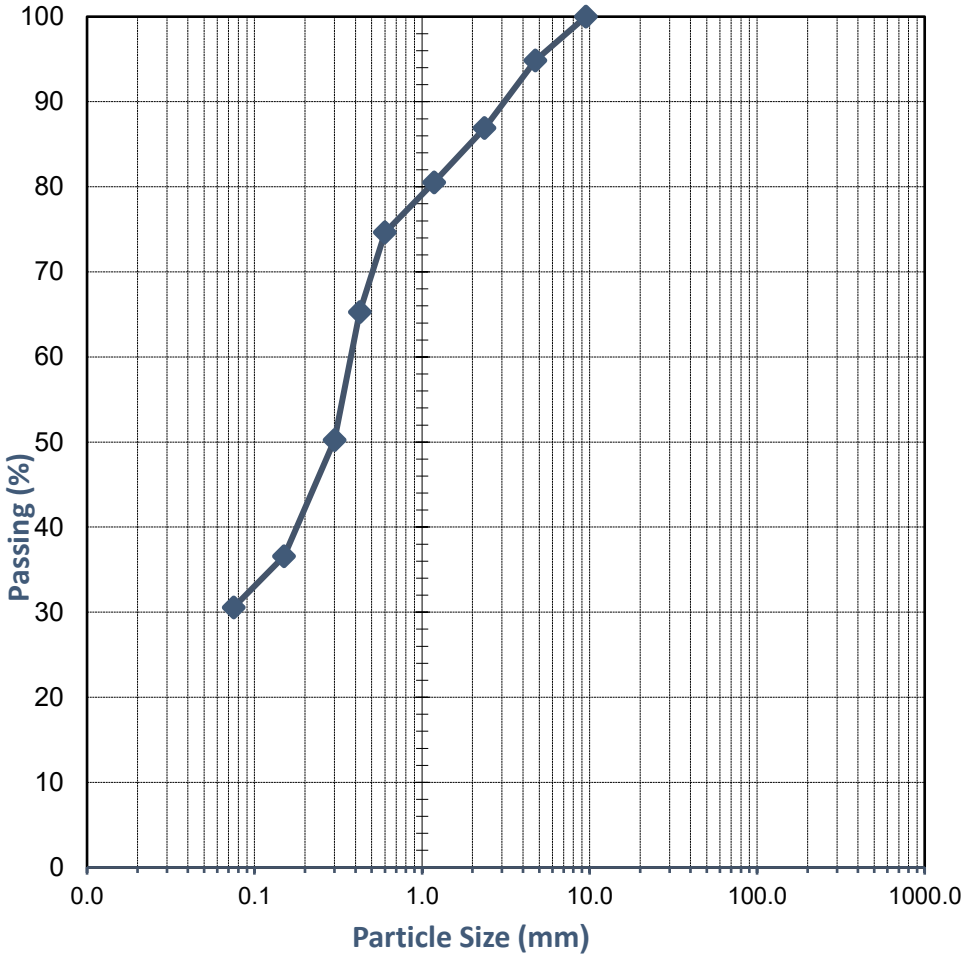
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10702_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10702
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH075 (0.6-1m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	95
2.36	87
1.18	81
0.600	75
0.425	65
0.300	50
0.150	37
0.075	31



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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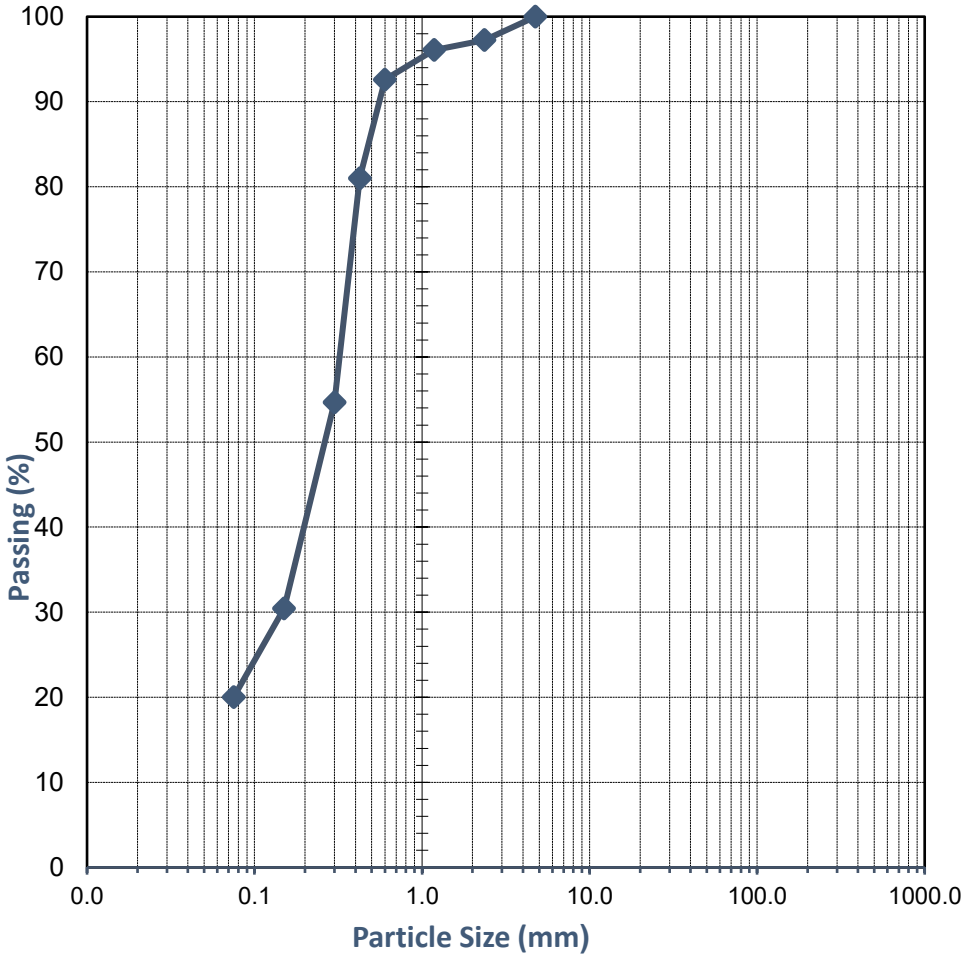
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10769_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10769
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH127 (1.5-1.7m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	97
1.18	96
0.600	93
0.425	81
0.300	55
0.150	30
0.075	20



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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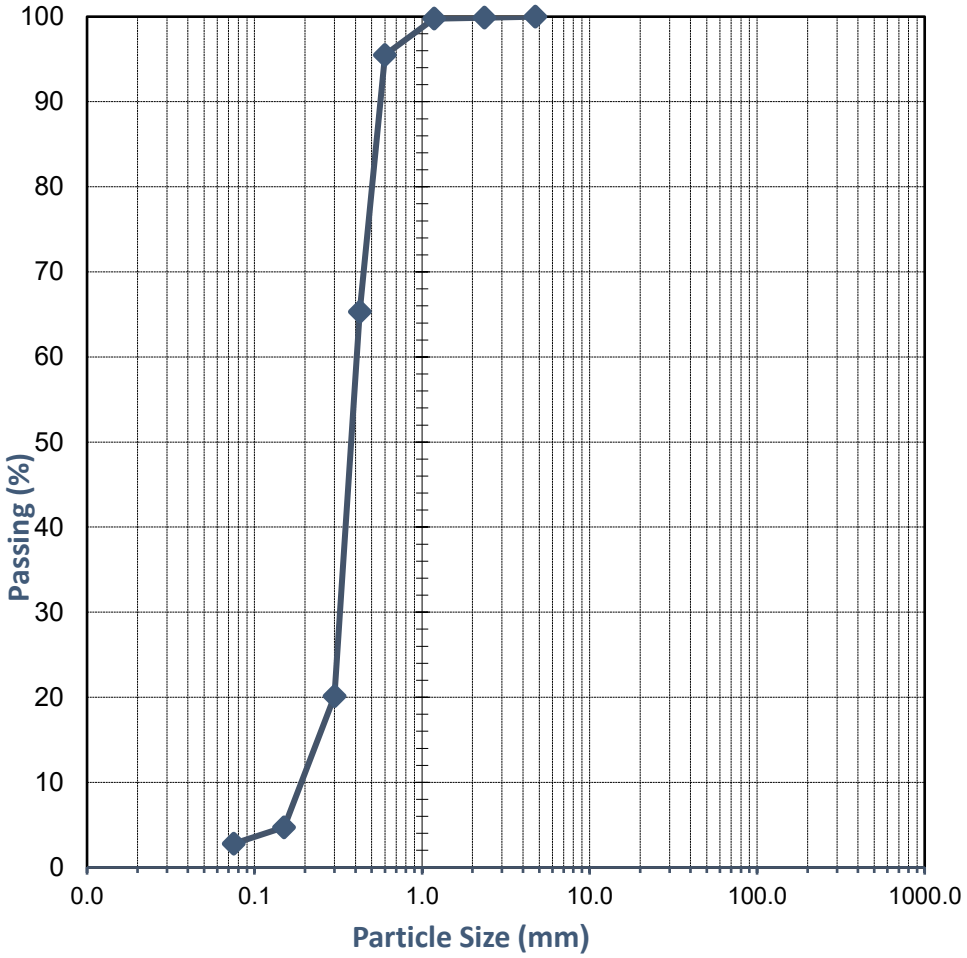
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10701_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10701
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH145 (0.5-1m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	95
0.425	65
0.300	20
0.150	5
0.075	3



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

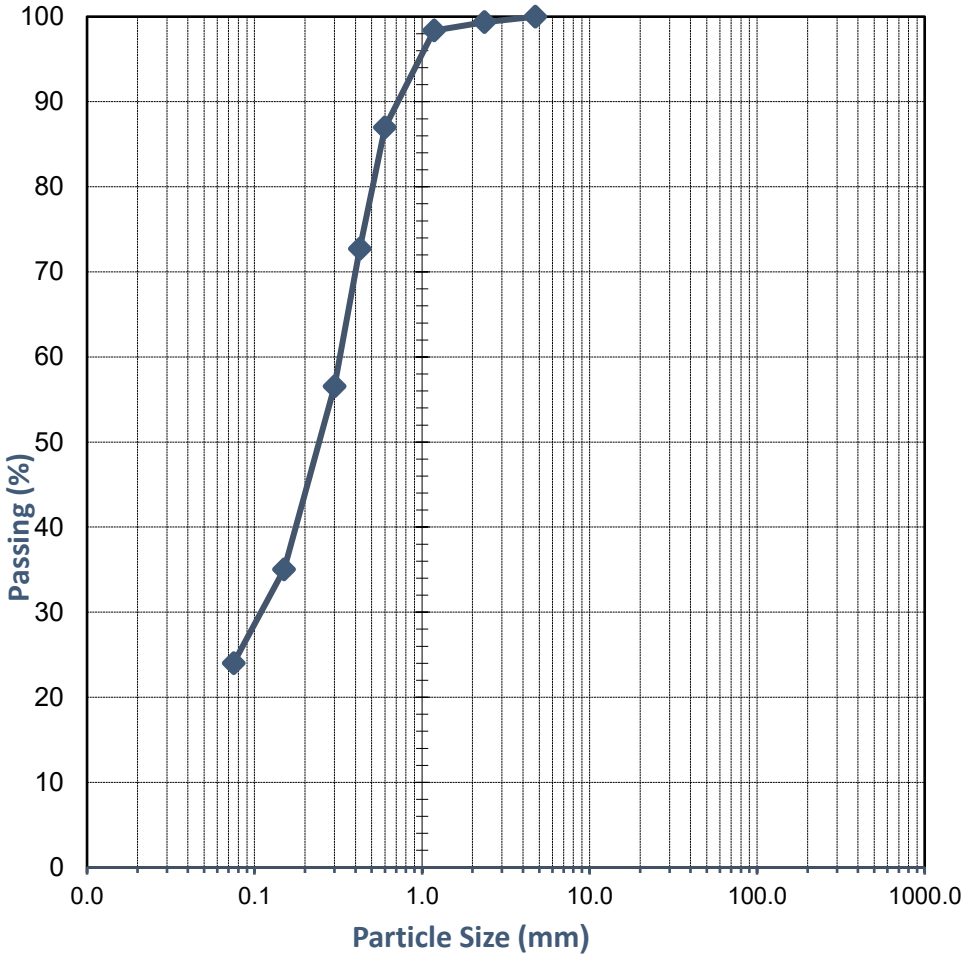
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10708_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10708
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH148 (0.2-0.4m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	99
1.18	98
0.600	87
0.425	73
0.300	57
0.150	35
0.075	24



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

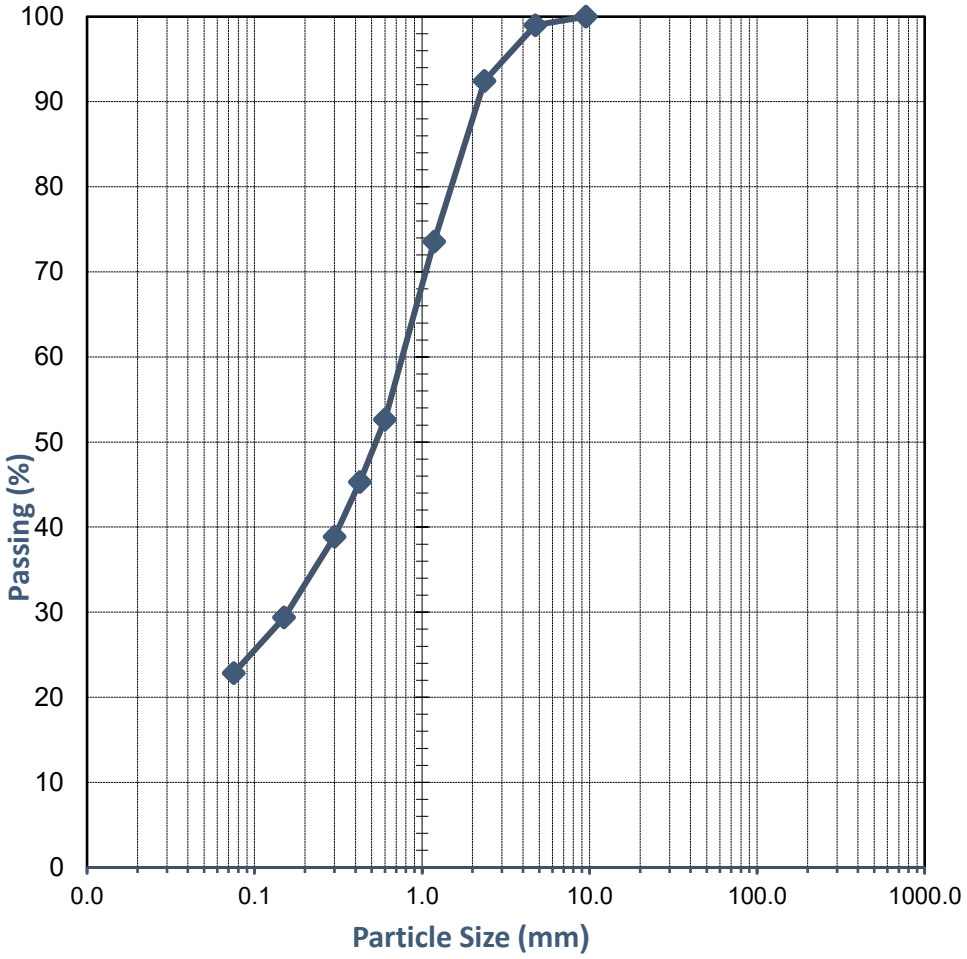
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10700_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10700
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH57 (0.4-0.7m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	92
1.18	74
0.600	53
0.425	45
0.300	39
0.150	29
0.075	23



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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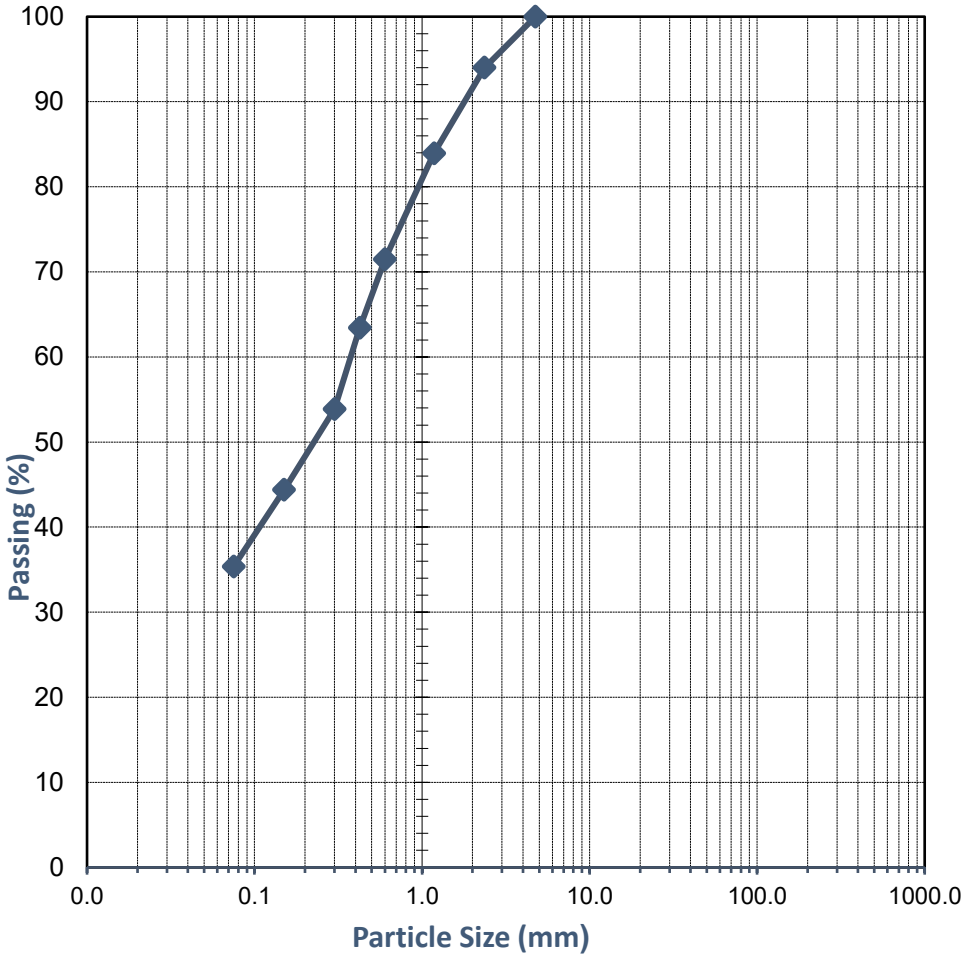
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10764_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10764
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH81 (0.3-0.5m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	94
1.18	84
0.600	71
0.425	63
0.300	54
0.150	44
0.075	35



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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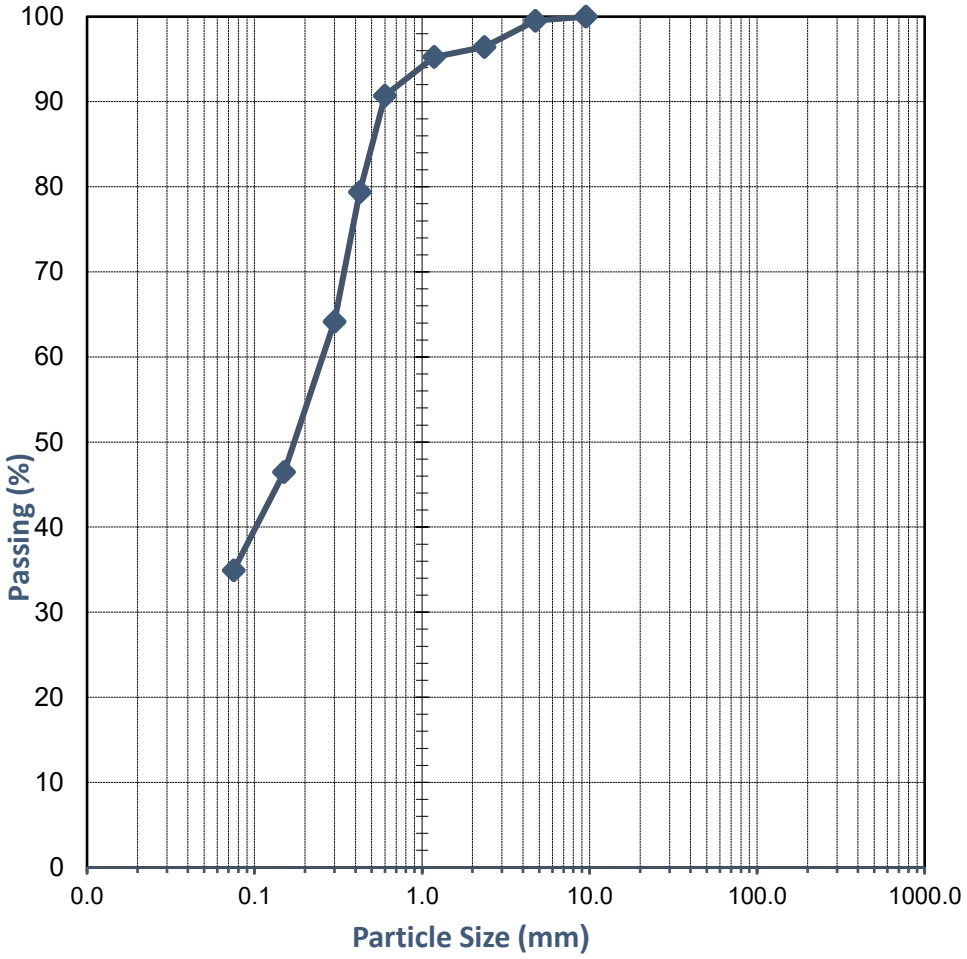
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10706_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10706
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH123 (2.5-3m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	96
1.18	95
0.600	91
0.425	79
0.300	64
0.150	46
0.075	35



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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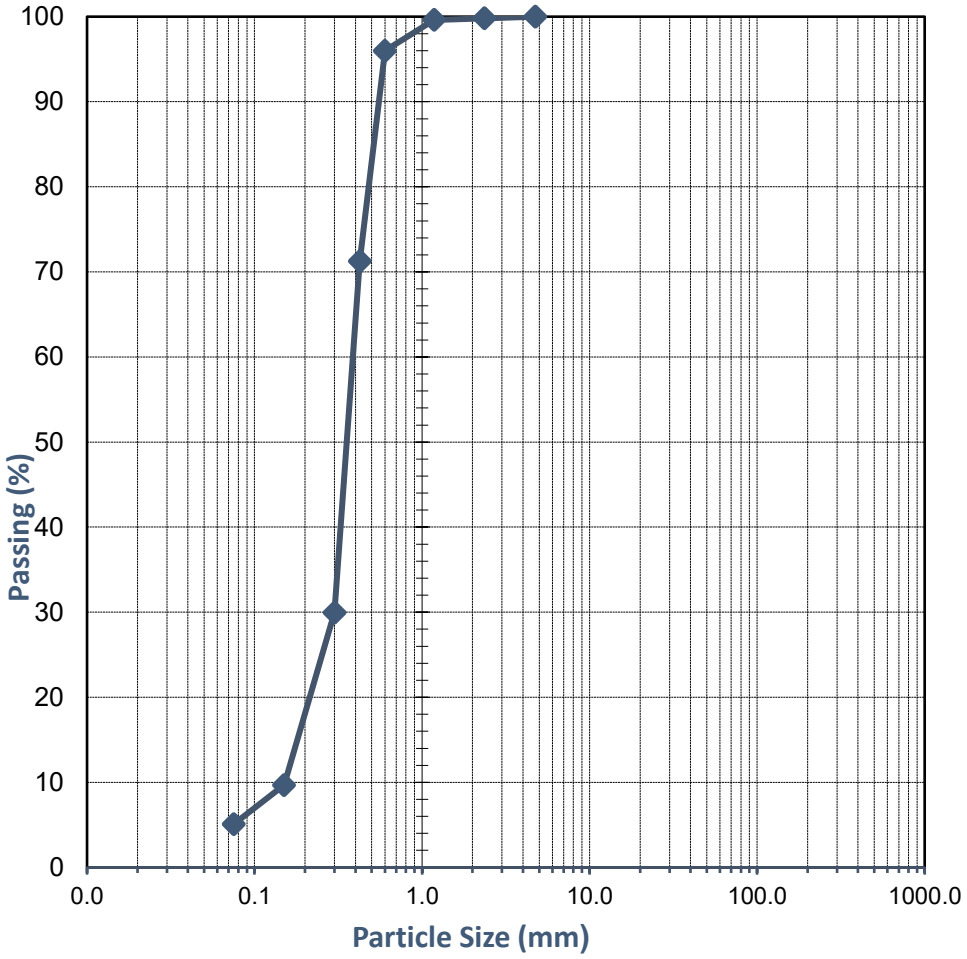
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10768_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10768
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH118 (1-1.3m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	96
0.425	71
0.300	30
0.150	10
0.075	5



Comments:

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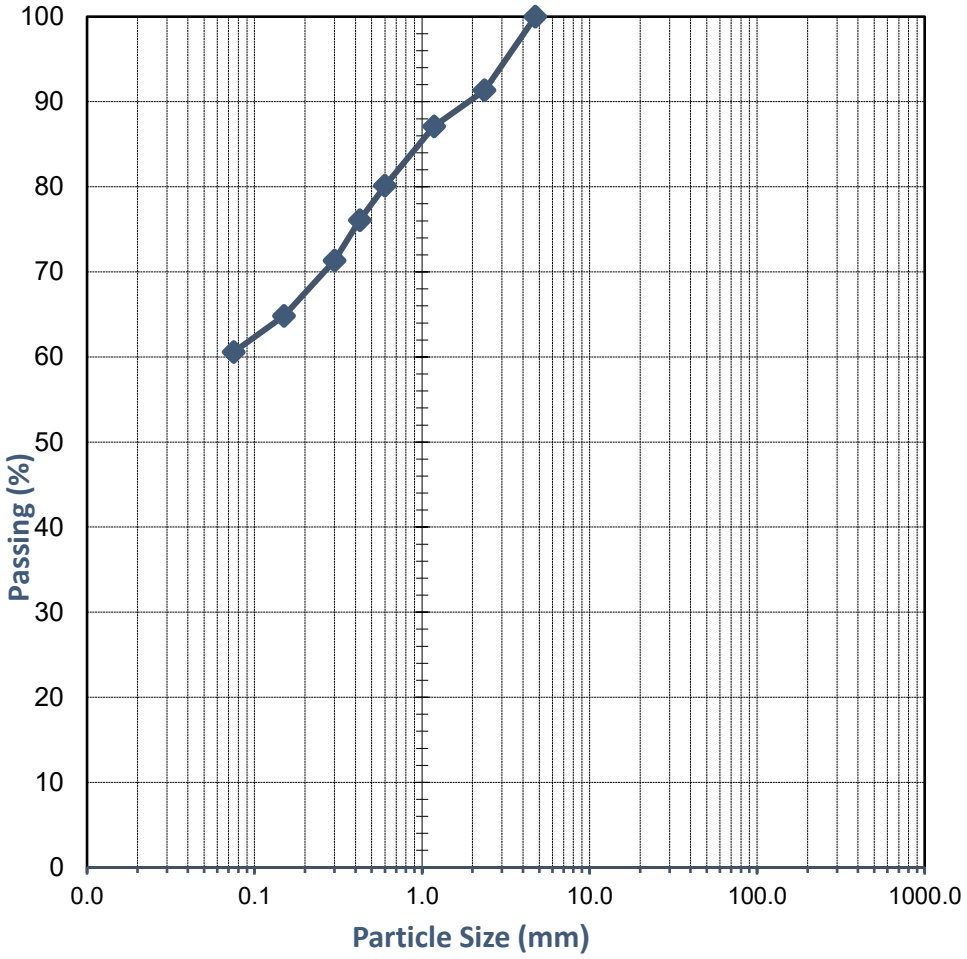
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10692_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10692
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH76 (0.1-0.6m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	91
1.18	87
0.600	80
0.425	76
0.300	71
0.150	65
0.075	61



Comments:

Approved Signatory:

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Date: 19/June/2025

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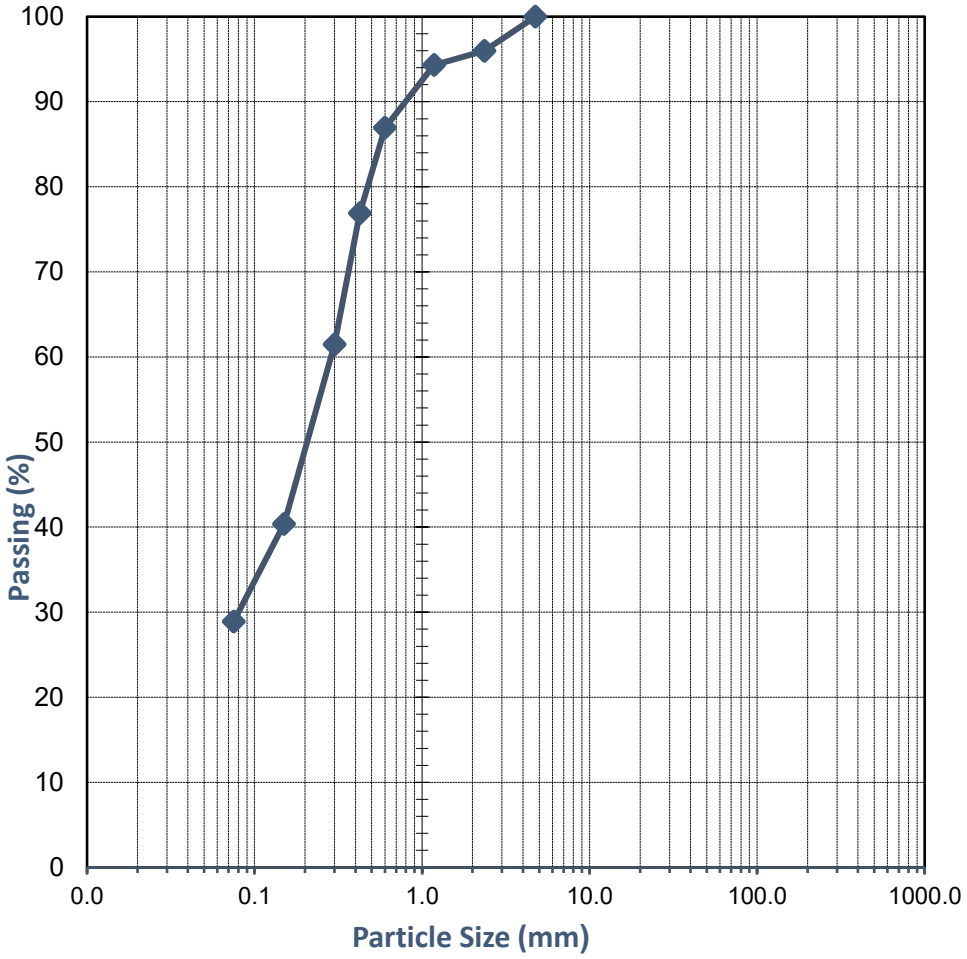
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10703_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10703
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH083 (0.3-0.5m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	96
1.18	94
0.600	87
0.425	77
0.300	61
0.150	40
0.075	29



Comments:

Approved Signatory:

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Date: 19/June/2025

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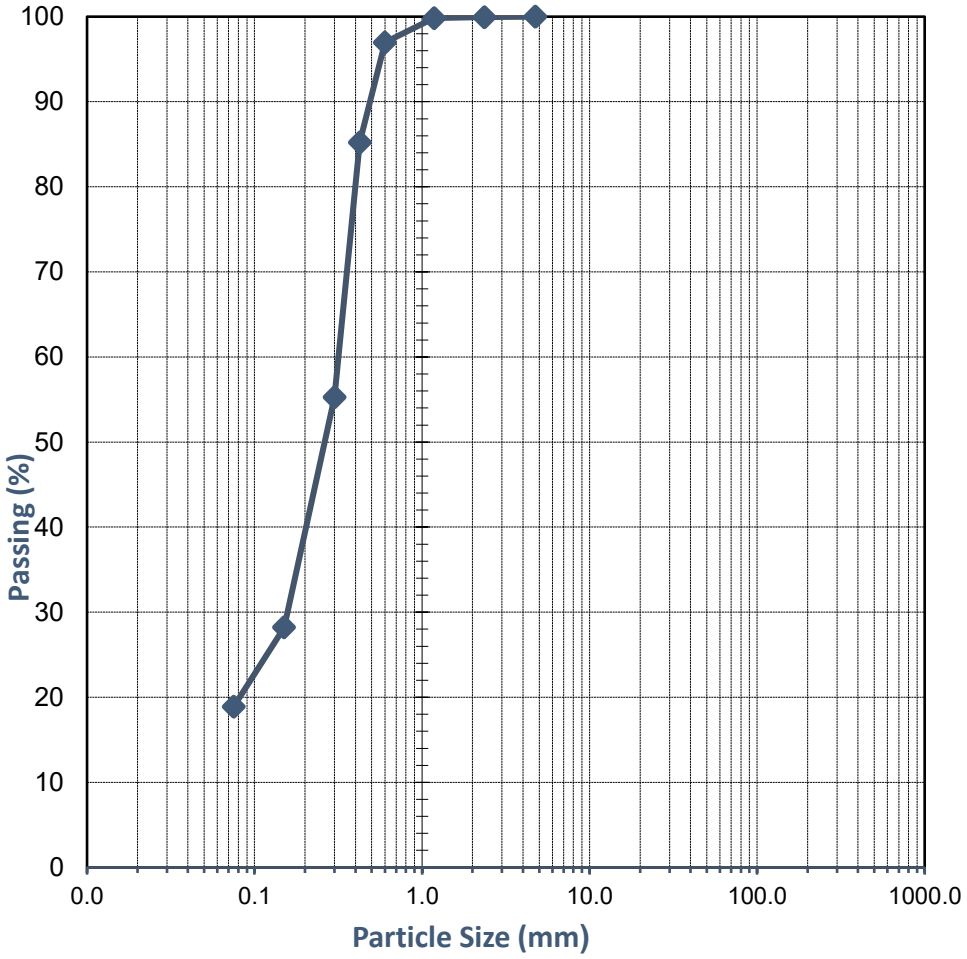
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10766_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10766
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH107 (1.5-2.0m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	100
0.600	97
0.425	85
0.300	55
0.150	28
0.075	19



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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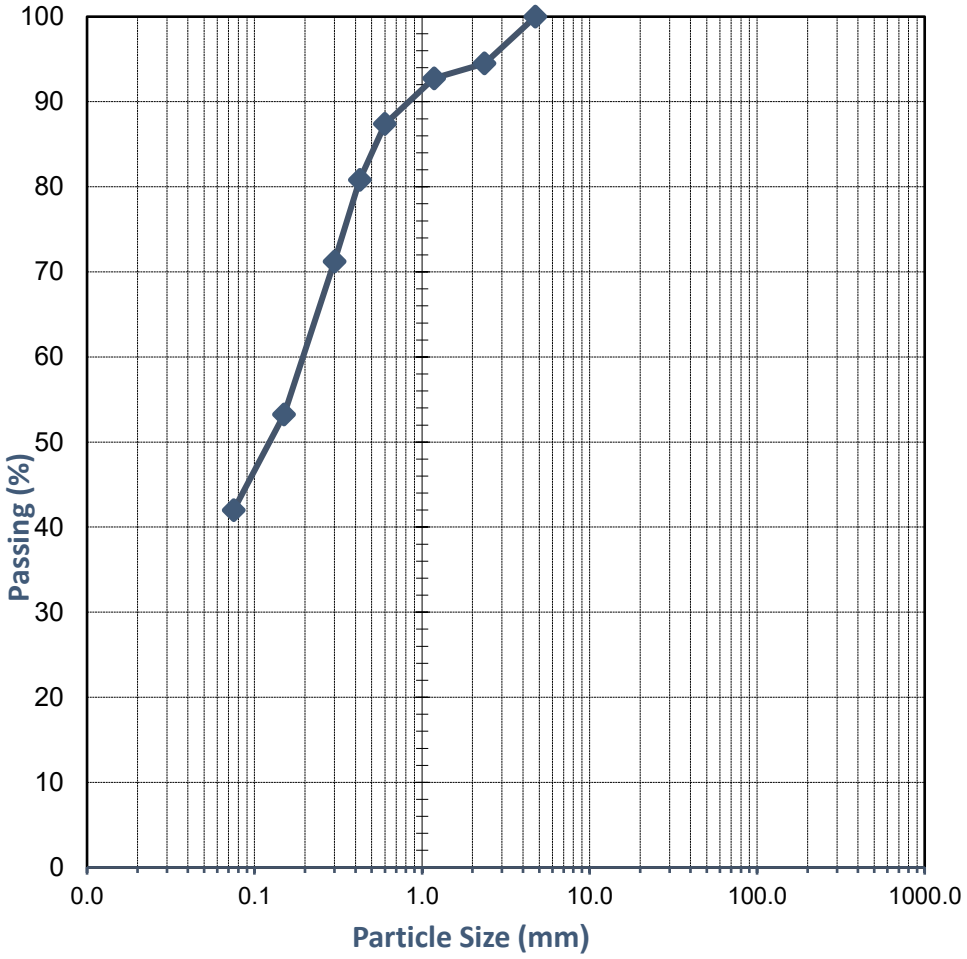
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10699_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10699
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH51 (1.1-1.6m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	95
1.18	93
0.600	87
0.425	81
0.300	71
0.150	53
0.075	42



Comments:

Approved Signatory:

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Date: 19/June/2025

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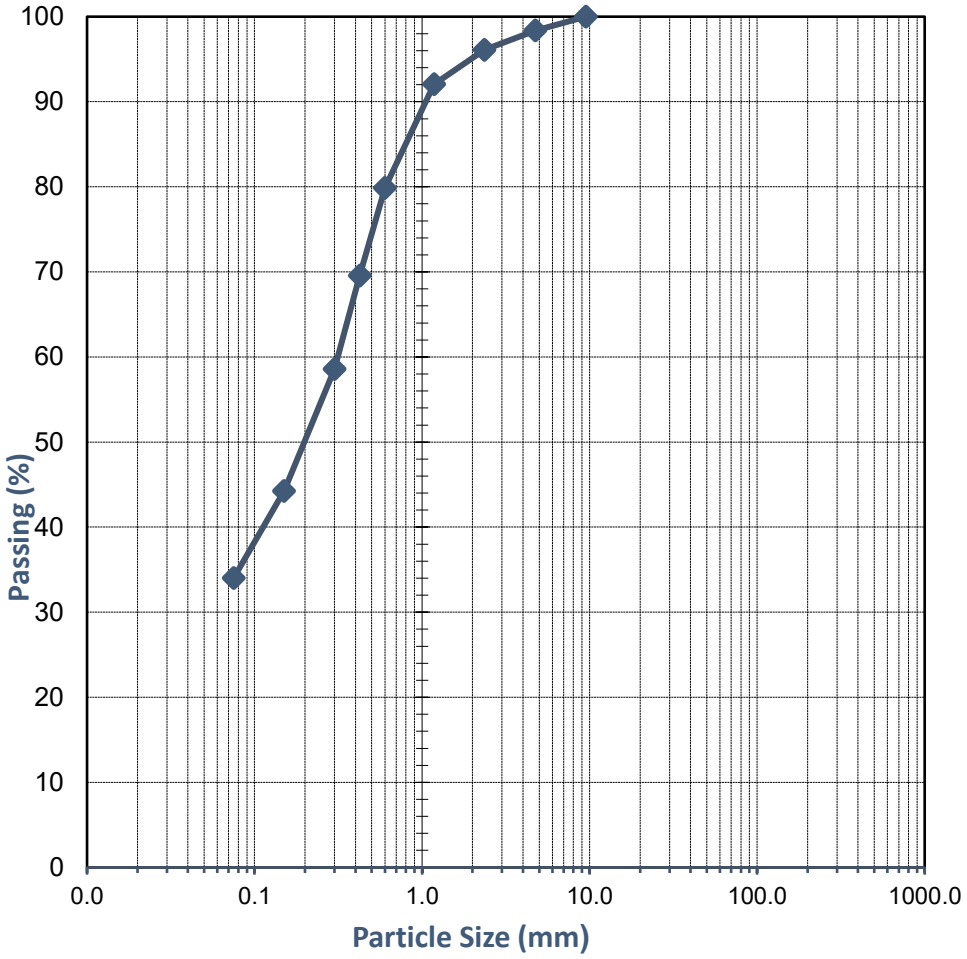
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10697_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10697
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH03 (0.15-0.5m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	98
2.36	96
1.18	92
0.600	80
0.425	70
0.300	59
0.150	44
0.075	34



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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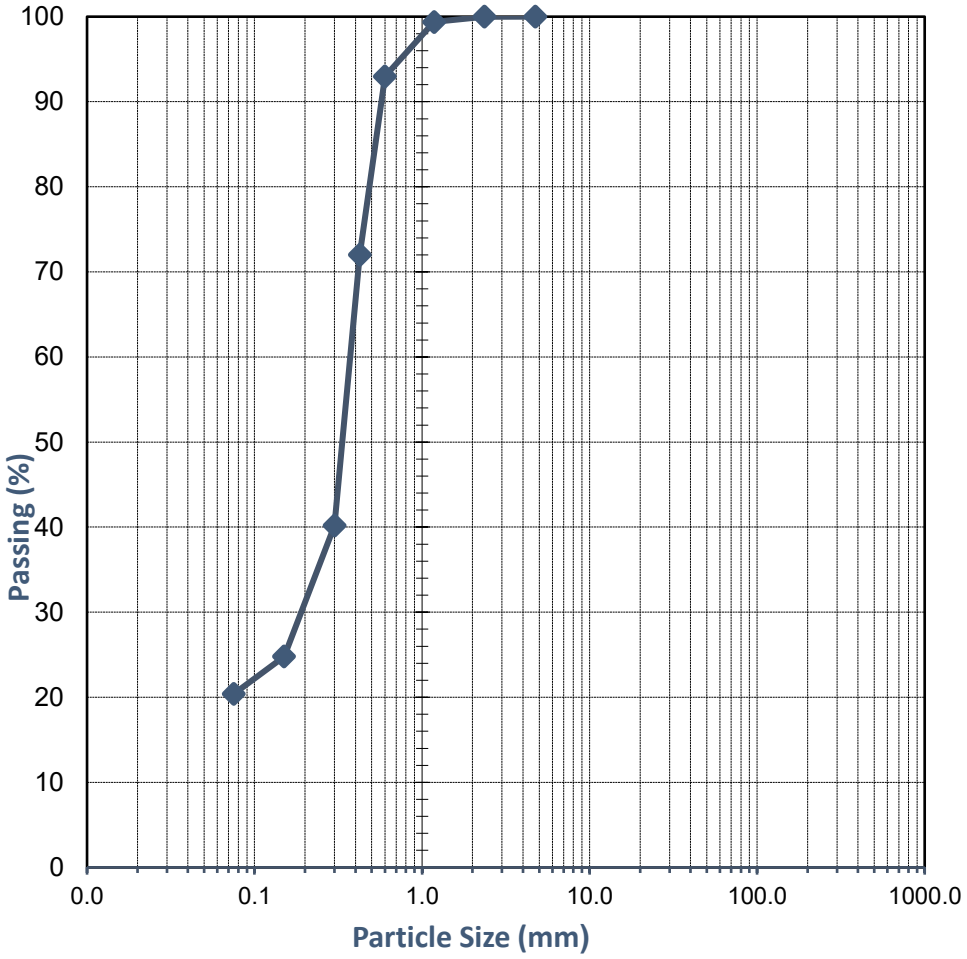
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10765_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10765
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH101 (1-1.3m)	*Date Tested:*	18/06 - 19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	
4.75	100
2.36	100
1.18	99
0.600	93
0.425	72
0.300	40
0.150	25
0.075	20



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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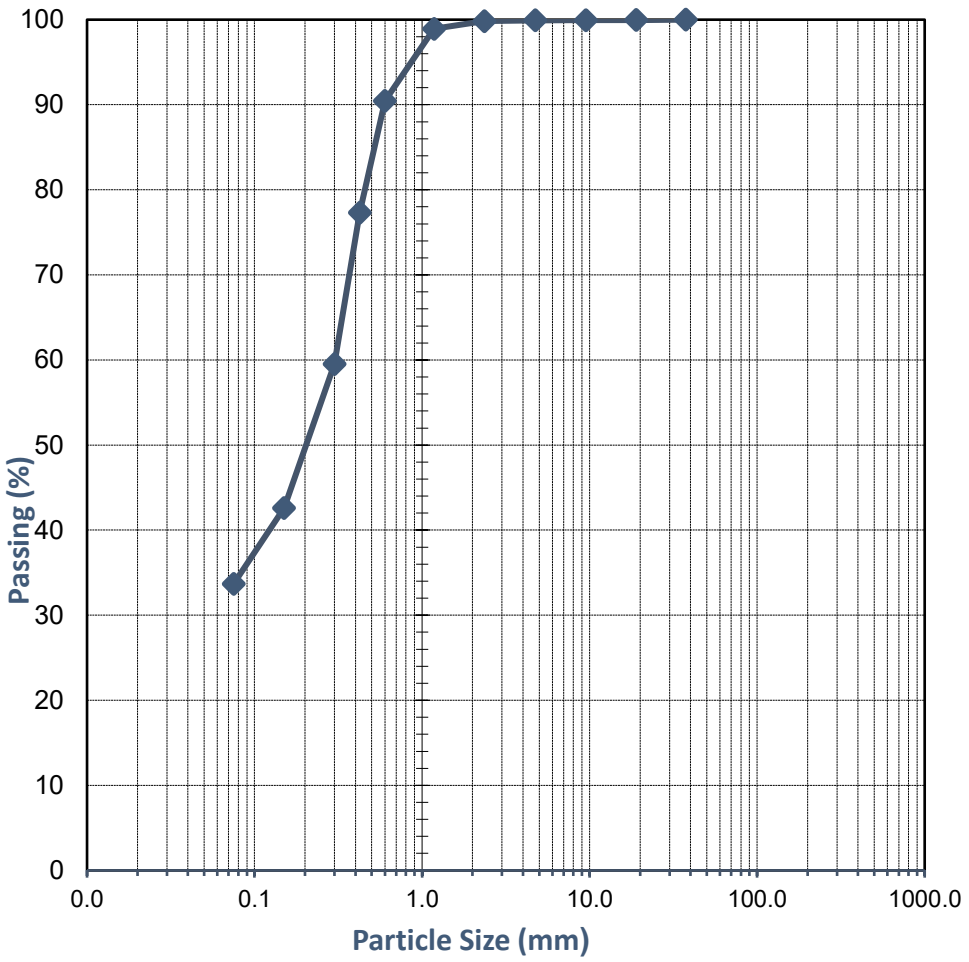
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10695_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10695
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH96 (0.1-0.5m)	*Date Tested:*	18/06-19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	100
9.5	100
4.75	100
2.36	100
1.18	99
0.600	90
0.425	77
0.300	60
0.150	43
0.075	34



Comments:

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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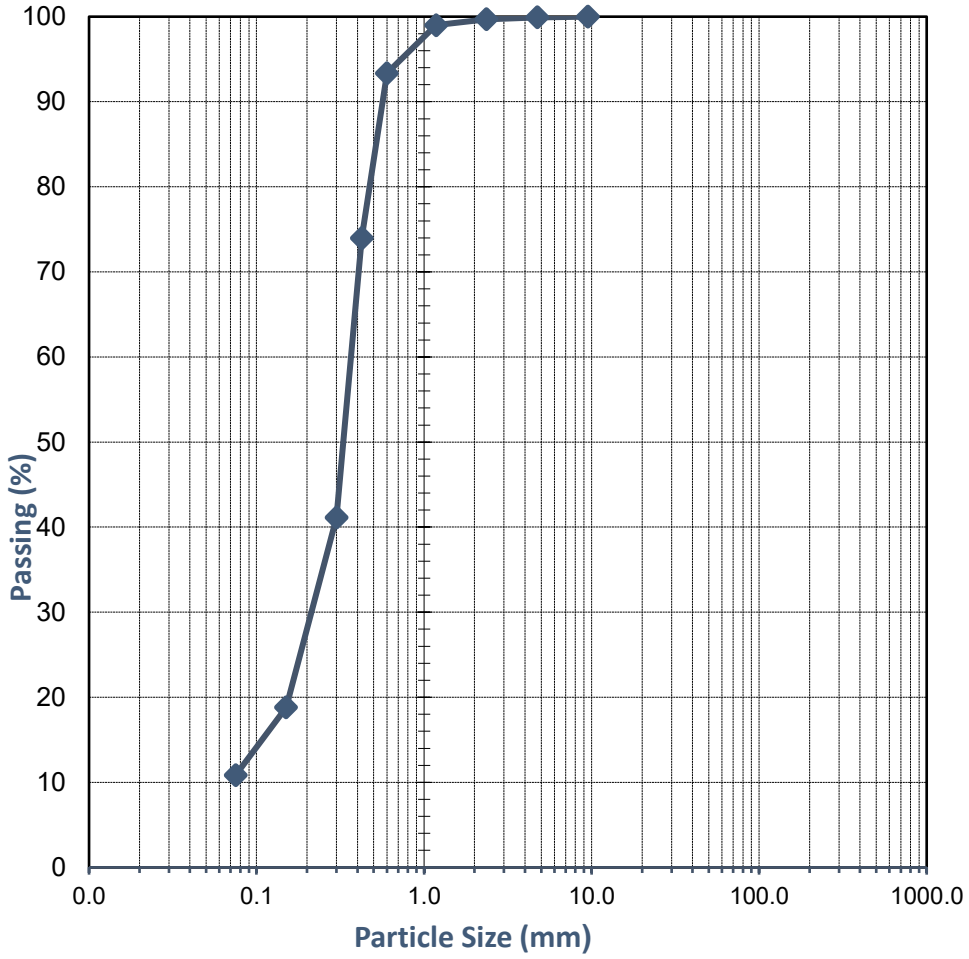
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10694_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10694
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH139 (0.1-0.6m)	*Date Tested:*	18/06-19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	100
2.36	100
1.18	99
0.600	93
0.425	74
0.300	41
0.150	19
0.075	11



Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 19/June/2025

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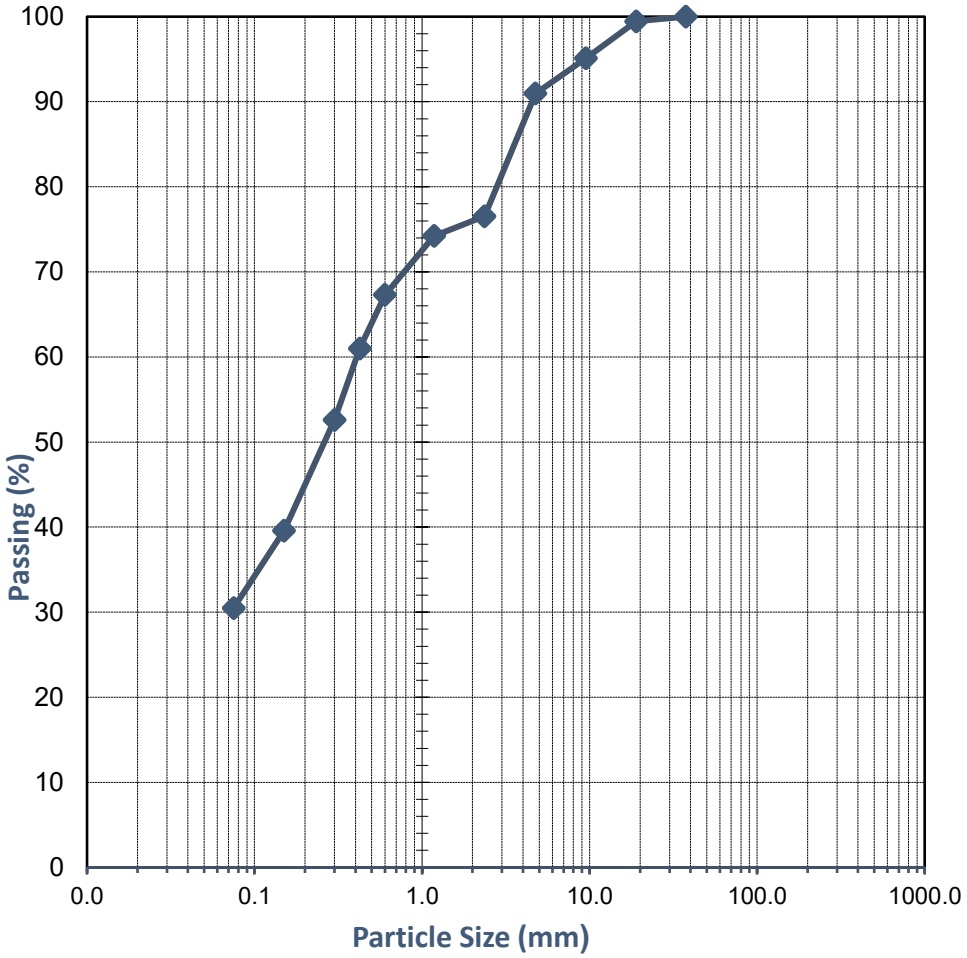
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10691_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10691
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH73 (0.1-0.6m)	*Date Tested:*	18/06-19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	100
19.0	99
9.5	95
4.75	91
2.36	77
1.18	74
0.600	67
0.425	61
0.300	53
0.150	40
0.075	30



Comments:

Approved Signatory:

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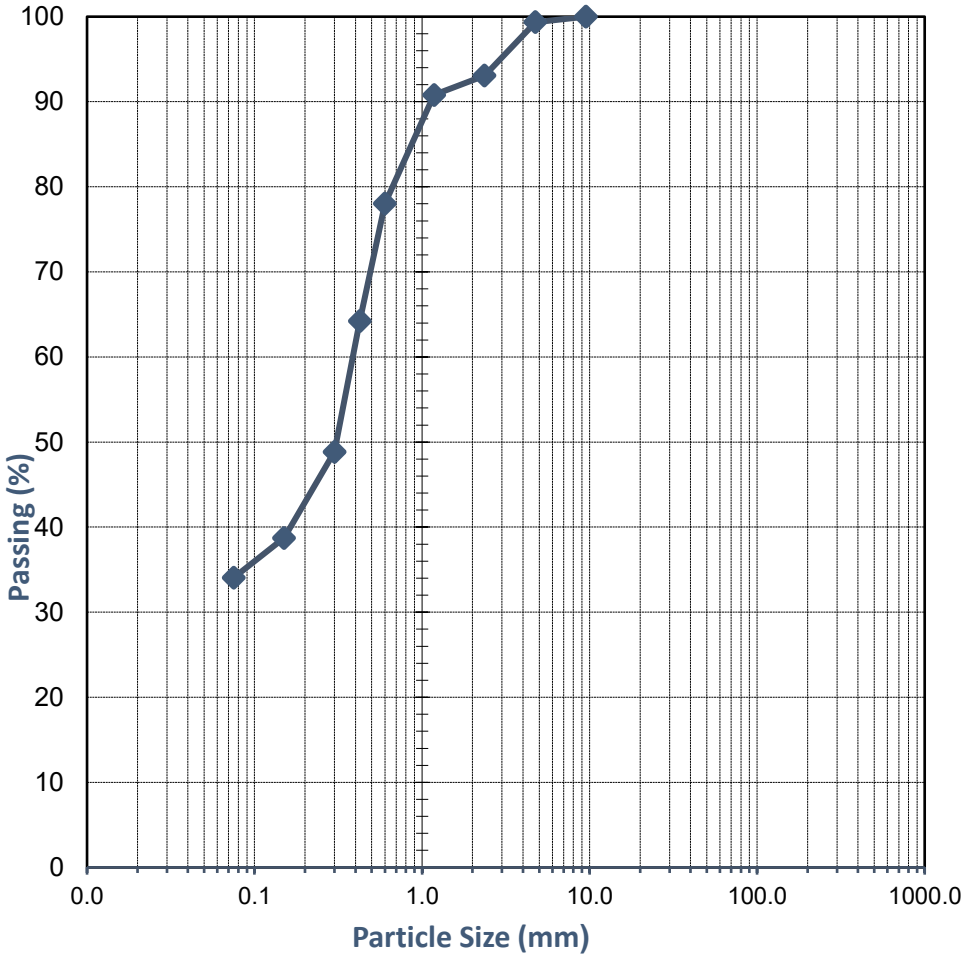
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10693_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10693
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH102 (0.1-0.6m)	*Date Tested:*	18/06-19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	
9.5	100
4.75	99
2.36	93
1.18	91
0.600	78
0.425	64
0.300	49
0.150	39
0.075	34



Comments:

Approved Signatory:

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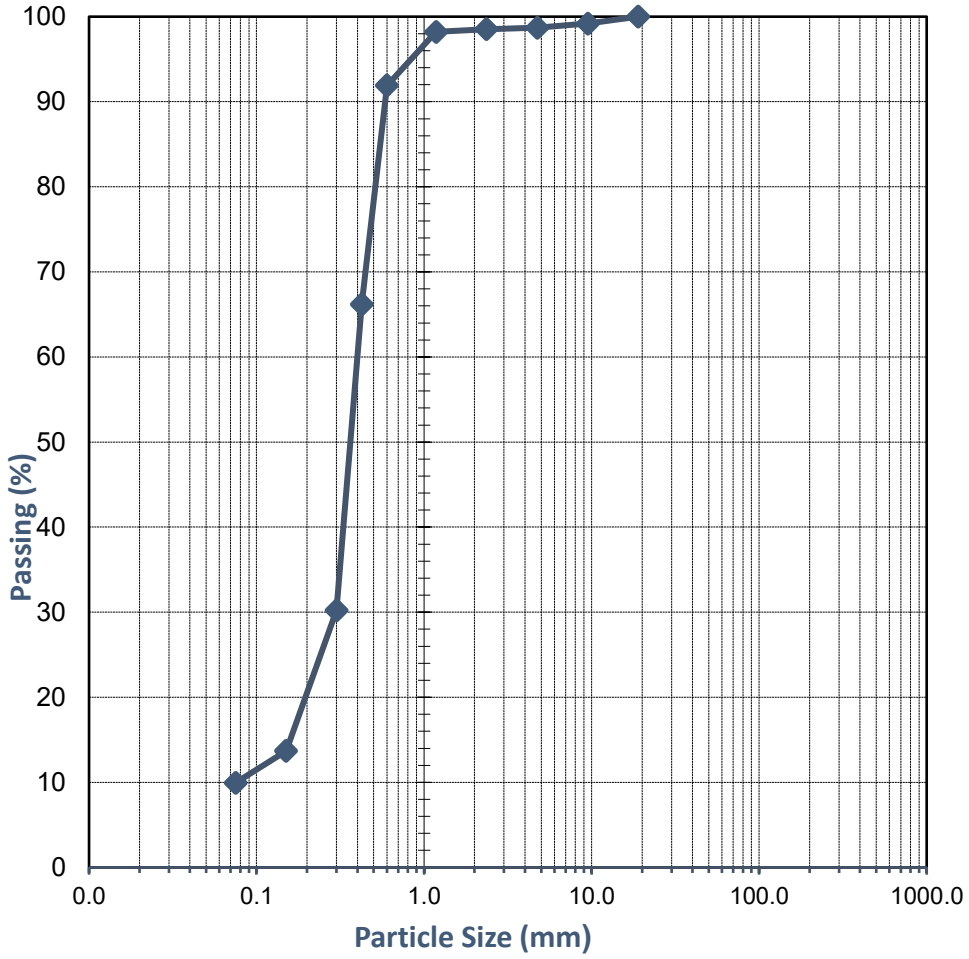
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10771_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10771
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH142 (1.5-1.7m)	*Date Tested:*	18/06-19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	99
4.75	99
2.36	99
1.18	98
0.600	92
0.425	66
0.300	30
0.150	14
0.075	10



Comments:

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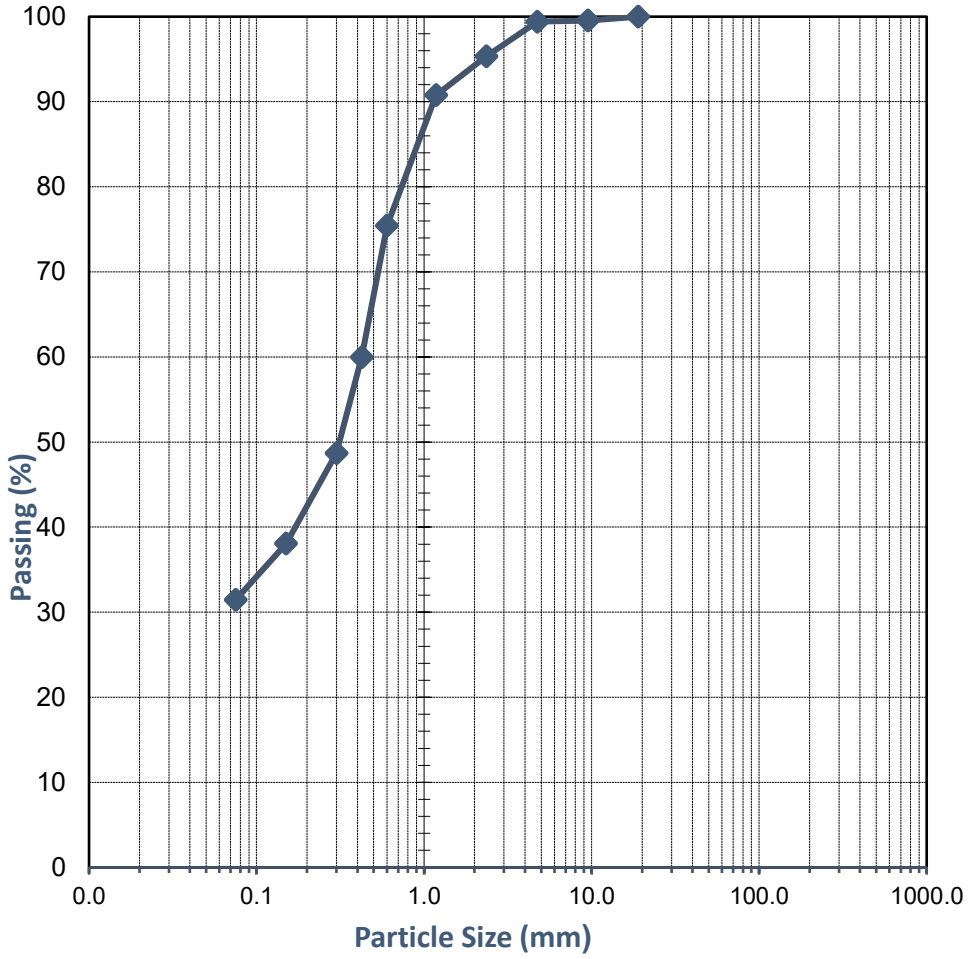
TEST REPORT - AS 1289.3.6.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10698_1_PSD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10698
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH45 (0.3-0.65m)	*Date Tested:*	18/06-19/06/2025

TEST RESULTS - Particle Size Distribution of Soil

Sampling Method: Sampled by Client, Tested as Received

Sieve Size (mm)	Percent Passing Sieve (%)
150.0	
100.0	
75.0	
37.5	
19.0	100
9.5	100
4.75	99
2.36	95
1.18	91
0.600	75
0.425	60
0.300	49
0.150	38
0.075	31



Comments:

Approved Signatory:

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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10696_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10696
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH10 (0.2-0.6m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**19**
AS 1289.3.2.1	**Plastic Limit (%)**	**15**
AS 1289.3.3.1	**Plasticity Index (%)**	**4**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**2.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 23/June/2025

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WESTERN GEOTECHNICAL & Laboratory Services

SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10692_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10692
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH76 (0.1-0.6m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**71**
AS 1289.3.2.1	**Plastic Limit (%)**	**20**
AS 1289.3.3.1	**Plasticity Index (%)**	**51**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**20.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Curled**

Comments:

Approved Signatory:



Name: Cody O'Neill

Date: 23/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.2, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10709_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10709
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH148 (1.8-2m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.2	**Liquid Limit (%)**	**34**
AS 1289.3.2.1	**Plastic Limit (%)**	**18**
AS 1289.3.3.1	**Plasticity Index (%)**	**16**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**9.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**125**
AS 1289.3.4.1	**Condition of Dry Specimen**	**Cracked**

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10706_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10706
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH123 (2.5-3m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**35**
AS 1289.3.2.1	**Plastic Limit (%)**	**15**
AS 1289.3.3.1	**Plasticity Index (%)**	**20**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**10.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10705_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10705
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH109 (1-1.3m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**44**
AS 1289.3.2.1	**Plastic Limit (%)**	**19**
AS 1289.3.3.1	**Plasticity Index (%)**	**25**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**11.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Curled**

Comments:

Approved Signatory:



Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10697_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10697
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH03 (0.15-0.5m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**29**
AS 1289.3.2.1	**Plastic Limit (%)**	**16**
AS 1289.3.3.1	**Plasticity Index (%)**	**13**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**7.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10695_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10695
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH96 (0.1-0.5m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**23**
AS 1289.3.2.1	**Plastic Limit (%)**	**15**
AS 1289.3.3.1	**Plasticity Index (%)**	**8**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**4.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Cracked**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10694_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10694
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH139 (0.1-0.6m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**Not Obtainable**
AS 1289.3.2.1	**Plastic Limit (%)**	**Non-Plastic**
AS 1289.3.3.1	**Plasticity Index (%)**	**Non-Plastic**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**0.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10693_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10693
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH102 (0.1-0.6m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**41**
AS 1289.3.2.1	**Plastic Limit (%)**	**15**
AS 1289.3.3.1	**Plasticity Index (%)**	**26**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**12.0**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**Curled**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.3.1.1, 3.2.1, 3.3.1 & 3.4.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10691_1_PI
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10691
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH73 (0.1-0.6m)	*Date Tested:*	19/06/2025

TEST RESULTS - Consistency Limits (Casagrande)

Sampling Method:	**Sampled by Client, Tested as Received**
History of Sample:	**Oven Dried <50°C**
Method of Preparation:	**Dry Sieved**

AS 1289.3.1.1	**Liquid Limit (%)**	**33**
AS 1289.3.2.1	**Plastic Limit (%)**	**15**
AS 1289.3.3.1	**Plasticity Index (%)**	**18**
AS 1289.3.4.1	**Linear Shrinkage (%)**	**8.5**
AS 1289.3.4.1	**Length of Mould (mm)**	**250**
AS 1289.3.4.1	**Condition of Dry Specimen:**	**-**

Comments:

Approved Signatory:

Name: Cody O'Neill

Date: 20/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10696_1_MMDD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10696
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH10 (0.2-0.6m)	*Date Tested:*	18/06/2025

TEST RESULTS - Modified Maximum Dry Density

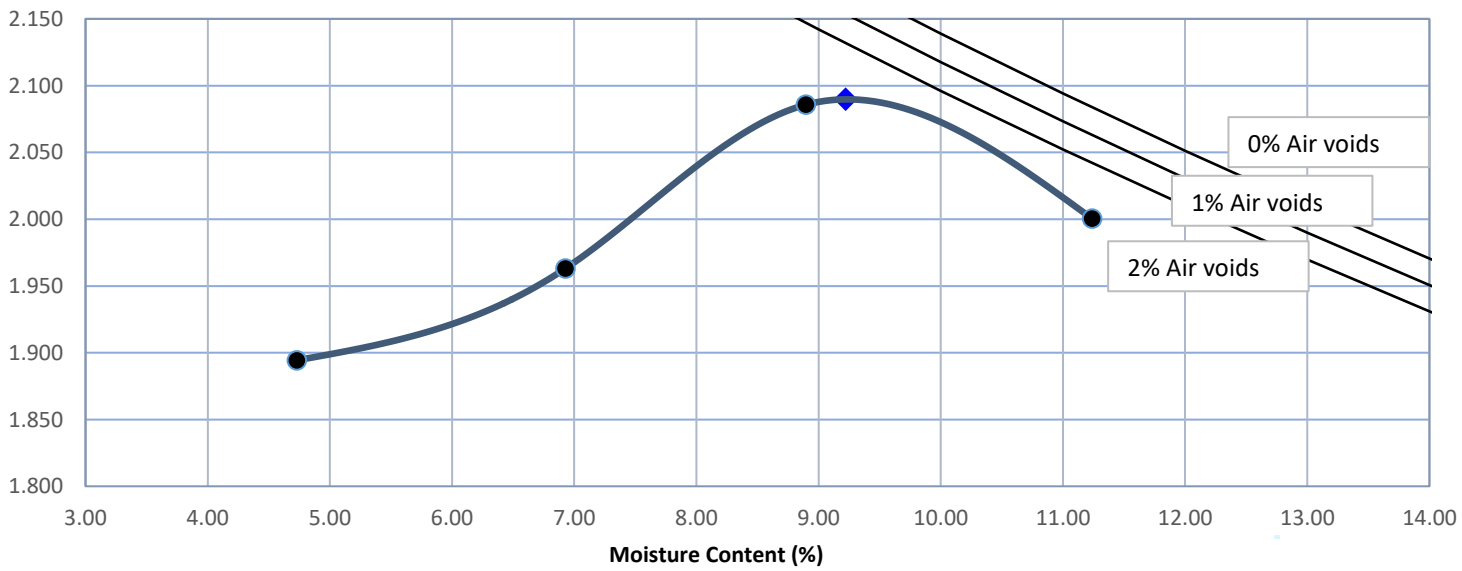
Sampling Method: Sampled by Client, Tested as Received

Sample Curing Time (Hours): >120

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 0 **Material + 37.5mm (%)** -

Moisture Content (%)	**4.7**	**6.9**	**8.9**	**11.2**	
Dry Density (t/m³)	**1.894**	**1.963**	**2.086**	**2.000**	



Modified Maximum Dry Density (t/m³) **2.09**

Optimum Moisture Content (%) **9.0**

Comments: *The above air void lines are derived from a calculated apparent particle density of 2.721 t/m³*

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10695_1_MMDD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10695
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH96 (0.1-0.5m)	*Date Tested:*	18/06/2025

TEST RESULTS - Modified Maximum Dry Density

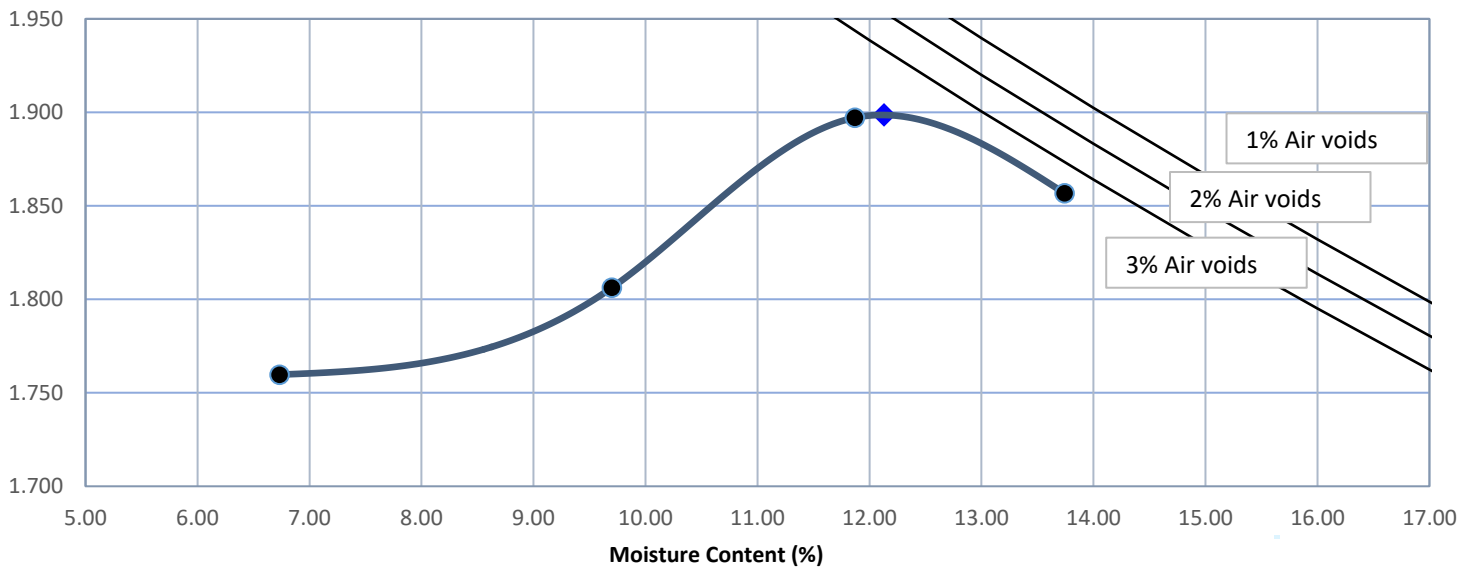
Sampling Method: Sampled by Client, Tested as Received

Sample Curing Time (Hours): >2

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 0 **Material + 37.5mm (%)** -

Moisture Content (%)	**6.7**	**9.7**	**11.9**	**13.7**	
Dry Density (t/m³)	**1.760**	**1.806**	**1.897**	**1.857**	



Modified Maximum Dry Density (t/m³) **1.90**

Optimum Moisture Content (%) **12.0**

Comments: *The above air void lines are derived from a calculated apparent particle density of 2.629 t/m³*

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10694_1_MMDD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10694
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH139 (0.1-0.6m)	*Date Tested:*	18/06/2025

TEST RESULTS - Modified Maximum Dry Density

Sampling Method: Sampled by Client, Tested as Received

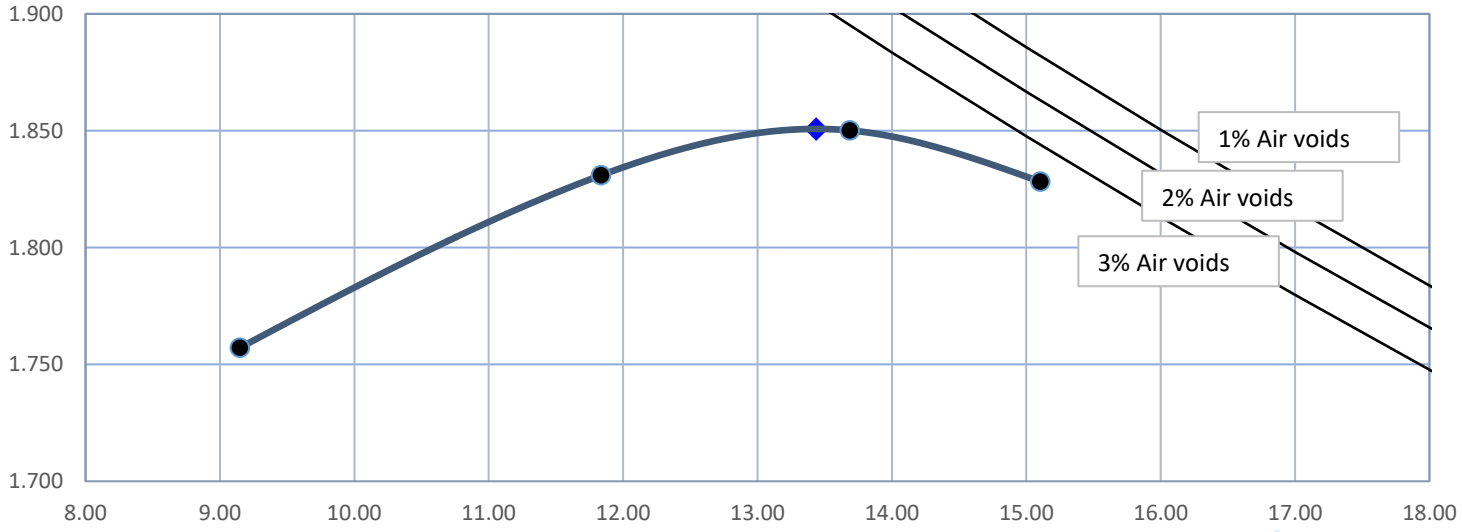
Sample Curing Time (Hours): >2

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 0 **Material + 37.5mm (%)** -

Moisture Content (%)	**9.1**	**11.8**	**13.7**	**15.1**	
Dry Density (t/m³)	**1.757**	**1.831**	**1.850**	**1.828**	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³) **1.85**

Optimum Moisture Content (%) **13.5**

Comments: *The above air void lines are derived from a calculated apparent particle density of 2.667 t/m³*

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10693_1_MMDD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10693
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH102 (0.1-0.6m)	*Date Tested:*	18/06/2025

TEST RESULTS - Modified Maximum Dry Density

Sampling Method: Sampled by Client, Tested as Received

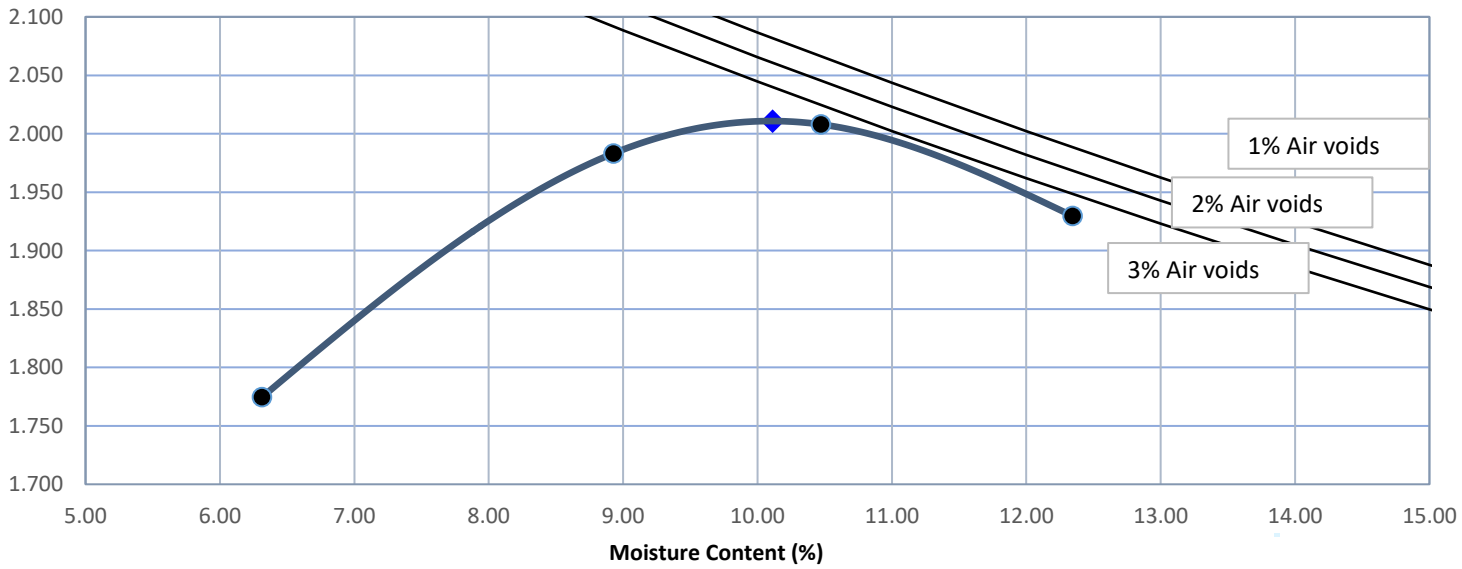
Sample Curing Time (Hours): >120

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 0 **Material + 37.5mm (%)** -

Moisture Content (%)	**6.3**	**8.9**	**10.5**	**12.3**	
Dry Density (t/m³)	**1.775**	**1.983**	**2.008**	**1.930**	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³) **2.01**

Optimum Moisture Content (%) **10.0**

Comments: *The above air void lines are derived from a calculated apparent particle density of 2.671 t/m³*

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10692_1_MMDD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10692
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH76 (0.1-0.6m)	*Date Tested:*	18/06/2025

TEST RESULTS - Modified Maximum Dry Density

Sampling Method: Sampled by Client, Tested as Received

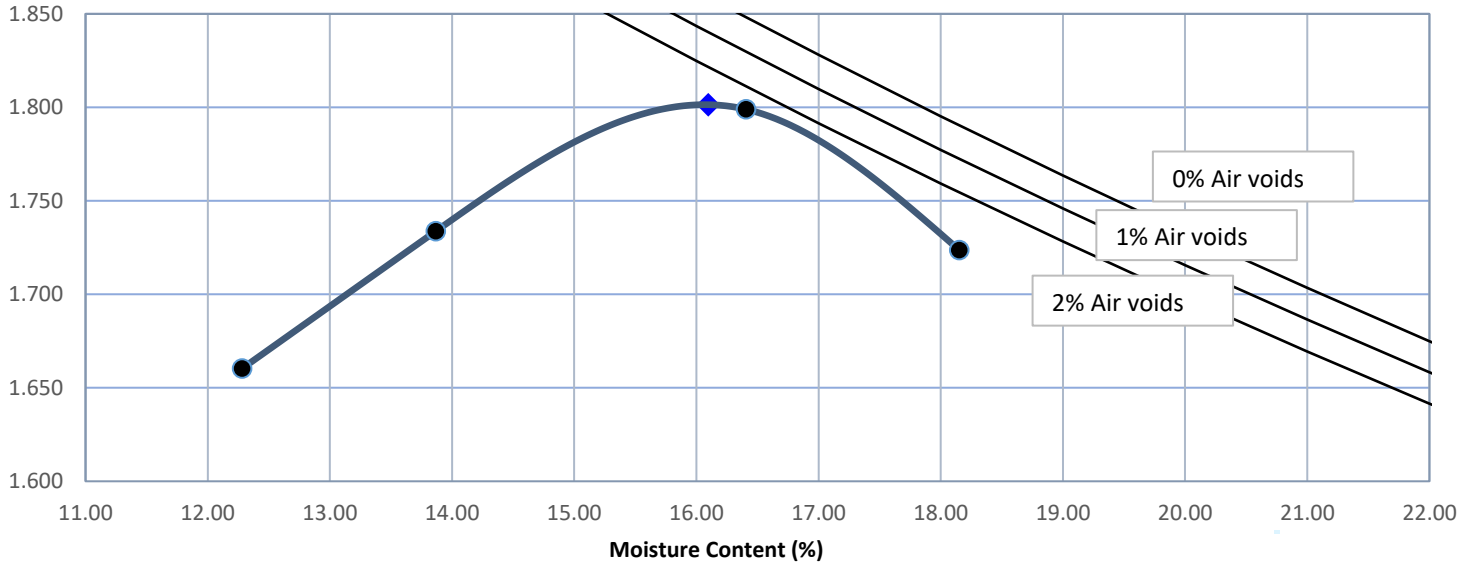
Sample Curing Time (Hours): >120

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 0 **Material + 37.5mm (%)** -

Moisture Content (%)	**12.3**	**13.9**	**16.4**	**18.2**	
Dry Density (t/m³)	**1.660**	**1.734**	**1.799**	**1.724**	

Dry Density (t/m³)



Modified Maximum Dry Density (t/m³) **1.80**

Optimum Moisture Content (%) **16.0**

Comments: *The above air void lines are derived from a calculated apparent particle density of 2.652 t/m³*

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.5.2.1

Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10691_1_MMDD
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10691
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH73 (0.1-0.6m)	*Date Tested:*	18/06/2025

TEST RESULTS - Modified Maximum Dry Density

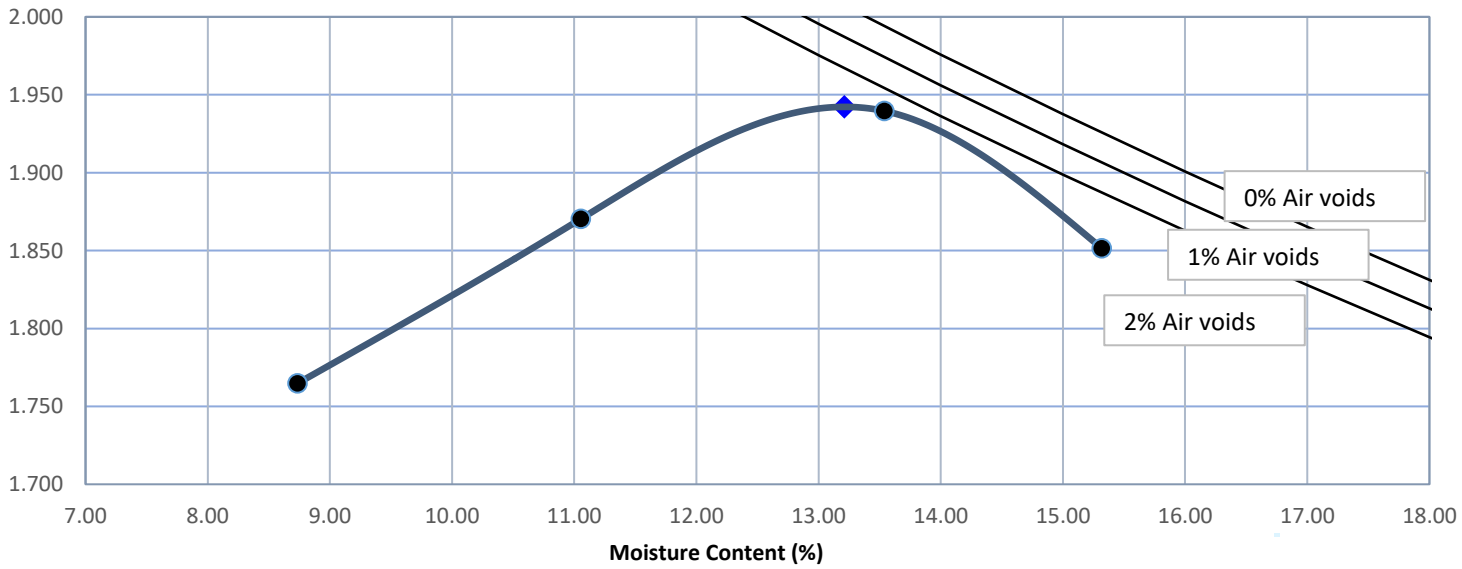
Sampling Method: Sampled by Client, Tested as Received

Sample Curing Time (Hours): >120

Method used to Determine Liquid Limit: Visual / Tactile Assessment by Competent Technician

Material + 19.0mm (%): 1 **Material + 37.5mm (%)** -

Moisture Content (%)	**8.7**	**11.1**	**13.5**	**15.3**	
Dry Density (t/m³)	**1.765**	**1.870**	**1.940**	**1.852**	



Modified Maximum Dry Density (t/m³) **1.94**

Optimum Moisture Content (%) **13.0**

Comments: *The above air void lines are derived from a calculated apparent particle density of 2.731 t/m³*

Approved Signatory:

Name: Matthew Lichon

Date: 19/June/2025

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SOIL | AGGREGATE | CONCRETE | CRUSHING

TEST REPORT - AS 1289.6.1.1

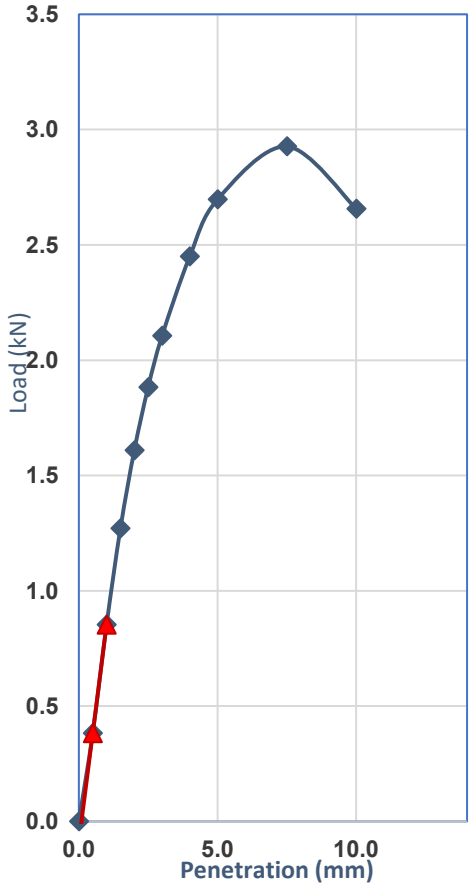
Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10695_1_SCBR
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10695
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH96 (0.1-0.5m)	*Date Tested:*	18/06 - 24/06/2025

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description: Silty Sand

Sampling Method: Sampled by Client, Tested as Received

Load Penetration Curve



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	>24
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m^3)	1.90	Optimum Moisture (%)	12.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.80	Moisture Content (%)	11.9
Density Ratio (%)	95.0	Moisture Ratio (%)	98.5

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.0
Dry Density (t/m³)	1.80	Dry Density Ratio (%)	95.0
Moisture Content (%)	15.1	Moisture Ratio (%)	125.0

Specimen Conditions After Test			
Top 30mm Moisture (%)	13.1	Remaining Depth (%)	15.4

Correction applied to Penetration: 0.1mm

Determined at a Penetration of: 2.5mm

California Bearing Ratio (CBR): 15%

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 25/June/2025

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TEST REPORT - AS 1289.6.1.1

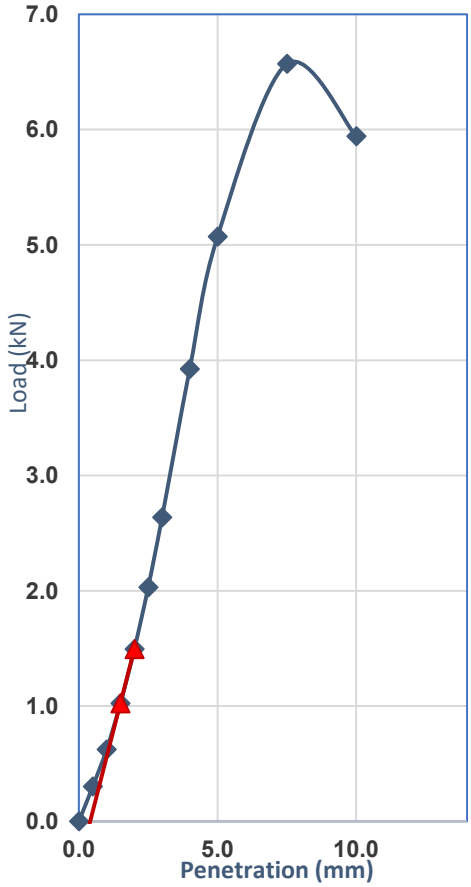
Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10694_1_SCBR
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10694
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH139 (0.1-0.6m)	*Date Tested:*	18/06 - 24/06/2025

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description: Sand

Sampling Method: Sampled by Client, Tested as Received

Load Penetration Curve



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	>24
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m^3)	1.85	Optimum Moisture (%)	13.5
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.75	Moisture Content (%)	13.6
Density Ratio (%)	94.5	Moisture Ratio (%)	101.5

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.0
Dry Density (t/m³)	1.75	Dry Density Ratio (%)	94.5
Moisture Content (%)	15.5	Moisture Ratio (%)	116.0

Specimen Conditions After Test			
Top 30mm Moisture (%)	14.4	Remaining Depth (%)	15.6

Correction applied to Penetration: 0.4mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 25%

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 25/June/2025

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TEST REPORT - AS 1289.6.1.1

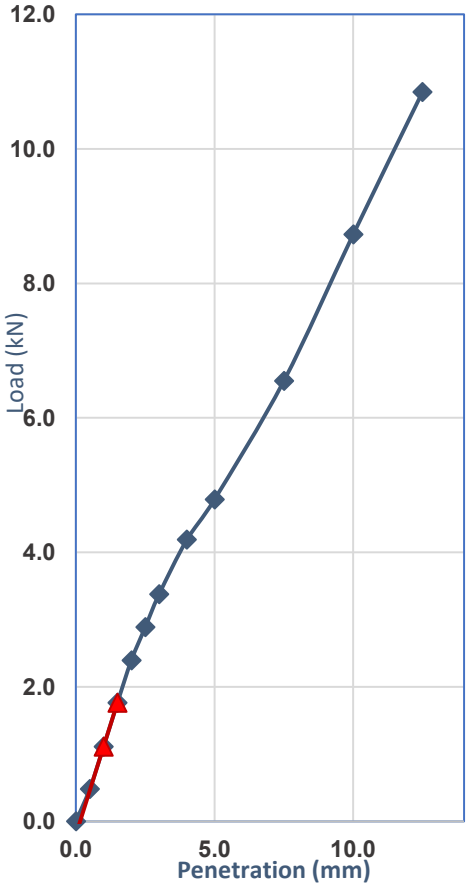
Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10696_1_SCBR
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10696
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH10 (0.2-0.6m)	*Date Tested:*	18/06 - 24/06/2025

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description: Silty Sand with Gravel

Sampling Method: Sampled by Client, Tested as Received

Load Penetration Curve



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	>24
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m^3)	2.09	Optimum Moisture (%)	9.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.98	Moisture Content (%)	9.5
Density Ratio (%)	94.5	Moisture Ratio (%)	103.5

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.0
Dry Density (t/m³)	1.98	Dry Density Ratio (%)	94.5
Moisture Content (%)	12.4	Moisture Ratio (%)	135.0

Specimen Conditions After Test			
Top 30mm Moisture (%)	10.2	Remaining Depth (%)	12.1

Correction applied to Penetration: 0.2mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 25%

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 25/June/2025

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TEST REPORT - AS 1289.6.1.1

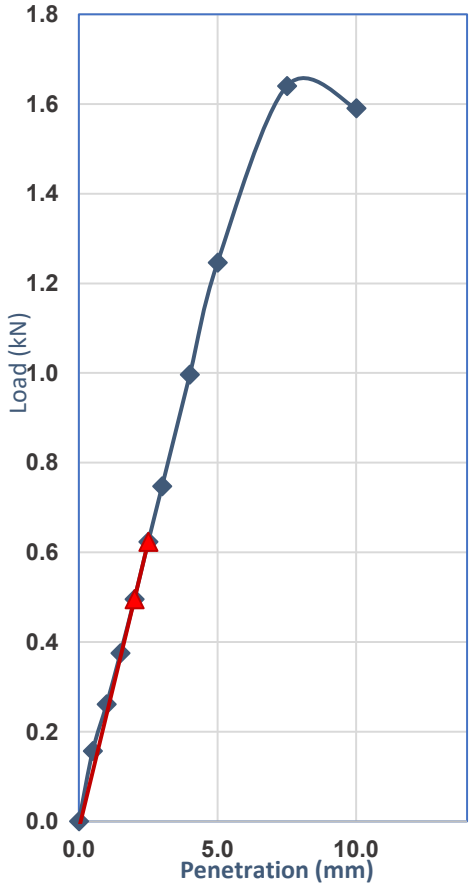
Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10693_1_SCBR
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10693
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH102 (0.1-0.6m)	*Date Tested:*	18/06 - 24/06/2025

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description: Clayey Sand trace Gravel

Sampling Method: Sampled by Client, Tested as Received

Load Penetration Curve



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	>24
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m^3)	2.01	Optimum Moisture (%)	10.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.91	Moisture Content (%)	10.2
Density Ratio (%)	95.0	Moisture Ratio (%)	101.0

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.5
Dry Density (t/m³)	1.90	Dry Density Ratio (%)	94.5
Moisture Content (%)	14.1	Moisture Ratio (%)	139.0

Specimen Conditions After Test			
Top 30mm Moisture (%)	15.0	Remaining Depth (%)	14.6

Correction applied to Penetration: 0.1mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 6%

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 25/June/2025

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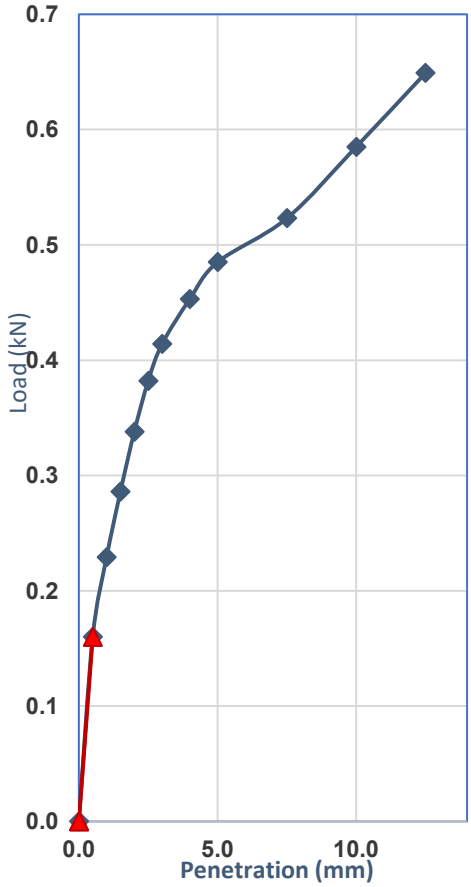
Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10692_1_SCBR
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10692
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH76 (0.1-0.6m)	*Date Tested:*	18/06 - 24/06/2025

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description: Sandy Clay trace Gravel

Sampling Method: Sampled by Client, Tested as Received

Load Penetration Curve



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	>24
% Retained 19.0mm	0	Excluded/Replaced	Excluded
Maximum Dry Density (t/m^3)	1.80	Optimum Moisture (%)	16.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.70	Moisture Content (%)	16.6
Density Ratio (%)	94.5	Moisture Ratio (%)	103.0

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	2.0
Dry Density (t/m³)	1.67	Dry Density Ratio (%)	92.5
Moisture Content (%)	25.4	Moisture Ratio (%)	158.0

Specimen Conditions After Test			
Top 30mm Moisture (%)	26.7	Remaining Depth (%)	22.0

Correction applied to Penetration: 0mm

Determined at a Penetration of: 2.5mm

California Bearing Ratio (CBR): 3%

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 25/June/2025

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TEST REPORT - AS 1289.6.1.1

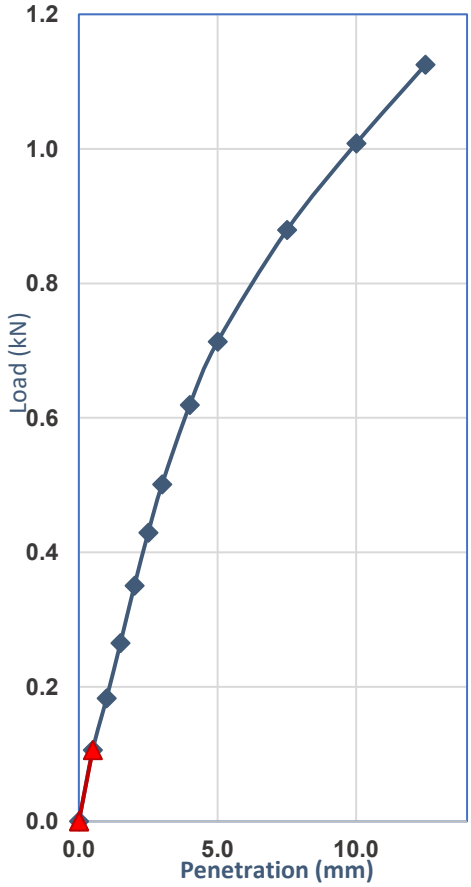
Client:	Parkridge Group Pty Ltd	*Ticket No.*	S17756
Client Address:	-	*Report No.*	WG25.10691_1_SCBR
Project:	Proposed Residential Subdivision	*Sample No.*	WG25.10691
Location:	Parkridge Estate, Eaton WA	*Date Sampled:*	Not Specified
Sample Identification:	BH73 (0.1-0.6m)	*Date Tested:*	18/06 - 24/06/2025

TEST RESULTS - CALIFORNIA BEARING RATIO

Sample Description: Sandy Clay with Gravel

Sampling Method: Sampled by Client, Tested as Received

Load Penetration Curve



Compaction Details			
Compaction Method	AS 1289.5.2.1	Hammer Type	Modified
Plasticity Determined by	Estimated	Curing Time (Hours)	>24
% Retained 19.0mm	1	Excluded/Replaced	Excluded
Maximum Dry Density (t/m^3)	1.94	Optimum Moisture (%)	13.0
Target Dry Density Ratio (%)	95	Target Moisture Ratio (%)	100

Specimen Conditions At Compaction			
Dry Density (t/m3)	1.84	Moisture Content (%)	13.4
Density Ratio (%)	95.0	Moisture Ratio (%)	101.0

Specimen Conditions After Soak			
Soaked or Unsoaked	Soaked	Soaking Period (days)	4
Surcharges Applied (kg)	4.50	Measured Swell (%)	0.5
Dry Density (t/m³)	1.83	Dry Density Ratio (%)	94.0
Moisture Content (%)	17.0	Moisture Ratio (%)	128.5

Specimen Conditions After Test			
Top 30mm Moisture (%)	16.1	Remaining Depth (%)	15.5

Correction applied to Penetration: 0mm

Determined at a Penetration of: 5.0mm

California Bearing Ratio (CBR): 3.5%

Comments:

Approved Signatory:

Name: Madhav Basnet

Date: 25/June/2025

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Appendix D: Environmental Results Table and Laboratory Certificates

Field Observations						Lab pH	Chromium Reducible Sulfur Suite			Acid Sulfate Soil Classification
Sample ID		pH_f	pH_{fox}	$pH_f - pH_{fox}$	Reaction Rate	pH_{KCl}	Titratable Actual Acidity	Chromium Reducible Sulfur	Net Acidity	
Location	Depth (m)	pH units	pH units	pH units	LMHXV	pH units	%S	%S	%S	
		4	4	1	NV	NV	0.03	0.03	0.03	NV
BH01	0.00	7.3	4.9	2.4	L	...	...	...	...	...
	0.25	6.9	4.9	2.0	L	...	...	...	...	...
	0.50	6.8	5.0	1.8	L	...	...	...	...	...
	0.75	6.6	5.1	1.5	L	...	...	...	...	...
	1.00	6.9	5.3	1.6	L	...	...	...	...	...
	1.25	6.9	5.4	1.5	L	5.8	0.010	<0.005	<0.02	NASS
	1.50	7.0	5.8	1.2	L	...	...	...	...	...
	1.75	6.7	5.9	0.8	M	...	...	...	...	...
	2.00	6.6	5.7	0.9	L	...	...	...	...	...
	2.25	6.7	5.7	1.0	M	4.7	0.040	0.005	0.05	ASS
	2.50	6.8	5.5	1.3	L	...	...	...	...	...
	2.75	7.6	5.4	2.2	L	...	...	...	...	...
	3.00	7.5	5.5	2.0	L	5.0	0.020	<0.005	0.02	NASS
BH02	0.00	6.7	5.1	1.6	L	...	...	...	...	...
	0.25	6.4	5.0	1.4	L	...	...	...	...	...
	0.50	6.4	5.4	1.0	L	...	...	...	...	...
	0.75	6.3	5.5	0.8	L	6.0	0.010	<0.005	<0.02	NASS
	1.00	6.4	5.7	0.7	L	...	...	...	...	...
	1.25	5.9	5.2	0.7	L	5.7	0.010	<0.005	<0.02	NASS
	1.50	6.3	4.9	1.4	L	...	...	...	...	...
	1.25	8.0	5.0	3.0	L	...	...	...	...	...
	1.50	8.0	5.0	3.0	L	...	...	...	...	...
	1.75	7.8	5.2	2.6	L	5.3	0.020	<0.005	0.02	NASS
	2.00	8.1	5.2	2.9	L	...	...	...	...	...
	2.25	8.0	5.3	2.7	L	...	...	...	...	...
	2.50	8.0	4.9	3.1	L	...	...	...	...	...
	2.75	7.7	4.7	3.0	L	5.0	0.030	<0.005	0.03	ASS
	3.00	7.4	4.9	2.5	L	...	...	...	...	...
BH20	0.00	6.9	2.5	4.4	H	...	...	...	...	...
	0.25	6.6	2.8	3.8	H	...	...	...	...	...
	0.50	6.4	3.1	3.3	L	...	...	...	...	...
	0.75	6.3	3.2	3.1	L	5.9	<0.003	<0.005	<0.02	NASS
	1.00	6.4	3.6	2.8	L	...	...	...	...	...
	1.25	6.4	3.6	2.8	L					
	1.50	6.4	3.6	2.8	L	...	...	...	...	...
	1.75	6.5	3.8	2.7	L	...	...	...	...	...
	2.00	6.4	3.8	2.6	L	5.2	0.020	<0.005	0.02	NASS
	2.25	6.7	3.9	2.8	L	...	...	...	...	...
	2.50	6.8	4.7	2.1	L	...	...	...	...	...
	2.75	6.8	4.7	2.1	L	5.7	0.010	<0.005	<0.02	NASS
	3.00	7.1	4.6	2.5	L	...	...	...	...	...

Field Observations						Lab pH	Chromium Reducible Sulfur Suite			Acid Sulfate Soil Classification
Sample ID		pH_f	pH_{fox}	$pH_f - pH_{fox}$	Reaction Rate	pH_{KCl}	Titratable Actual Acidity	Chromium Reducible Sulfur	Net Acidity	
Location	Depth (m)	pH units	pH units	pH units	LMHXV	pH units	%S	%S	%S	
		4	4	1	NV	NV	0.03	0.03	0.03	NV
BH54	0.00	5.0	3.4	1.6	M	...	...	...	...	...
	0.25	5.2	3.4	1.8	L	...	...	...	...	...
	0.50	8.1	5.0	3.1	L	...	...	...	...	...
	0.75	8.0	5.3	2.7	L	...	...	...	...	...
	1.00	7.5	5.2	2.3	L	5.8	0.010	<0.005	<0.02	NASS
	1.25	7.6	5.4	2.2	L	...	...	...	...	...
	1.50	7.6	5.5	2.1	L	...	...	...	...	...
	1.75	6.4	5.6	0.8	L	...	...	...	...	...
	2.00	6.2	5.4	0.8	L	5.0	0.020	<0.005	0.02	NASS
	2.25	6.0	5.7	0.3	L	...	...	...	...	...
	2.50	6.1	6.0	0.1	L	...	...	...	...	...
	2.75	6.3	6.4	-0.1	L	...	...	...	...	...
	3.00	6.4	5.9	0.5	L	5.1	0.020	<0.005	0.02	NASS
BH86	0.25	6.7	5.3	1.4	L	...	...	...	...	...
	0.50	6.5	5.2	1.3	L	5.7	0.010	<0.005	<0.02	NASS
	0.75	6.4	5.3	1.1	L	...	...	...	...	...
	1.00	6.5	5.3	1.2	L	...	...	...	...	...
	1.25	6.6	5.2	1.4	L	...	...	...	...	...
	1.50	6.7	5.1	1.6	L	5.2	0.010	0.008	0.02	NASS
	1.75	6.8	3.7	3.1	M	...	...	...	...	...
	2.00	6.8	3.1	3.7	H	...	...	...	...	...
	2.25	6.8	5.1	1.7	L	...	...	...	...	...
	2.50	6.7	5.0	1.7	M	4.9	0.020	0.12	0.14	NASS
	2.75	6.9	2.8	4.1	H	...	...	...	...	...
	3.00	6.9	2.8	4.1	H	4.8	0.020	0.12	0.14	NASS
BH97	0.00	6.9	5.0	1.9	L	...	...	...	...	...
	0.25	7.0	5.0	2.0	L	...	...	...	...	...
	0.50	6.5	5.0	1.5	L	5.5	0.020	<0.005	0.02	NASS
	0.75	6.5	5.0	1.5	L	...	...	...	...	...
	1.00	6.4	5.0	1.4	L	...	...	...	...	...
	1.25	6.5	5.4	1.1	L	...	...	...	...	...
	1.50	6.5	5.5	1.0	L	5.6	0.010	0.006	0.02	NASS
	1.75	6.6	5.5	1.1	L	...	...	...	...	...
	2.00	6.8	5.7	1.1	L	...	...	...	...	...
	2.25	7.1	5.8	1.3	L	...	...	...	...	...
	2.50	7.0	5.6	1.4	L	5.6	0.020	<0.005	0.02	NASS
	2.75	7.1	5.5	1.6	L	...	...	...	...	...

eurofins | Environment Testing

Galt Environment P/L
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Osborne Park
WA 6017

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Attention: **- ALL SRA/Results**

Report **1232856-S-V2**
Project name PARKRIDGE EATON
Project ID WAG190133
Received Date Jun 16, 2025

Client Sample ID			**BH01/1.25**	**BH01/2.25**	**BH01/3.0**	**BH02/0.75**
Sample Matrix			**Soil**	**Soil**	**Soil**	**Soil**
Eurofins Sample No.			**L25-Jn0040997**	**L25-Jn0040998**	**L25-Jn0040999**	**L25-Jn0041000**
Date Sampled			**Jun 03, 2025**	**Jun 03, 2025**	**Jun 03, 2025**	**Jun 03, 2025**
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	110	77	110	110
>2mm Fraction	0.005	g	9.9	19	7.4	9.4
Analysed Material	0.1	%	92	80	94	92
Extraneous Material	0.1	%	8.3	20	6.3	7.7
Chromium Suite - NASSG (Excluding ANC)						
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	2.1	1.2	< 1
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	29	15	< 10
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	0.05	0.02	< 0.02
pH-KCL (NLM-3.1)	0.1	pH Units	5.8	4.7	5.0	6.0
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	4.0	25	15	3.0
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	0.010	0.040	0.020	0.010
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)[S04]	0.005	% S	< 0.005	0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	3	mol H+/t	< 3	3.3	< 3	< 3
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	N/A	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	0.05	0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	29	15	< 10
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	2.1	1.2	< 1
% Moisture	1	%	18	17	22	7.9

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Client Sample ID			BH02/1.75	BH02/2.75	BH54/1.0	BH54/2.0
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L25-Jn0041001	L25-Jn0041002	L25-Jn0041003	L25-Jn0041004
Date Sampled			Jun 03, 2025	Jun 03, 2025	Jun 03, 2025	Jun 03, 2025
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	130	75	110	90
>2mm Fraction	0.005	g	7.9	< 0.005	7.1	6.9
Analysed Material	0.1	%	94	100	94	93
Extraneous Material	0.1	%	5.9	< 0.1	6.2	7.1
Chromium Suite - NASSG (Excluding ANC)						
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	1.4	< 1	1.1
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	13	19	< 10	15
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	0.02	0.03	< 0.02	0.02
pH-KCL (NLM-3.1)	0.1	pH Units	5.3	5.0	5.8	5.0
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	13	19	7.0	15
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	0.020	0.030	0.010	0.020
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)[S04]	0.005	% S	< 0.005	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3	< 3
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	N/A	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	0.02	0.03	< 0.02	0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	13	19	< 10	15
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	1.4	< 1	1.1
% Moisture	1	%	25	32	9.7	13

Client Sample ID			BH54/3.0	BH97/2.5	BH97/1.5	BH97/0.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L25-Jn0041005	L25-Jn0041006	L25-Jn0041007	L25-Jn0041008
Date Sampled			Jun 03, 2025	Jun 03, 2025	Jun 03, 2025	Jun 03, 2025
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	90	45	93	110
>2mm Fraction	0.005	g	5.2	< 0.005	8.8	< 0.005
Analysed Material	0.1	%	95	100	91	100
Extraneous Material	0.1	%	5.5	< 0.1	8.6	< 0.1
Chromium Suite - NASSG (Excluding ANC)						
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	1.0	< 1	< 1	1.1
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	14	10	13	15
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	0.02	0.02	0.02	0.02
pH-KCL (NLM-3.1)	0.1	pH Units	5.1	5.6	5.6	5.5
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	14	10	9.0	15
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	0.020	0.020	0.010	0.020
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)[S04]	0.005	% S	< 0.005	< 0.005	0.006	< 0.005
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	3	mol H+/t	< 3	< 3	3.9	< 3

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Client Sample ID			BH54/3.0	BH97/2.5	BH97/1.5	BH97/0.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L25-Jn0041005	L25-Jn0041006	L25-Jn0041007	L25-Jn0041008
Date Sampled			Jun 03, 2025	Jun 03, 2025	Jun 03, 2025	Jun 03, 2025
Test/Reference	LOR	Unit				
Chromium Suite - NASSG (Excluding ANC)						
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	N/A	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	0.02	0.02	0.02	0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	14	10	13	15
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	1.0	< 1	< 1	1.1
% Moisture	1	%	18	27	25	14

Client Sample ID			BH86/0.5	BH86/1.5	BH86/3.0	BH86/2.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L25-Jn0041009	L25-Jn0041010	L25-Jn0041011	L25-Jn0041012
Date Sampled			Jun 03, 2025	Jun 03, 2025	Jun 03, 2025	Jun 03, 2025
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	82	130	150	160
>2mm Fraction	0.005	g	< 0.005	11	< 0.005	< 0.005
Analysed Material	0.1	%	100	92	100	100
Extraneous Material	0.1	%	< 0.1	7.9	< 0.1	< 0.1
Chromium Suite - NASSG (Excluding ANC)						
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	6.4	6.5
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	13	85	87
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	0.02	0.14	0.14
pH-KCL (NLM-3.1)	0.1	pH Units	5.7	5.2	4.8	4.9
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	3.0	8.0	12	11
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	0.010	0.010	0.020	0.020
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)[S04]	0.005	% S	< 0.005	0.008	0.12	0.12
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	3	mol H+/t	< 3	5.0	73	76
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	N/A	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	0.02	0.14	0.14
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	13	85	87
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	< 1	6.4	6.5

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Client Sample ID			BH86/0.5	BH86/1.5	BH86/3.0	BH86/2.5
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L25-Jn0041009	L25-Jn0041010	L25-Jn0041011	L25-Jn0041012
Date Sampled			Jun 03, 2025	Jun 03, 2025	Jun 03, 2025	Jun 03, 2025
Test/Reference	LOR	Unit				
% Moisture	1	%	13	16	16	14

Client Sample ID			BH20/0.75	BH2./1.25	BH20/2.00	BH20/2.75
Sample Matrix			Soil	Soil	Soil	Soil
Eurofins Sample No.			L25-Jn0041013	L25-Jn0041014	L25-Jn0041015	L25-Jn0041016
Date Sampled			Jun 03, 2025	Jun 03, 2025	Jun 03, 2025	Jun 03, 2025
Test/Reference	LOR	Unit				
Extraneous Material						
<2mm Fraction	0.005	g	90	130	65	120
>2mm Fraction	0.005	g	3.2	4.3	< 0.005	14
Analysed Material	0.1	%	97	97	100	89
Extraneous Material	0.1	%	3.5	3.1	< 0.1	11
Chromium Suite - NASSG (Excluding ANC)						
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	< 1	< 1	1.0	< 1
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	< 10	< 10	13	< 10
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	< 0.02	< 0.02	0.02	< 0.02
pH-KCL (NLM-3.1)	0.1	pH Units	5.9	5.7	5.2	5.7
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	3.0	6.0	13	6.0
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	< 0.003	0.010	0.020	0.010
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)[S04]	0.005	% S	< 0.005	< 0.005	< 0.005	< 0.005
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	3	mol H+/t	< 3	< 3	< 3	< 3
Sulfur - KCl Extractable	0.005	% S	N/A	N/A	N/A	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0	2.0	2.0	2.0
HCl Extractable Sulfur	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A	N/A	N/A	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A	N/A	N/A	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	N/A	N/A	N/A	N/A
ANC Fineness Factor		factor	1.5	1.5	1.5	1.5
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	< 0.02	< 0.02	0.02	< 0.02
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	< 10	< 10	13	< 10
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	< 1	< 1	1.0	< 1
% Moisture	1	%	3.4	15	24	9.0

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Client Sample ID			QC101
Sample Matrix			Soil
Eurofins Sample No.			L25-Jn0041017
Date Sampled			Jun 03, 2025
Test/Reference	LOR	Unit	
Extraneous Material			
<2mm Fraction	0.005	g	64
>2mm Fraction	0.005	g	< 0.005
Analysed Material	0.1	%	100
Extraneous Material	0.1	%	< 0.1
Chromium Suite - NASSG (Excluding ANC)			
CRS Suite - Liming Rate - NASSG (Excluding ANC)	1	kg CaCO3/t	1.2
CRS Suite - Net Acidity - NASSG (Excluding ANC)	10	mol H+/t	16
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	0.02	% S	0.03
pH-KCL (NLM-3.1)	0.1	pH Units	5.4
Titratable Actual Acidity (NLM-3.2)	2	mol H+/t	16
Titratable Actual Acidity (NLM-3.2)	0.003	% pyrite S	0.030
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)[S04]	0.005	% S	< 0.005
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	3	mol H+/t	< 3
Sulfur - KCl Extractable	0.005	% S	N/A
HCl Extractable Sulfur Correction Factor	1	factor	2.0
HCl Extractable Sulfur	0.005	% S	N/A
Net Acid soluble sulfur (SNAS) NLM-4.1	0.005	% S	N/A
Net Acid soluble sulfur (a-SNAS) NLM-4.1	2	mol H+/t	N/A
Net Acid soluble sulfur (s-SNAS) NLM-4.1[S02]	0.005	% S	N/A
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	0.01	% CaCO3	N/A
Acid Neutralising Capacity - (a-ANCbt) (NLM-5.2)	2	mol H+/t	N/A
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)[S03]	0.02	% S	N/A
ANC Fineness Factor		factor	1.5
s-CRS Suite - Net Acidity - NASSG (including ANC)	0.02	% S	0.03
CRS Suite - Net Acidity - NASSG (Including ANC)	10	mol H+/t	16
CRS Suite - Liming Rate - NASSG (Including ANC)[S01]	1	kg CaCO3/t	1.2
% Moisture	1	%	14

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Sample History

Where samples are submitted/analysed over several days, the last date of extraction is reported.

If the date and time of sampling are not provided, the Laboratory will not be responsible for compromised results should testing be performed outside the recommended holding time.

Description	Testing Site	Extracted	Holding Time
Extraneous Material	Brisbane	Jun 19, 2025	6 Week
- Method: LTM-GEN-7050/7070			
Chromium Suite - NASSG (Excluding ANC)	Brisbane	Jun 19, 2025	6 Week
- Method: LTM-GEN-7070 Chromium Reducible Sulfur Suite			
% Moisture	Brisbane	Jun 16, 2025	14 Days
- Method: LTM-GEN-7080 Moisture			

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Project ID: WAG190133

Order No.: WAG190133
Report #: 1232856
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Received: Jun 16, 2025 1:30 PM
Due: Jun 23, 2025
Priority: 5 Day
Contact Name: - ALL SRA/Results

Eurofins Analytical Services Manager : Natalie Hill

Sample Detail						Moisture Set	Chromium Suite - NASSG (Excluding ANC)
Brisbane Laboratory - NATA # 1261 Site # 20794 & 2780						X	X
External Laboratory							
No	**Sample ID**	**Sample Date**	**Sampling Time**	**Matrix**	**LAB ID**		
1	BH01/1.25	Jun 03, 2025		Soil	L25-Jn0040997	X	X
2	BH01/2.25	Jun 03, 2025		Soil	L25-Jn0040998	X	X
3	BH01/3.0	Jun 03, 2025		Soil	L25-Jn0040999	X	X
4	BH02/0.75	Jun 03, 2025		Soil	L25-Jn0041000	X	X
5	BH02/1.75	Jun 03, 2025		Soil	L25-Jn0041001	X	X
6	BH02/2.75	Jun 03, 2025		Soil	L25-Jn0041002	X	X
7	BH54/1.0	Jun 03, 2025		Soil	L25-Jn0041003	X	X
8	BH54/2.0	Jun 03, 2025		Soil	L25-Jn0041004	X	X
9	BH54/3.0	Jun 03, 2025		Soil	L25-Jn0041005	X	X
10	BH97/2.5	Jun 03, 2025		Soil	L25-Jn0041006	X	X
11	BH97/1.5	Jun 03, 2025		Soil	L25-Jn0041007	X	X
12	BH97/0.5	Jun 03, 2025		Soil	L25-Jn0041008	X	X
13	BH86/0.5	Jun 03, 2025		Soil	L25-Jn0041009	X	X
14	BH86/1.5	Jun 03, 2025		Soil	L25-Jn0041010	X	X

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Project Name: PARKRIDGE EATON
Project ID: WAG190133

Order No.: WAG190133
Report #: 1232856
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Received: Jun 16, 2025 1:30 PM
Due: Jun 23, 2025
Priority: 5 Day
Contact Name: - ALL SRA/Results

Eurofins Analytical Services Manager : Natalie Hill

Sample Detail						Moisture Set	Chromium Suite - NASSG (Excluding ANC)
Brisbane Laboratory - NATA # 1261 Site # 20794 & 2780						X	X
15	BH86/3.0	Jun 03, 2025		Soil	L25-Jn0041011	X	X
16	BH86/2.5	Jun 03, 2025		Soil	L25-Jn0041012	X	X
17	BH20/0.75	Jun 03, 2025		Soil	L25-Jn0041013	X	X
18	BH2./1.25	Jun 03, 2025		Soil	L25-Jn0041014	X	X
19	BH20/2.00	Jun 03, 2025		Soil	L25-Jn0041015	X	X
20	BH20/2.75	Jun 03, 2025		Soil	L25-Jn0041016	X	X
21	QC101	Jun 03, 2025		Soil	L25-Jn0041017	X	X
Test Counts						21	21

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Internal Quality Control Review and Glossary

General

1. Laboratory QC results for Method Blanks, Duplicates, Matrix Spikes, and Laboratory Control Samples follow guidelines delineated in the National Environment Protection (Assessment of Site Contamination) Measure 1999, as amended May 2013. They are included in this QC report where applicable. Additional QC data may be available on request.
2. Unless otherwise stated, all soil/sediment/solid results are reported on a dry weight basis.
3. Unless otherwise stated, all biota/food results are reported on a wet weight basis on the edible portion.
4. For CEC results where the sample's origin is unknown or environmentally contaminated, the results should be used advisedly.
5. Actual LORs are matrix dependent. Quoted LORs may be raised where sample extracts are diluted due to interferences.
6. Results are uncorrected for matrix spikes or surrogate recoveries except for PFAS compounds where annotated.
7. SVOC analysis on waters is performed on homogenised, unfiltered samples unless noted otherwise.
8. Samples were analysed on an 'as received' basis.
9. Information identified in this report with **blue** colour indicates data provided by customers that may have an impact on the results.
10. This report replaces any interim results previously issued.

Holding Times

Please refer to the 'Sample Preservation and Container Guide' for holding times (QS3001).

For samples received on the last day of holding time, notification of testing requirements should have been received at least 6 hours before sample receipt deadlines as stated on the SRA.

If the Laboratory did not receive the information in the required timeframe, and despite any other integrity issues, suitably qualified results may still be reported.

Holding times apply from the sampling date; therefore, compliance with these may be outside the laboratory's control.

For VOCs containing vinyl chloride, styrene and 2-chloroethyl vinyl ether, the holding time is seven days; however, for all other VOCs, such as BTEX or C6-10 TRH, the holding time is 14 days.

Units

mg/kg: milligrams per kilogram	**mg/L:** milligrams per litre	**ppm:** parts per million
µg/L: micrograms per litre	**ppb:** parts per billion	**%:** Percentage
org/100 mL: Organisms per 100 millilitres	**NTU:** Nephelometric Turbidity Units	**MPN/100 mL:** Most Probable Number of organisms per 100 millilitres
CFU: Colony Forming Unit	**Colour:** Pt-Co Units (CU)	

Terms

APHA	American Public Health Association
CEC	Cation Exchange Capacity
COC	Chain of Custody
CP	Client Parent - QC was performed on samples pertaining to this report
CRM	Certified Reference Material (ISO17034) - reported as percent recovery.
Dry	Where moisture has been determined on a solid sample, the result is expressed on a dry weight basis.
Duplicate	A second piece of analysis from the same sample and reported in the same units as the result to show comparison.
LOR	Limit of Reporting.
LCS	Laboratory Control Sample - reported as percent recovery.
Method Blank	In the case of solid samples, these are performed on laboratory-certified clean sands and in the case of water samples, these are performed on de-ionised water.
NCP	Non-Client Parent - QC performed on samples not pertaining to this report, QC represents the sequence or batch that client samples were analysed within.
RPD	Relative Percent Difference between two Duplicate pieces of analysis.
SPIKE	Addition of the analyte to the sample and reported as percentage recovery.
SRA	Sample Receipt Advice
Surr - Surrogate	The addition of a similar compound to the analyte target is reported as percentage recovery. See below for acceptance criteria.
TBTO	Tributyltin oxide (*bis*-tributyltin oxide) - individual tributyltin compounds cannot be identified separately in the environment; however, free tributyltin was measured, and its values were converted stoichiometrically into tributyltin oxide for comparison with regulatory limits.
TCLP	Toxicity Characteristic Leaching Procedure
TEQ	Toxic Equivalency Quotient or Total Equivalence
QSM	US Department of Defense Quality Systems Manual Version 6.0
US EPA	United States Environmental Protection Agency
WA DWER	Sum of PFBA, PFPeA, PFHxA, PFHpA, PFOA, PFBS, PFHxS, PFOS, 6:2 FTSA, 8:2 FTSA

QC - Acceptance Criteria

The acceptance criteria should only be used as a guide and may be different when site-specific Sampling Analysis and Quality Plan (SAQP) have been implemented.

RPD Duplicates: Global RPD Duplicates Acceptance Criteria is ≤30%; however, the following acceptance guidelines are equally applicable:

Results <10 times the LOR:	No Limit
Results between 10-20 times the LOR:	RPD must lie between 0-50%
Results >20 times the LOR:	RPD must lie between 0-30%

NOTE: pH duplicates are reported as a range, not as RPD

Surrogate Recoveries: Recoveries must lie between 20-130% for Speciated Phenols & 50-150% for PFAS. SVOCs recoveries 20 – 150%, VOC recoveries 50 – 150%

PFAS field samples containing surrogate recoveries above the QC limit designated in QSM 6.0, where no positive PFAS results have been reported or reviewed, and no data was affected.

QC Data General Comments

1. Where a result is reported as less than (<), higher than the nominated LOR, this is due to either matrix interference, extract dilution required due to interferences or contaminant levels within the sample, high moisture content or insufficient sample provided.
2. Duplicate data shown within this report that states the word "BATCH" is a Batch Duplicate from outside of your sample batch but within the laboratory sample batch at a 1:10 ratio. The Parent and Duplicate data shown are not data from your samples.
3. pH and Free Chlorine analysed in the laboratory - Analysis on this test must begin within 30 minutes of sampling. Therefore, laboratory analysis is unlikely to be completed within holding time.Analysis will begin as soon as possible after sample receipt.
4. Recovery Data (Spikes & Surrogates) - where chromatographic interference does not allow the determination of recovery, the term "INT" appears against that analyte.
5. For Matrix Spikes and LCS results, a dash "-" in the report means that the specific analyte was not added to the QC sample.
6. Duplicate RPDs are calculated from raw analytical data; thus, it is possible to have two sets of data.

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Quality Control Results

Test			Units	Result 1			Acceptance Limits	Pass Limits	Qualifying Code
LCS - % Recovery									
Chromium Suite - NASSG (Excluding ANC)									
pH-KCL (NLM-3.1)			%	98			80-120	Pass	
Titratable Actual Acidity (NLM-3.2)			%	105			80-120	Pass	
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)			%	104			80-120	Pass	
Test	**Lab Sample ID**	**QA Source**	**Units**	**Result 1**			**Acceptance Limits**	**Pass Limits**	**Qualifying Code**
Duplicate									
Chromium Suite - NASSG (Excluding ANC)				Result 1	Result 2	RPD			
CRS Suite - Liming Rate - NASSG (Excluding ANC)	L25-Jn0040998	CP	kg CaCO3/t	2.1	2.1	<1	30%	Pass	
CRS Suite - Net Acidity - NASSG (Excluding ANC)	L25-Jn0040998	CP	mol H+/t	29	28	<1	20%	Pass	
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	L25-Jn0040998	CP	% S	0.05	0.05	<1	30%	Pass	
pH-KCL (NLM-3.1)	L25-Jn0040998	CP	pH Units	4.7	4.8	<1	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L25-Jn0040998	CP	mol H+/t	25	25	1.0	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L25-Jn0040998	CP	% pyrite S	0.040	0.040	1.0	30%	Pass	
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)	L25-Jn0040998	CP	% S	0.005	0.005	<1	20%	Pass	
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	L25-Jn0040998	CP	mol H+/t	3.3	3.3	<1	30%	Pass	
Sulfur - KCl Extractable	L25-Jn0040998	CP	% S	N/A	N/A	N/A	30%	Pass	
HCl Extractable Sulfur	L25-Jn0040998	CP	% S	N/A	N/A	N/A	20%	Pass	
Net Acid soluble sulfur (SNAS) NLM-4.1	L25-Jn0040998	CP	% S	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (a-SNAS) NLM-4.1	L25-Jn0040998	CP	mol H+/t	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (s-SNAS) NLM-4.1	L25-Jn0040998	CP	% S	N/A	N/A	N/A	30%	Pass	
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	L25-Jn0040998	CP	% CaCO3	N/A	N/A	N/A	20%	Pass	
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)	L25-Jn0040998	CP	% S	N/A	N/A	N/A	30%	Pass	
ANC Fineness Factor	L25-Jn0040998	CP	factor	1.5	1.5	<1	30%	Pass	
s-CRS Suite - Net Acidity - NASSG (including ANC)	L25-Jn0040998	CP	% S	0.05	0.05	<1	30%	Pass	
CRS Suite - Net Acidity - NASSG (Including ANC)	L25-Jn0040998	CP	mol H+/t	29	28	<1	30%	Pass	
CRS Suite - Liming Rate - NASSG (Including ANC)	L25-Jn0040998	CP	kg CaCO3/t	2.1	2.1	<1	30%	Pass	
Duplicate									
Chromium Suite - NASSG (Excluding ANC)				Result 1	Result 2	RPD			
CRS Suite - Liming Rate - NASSG (Excluding ANC)	L25-Jn0041002	CP	kg CaCO3/t	1.4	1.5	3.0	30%	Pass	
CRS Suite - Net Acidity - NASSG (Excluding ANC)	L25-Jn0041002	CP	mol H+/t	19	20	3.0	20%	Pass	
s-CRS Suite - Net Acidity - NASSG (Excluding ANC)	L25-Jn0041002	CP	% S	0.03	0.03	3.0	30%	Pass	
pH-KCL (NLM-3.1)	L25-Jn0041002	CP	pH Units	5.0	5.0	<1	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L25-Jn0041002	CP	mol H+/t	19	20	3.0	20%	Pass	
Titratable Actual Acidity (NLM-3.2)	L25-Jn0041002	CP	% pyrite S	0.030	0.030	3.0	30%	Pass	
Chromium Reducible Sulfur (s-SCR) (NLM-2.1)	L25-Jn0041002	CP	% S	< 0.005	< 0.005	<1	20%	Pass	
Chromium Reducible Sulfur (a-SCR) (NLM-2.1)	L25-Jn0041002	CP	mol H+/t	< 3	< 3	<1	30%	Pass	
Sulfur - KCl Extractable	L25-Jn0041002	CP	% S	N/A	N/A	N/A	30%	Pass	
HCl Extractable Sulfur	L25-Jn0041002	CP	% S	N/A	N/A	N/A	20%	Pass	

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Duplicate									
Chromium Suite - NASSG (Excluding ANC)				Result 1	Result 2	RPD			
Net Acid soluble sulfur (SNAS) NLM-4.1	L25-Jn0041002	CP	% S	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (a-SNAS) NLM-4.1	L25-Jn0041002	CP	mol H+/t	N/A	N/A	N/A	30%	Pass	
Net Acid soluble sulfur (s-SNAS) NLM-4.1	L25-Jn0041002	CP	% S	N/A	N/A	N/A	30%	Pass	
Acid Neutralising Capacity - (ANCbt) (NLM-5.2)	L25-Jn0041002	CP	% CaCO3	N/A	N/A	N/A	20%	Pass	
Acid Neutralising Capacity - (s-ANCbt) (NLM-5.2)	L25-Jn0041002	CP	% S	N/A	N/A	N/A	30%	Pass	
ANC Fineness Factor	L25-Jn0041002	CP	factor	1.5	1.5	<1	30%	Pass	
s-CRS Suite - Net Acidity - NASSG (including ANC)	L25-Jn0041002	CP	% S	0.03	0.03	3.0	30%	Pass	
CRS Suite - Net Acidity - NASSG (Including ANC)	L25-Jn0041002	CP	mol H+/t	19	20	3.0	30%	Pass	
CRS Suite - Liming Rate - NASSG (Including ANC)	L25-Jn0041002	CP	kg CaCO3/t	1.4	1.5	3.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	L25-Jn0041005	CP	%	18	20	7.0	30%	Pass	
Duplicate									
				Result 1	Result 2	RPD			
% Moisture	L25-Jn0041016	CP	%	9.0	7.9	12	30%	Pass	

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Comments

Report 1232856-S-V2 (amendment to report 1232856-S) has been issued with amended ID's for BH47 to BH97 as per client request.

Sample Integrity

Custody Seals Intact (if used)	N/A
Attempt to Chill was evident	Yes
Sample correctly preserved	Yes
Appropriate sample containers have been used	Yes
Sample containers for volatile analysis received with minimal headspace	Yes
Samples received within HoldingTime	Yes
Some samples have been subcontracted	No

Qualifier Codes/Comments

Code	Description
S01	Liming rate is calculated and reported on a dry weight basis assuming use of fine agricultural lime (CaCO3) and using a safety factor of 1.5 to allow for non-homogeneous mixing and poor reactivity of lime. For conversion of Liming Rate from 'kg/t dry weight' to 'kg/m3 in-situ soil' multiply 'reported results' x 'wet bulk density of soil in t/m3'
S02	Retained Acidity is Reported when the pHKCl is less than pH 4.5
S03	Acid Neutralising Capacity is only required if the pHKCl if greater than or equal to pH 6.5
S04	Acid Sulfate Soil Samples have a 24 hour holding time unless frozen or dried within that period

Authorised by:

Natalie Hill	Analytical Services Manager
Jonathon Angell	Senior Analyst-Sample Properties
Jonathon Angell	Senior Analyst-SPOCAS



Glenn Jackson
Managing Director

Final Report – this report replaces any previously issued Report

- Indicates Not Requested

* Indicates NATA accreditation does not cover the performance of this service

Measurement uncertainty of test data is available on request or please click here.

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Standard Geotechnical Definitions, Recommendations, Requirements and Limitations

GDR1 ABOUT THIS APPENDIX

These technical notes are to be read with the attached report. These notes contain important information regarding the study in the attached report, and the report cannot be considered in isolation without full reading of these notes.

Where there are conflicts between this appendix and the report text, the report text takes precedence.

Unless noted otherwise, geotechnical investigations are conducted in accordance with AS1726-2017, “Geotechnical site investigations”.

Unless noted otherwise, the report does not include any assessment (or implied assessment) of karst risk.

GDR2 DEFINITIONS

The following definitions apply:

- **Approved Fill** – fill that has been assessed and approved by the geotechnical engineer or civil designer for a particular purpose.
- **Bedding** – A controlled fill layer placed beneath buried elements such as pipes, cables or other infrastructure to provide uniform support and distribute loading.
- **Bulk Fill** – Controlled fill intended to support future infrastructure, but potentially lacking some engineering properties required for upper fill layers or adjacent to structures, where fill with specific properties may be required. Contrast with Select Fill.
- **Civil Design** – the engineering design of the earthworks including surface water and erosion control and subsurface drainage control (where required) to achieve an earthworked, drained site which is capable of supporting the proposed development (including target site classification to AS2870, where relevant). This design is separate to this geotechnical investigation and is a required element of a site development.
- **Clay** – A component of a soil with particles smaller than 0.002 mm in size.
- **Cohesionless (Non-cohesive) Soil** – A soil mass that has does not hold together at low applied stress levels. The strength of the soil depends solely on friction between particles.
- **Cohesive Soil** – A soil mass that has holds together and can adhere to itself.
- **Collapsible Soil** – a soil with high void ratio that is typically strong when dry but loses strength and consolidates under constant stress when wetted, usually due to loss of soil matric suction or dissolving of a chemical cementing agent.
- **Compaction –** The process of increasing the soil density, typically be mechanical means.
- **Competent Person** – A person who has, through a combination of training, education and experience, acquired knowledge and skills enabling that person to correctly perform a specified task.
- **Consistency** – The stiffness of a cohesive soil, at specific moisture contents, to resist mechanical stress or manipulation (remoulding).
- **Controlled (or engineered) Fill** – Any fill for which engineering properties are controlled during placement. Also referred to as structural fill.
- **Dense –** with respect to sandy soils, at a relatively high density index or dry density ratio, exhibiting better engineering parameters with respect to strength and stiffness than the same material at a lower density index.
- **Density** – A measure of the mass of material per unit volume.
- **Eccentric Load** – a load incorporating either a varying vertical load and/or a horizontal load such that the peak vertical stress exceeds the average vertical stress.
- **Embedment Fill** – A controlled fill material placed around and above buried infrastructure (such as pipes, cables or conduits) to provide protection and support.
- **Fill** – Any material that has been placed by anthropogenic processes.
- **Fines** – A component of a soil with particles smaller than 0.075 mm in size.
- **Groundwater** – Water located beneath the earth’s surface in pore spaces, fractures and voids in soil or rock.

- **Gravel** – A component of a soil with particles between 2.36 mm and 63 mm in size.
- **Heavily Loaded** – in reference to mobile plant, particularly intended for equipment where ground bearing pressures exceed 50 kPa and/or equipment has a high centre of gravity and could be prone to toppling. In reference to buildings/structures, where footing pressures exceed 100 kPa and/or footing dimensions exceed 1 m wide.
- **Hydraulic Conductivity** – ratio of volume flux to hydraulic gradient – a quantitative measure of soil's ability to transmit water when subjected to a hydraulic gradient. k_{sat} – saturated hydraulic conductivity, intended for dewatering assessment, subsoil drainage design and other engineering assessments where saturated soils are relevant. k_{unsat} – unsaturated hydraulic conductivity, intended for design of stormwater disposal elements such as soakwells and infiltration basins, where the base of disposal elements is above the groundwater level.
- **In situ** – In the place and condition in which it exists naturally. May also refer to fill that is present at any site prior to an investigation taking place.
- **Limestone** – A sedimentary carbonate rock. The use of the term does not infer a specific strength, carbonate content or grain size. Refer to GDR4.1 for further detail.
- **Loose** – with respect to sand soils, at a relatively low density index or dry density ratio, typically indicating poorer engineering parameters with respect to strength and stiffness than the same material at a higher density index.
- **Material** – Matter that meets the definitions of 'soil', 'rock', other engineered matter (i.e., concrete, bricks etc.) or non-engineered matter (organics, contaminated refuse, deleterious material).
- **May** – Indicates that the statement is an option.
- **Must** – Indicates that the statement is mandatory.
- **Natural** – In the context of soil or rock, material which is present as a result of natural geological processes and has not been subject to anthropogenic engineering processes (such as filling, excavation, replacement, etc).
- **Organic** – In the context of soil, material derived from living matter, primarily plants.
- **Overconsolidated** – a soil that has been subjected to a greater vertical stress than its current state.
- **Permeable Soil** – soil that meets the civil design permeability requirements to allow relatively rapid flow of water through the soil matrix.
- **Rock** – Any aggregate of minerals and/or materials that cannot be disaggregated by hand in air or water without prior soaking.
- **Sand** – a component of soil with particle size between 0.075 mm and 2.36 mm.
- **Select Fill** – a controlled fill which has been chosen for particular engineering characteristics (such as strength, CBR, grading, permeability, etc), commonly for use as a higher-grade capping layer or adjacent to structures. Contrast with Bulk Fill.
- **Shall** – Indicates that the statement is mandatory.
- **Should** – Indicates that the statement is a recommendation.
- **Silt** – A component of a soil with particles between 0.075 mm and 0.002 mm in size.
- **Soil** – Particulate materials that occur in the ground and can be disaggregated or remoulded by hand in air or water without prior soaking.
- **Sand** – A component of a soil with particle between 0.075 mm and 2.36 mm in size.
- **Uncontrolled Fill** – Any material that has been deposited by anthropogenic process, which does not meet the definition of 'controlled fill'.

GDR3 GEOTECHNICAL TEST METHODS AND INTERPRETATION

GDR3.1 Test Pit Excavation

Test pit excavations are formed using mechanical excavation equipment (typically an excavator) or hand dug, with the objective of inspecting (or profiling) the soil exposed in the excavation.

Typical limitations on test pit excavations are:

- Limited depth of excavation – typically governed by reach of the excavator arm.
- Cannot be excavated below groundwater in cohesionless soils, due to collapse and water ingress.
- Cannot be excavated through very stiff / very dense soils (i.e., desiccated clays or cemented soils) or most rock.
- Cannot typically obtain rock samples that are suitable for strength testing.

Test pits are usually mechanically excavated with a toothed bucket (intended for excavation in clay or weak rock) or a flat-edged bucket (typically for sands).

When hand-dug test pits are excavated, it is usually for recovery of near-surface soils or inspection of shallow in-ground elements.

We note that where test pits are excavated on a site, they are only ever loosely backfilled during our studies. They must always be located during site preparation works, over-excavated to their full depth and plan extents and re-filled with approved fill in compacted layers.

GDR3.2 Cone Penetration Tests (CPTs)

Cone penetration testing (CPT) is done by Galt or specialist contractors and typically to AS1289.6.5.1. The test involves pushing an instrumented cone into the soil with a hydraulically operated pushing frame. The test measures tip resistance and sleeve friction on the cone, which are then plotted with depth.

We interpret soil types and associated geotechnical soil parameters from CPT data using the following:

Technical Interpretations and International Guides

- Robertson P.K., Campanella R.G., Gillespie D. and Grieg J. (1986). “Use of piezometer cone data”. Proceedings of the ASCE Speciality Conference In Situ ’86: Use of In Situ Tests in Geotechnical Engineering, Blacksburg, pp 1263-80, American Society of Civil Engineers (ASCE).
- Robertson, P.K., Cabal K.L. (2016) “Guide to Cone Penetration Testing for Geotechnical Engineering 6th Edition 2015”. Gregg Drilling & Testing, Inc., California.
- Baldi G., Bellotti R., Ghionna V.H., Jamiolkowski M., Lo Presti D. C. (1989) “Modulus of sands from CPTs and DMTs”. Proc. 12th Int. Conf. on SMFE, Rio de Janeiro, Vol 1, p165-170, Balkema, Rotterdam.

Local (Perth and Western Australia) Research, Interpretation and Guides

- Fahey, M., Lehane, B., Stewart, D. (2003) “Soil stiffness for shallow foundation design in the Perth CBD”. Australian Geomechanics Vol. 8 No. 3.
- Main Roads Western Australia (MRWA) (2009) “Structures Engineering Design Manual”. Document 3912/03, Perth.
- Lehane B. (2017). “CPT-Based Design of Foundations”, E.H. Davis Memorial Lecture, Australian Geomechanics, Vol 54. No. 4’ and
- Galt’s in-house correlations between CPT data and other geotechnical testing.

GDR3.3 Borehole Drilling

Boreholes are drilled for sampling of the soil and rock, with a small disturbance footprint. Typical techniques are:

- Auger drilling (hand auger or machine auger) – for recovery of soil at relatively shallow depths only. Cannot penetrate cemented soils or rock.
- Push probe drilling – for recovery of soil at relatively shallow depths and below groundwater. Cannot penetrate cemented soils or rock.

- Air core drilling – for recovery of soil, cemented soil and rock (typically up to high strength rock). Not suited to drilling of very high strength rock.
- Diamond coring (or rotary coring) – for recovery of cemented soil, rock and some soil types (typically not sand). Suited to all strengths of rock.

If used, standard penetration tests (SPTs) are done in accordance with AS1289.6.3.1. Correlations for consistency and density are based on:

- Standards Australia (2016), "HB160-2006, Soils Testing".

GDR3.4 Dynamic Cone Penetrometer (DCP)

The DCP is a hand-held tool for assessing penetration resistance of a soil. This comprises a 16 mm rod equipped with a 20 mm cone, hammered into the ground using a falling 9 kg weight on a 510 mm slide hammer on the top of the rod. This is done in accordance with AS1289.6.3.2 and the blow counts to hammer in the rod are measured in 100 mm penetration increments. Where provided, correlations for consistency and density are based on:

- Standards Australia (2016), "HB160-2006, Soils Testing".

GDR3.5 Perth Sand Penetrometer (PSP)

The PSP is a variation on a DCP and uses a 9 kg weight on a 600 mm slide hammer to hammer in a 16 mm rod with a blunt (square-faced) end. Testing is done in accordance with AS1289.6.3.3, with the following typical variations:

- Testing is often done to a greater depth than the 450 mm covered in the standard.
- Blow counts are sometimes recorded in 150 mm intervals (compared to 300 mm intervals used in the standard) to provide better resolution on the tests.

Where provided, correlations for density are based on:

- Standards Australia (2016), "HB160-2006, Soils Testing".

GDR3.6 Dynamic Probing Super Heavy (DPSH)

The DPSH test involves driving a solid cone (20 cm^2) into the ground using a 63.5 kg hammer falling 760 mm. Testing is done in accordance with EN ISO 22476-2 – Geotechnical engineering – Field testing – Part 2: Dynamic probing – DPSH-B.

Results may be presented as either:

- N10 (No. of blows required for every 100 mm penetration);
- N30 (No. of blows required for every 300 mm penetration); or
- q_d (dynamic tip resistance, analogous to CPT q_c).

GDR3.7 Inverse Auger Hole Infiltration Test (Falling Head, Unsaturated Soil)

Infiltration tests are carried out using the 'inverse auger hole' method described by:

- Cocks, G (2007), "Disposal of Stormwater Runoff by Soakage in Perth Western Australia", Journal and News of the Australian Geomechanics Society, Volume 42 No. 3, pp 101-114

This test is an unsaturated falling head test, in that it is carried out above the groundwater table and is intended to mimic the behaviour of soak wells and similar drainage elements (i.e. soakage basins), which discharge stormwater into an unsaturated medium.

The hole is wetted only for a short period prior to the testing.

The test is usually repeated three times, with the intention that the second and third tests provide similar results (within about 10%-20%). Tests are done over a short duration, typically 2 minutes to 10 minutes. The focus of the testing is generally when the head is low (200 mm or lower), such that the relevant lateral zone is as saturated as the zone directly below the borehole.

The hydraulic conductivity derived from this test is not to be used for applications where saturated hydraulic conductivity is relevant, e.g.:

- Subsoil drainage design; and

- Dewatering estimations.

Based on Galt's in-house research, this method does not completely saturate the soil in any reasonable test length, and thus may not be suitable for assessment of soils at sites where the critical drainage condition is a fully saturated soil (i.e., in areas with high groundwater tables). Our research on sand sites indicates that the test does correlate well with actual soak well performance, in unsaturated sand zones without impermeable zones.

GDR3.8 Guelph Permeameter Test (Constant Head, Quasi-Saturated Soil)

The Guelph permeameter test, conducted in accordance with the constant head test method outlined in Appendix G of AS1547, is a constant-head test in nominally "saturated" soil (in that the test is conducted until a "steady state" is reached). However, we note that this test can only be done above the groundwater table and as such, is in an unsaturated zone. Therefore, the hydraulic conductivity derived from this test should be used with caution and evaluated against other test methods (such as saturated, constant-head permeability testing from laboratory samples, or in situ saturated hydraulic conductivity testing below the groundwater table).

GDR4 GEOLOGICAL UNITS

GDR4.1 Limestone

The term 'Limestone' is used to describe a carbonate rock. Tamala Limestone is the common limestone in Western Australia, and typically comprises cemented quartz and shell fragments cemented together by calcium carbonate.

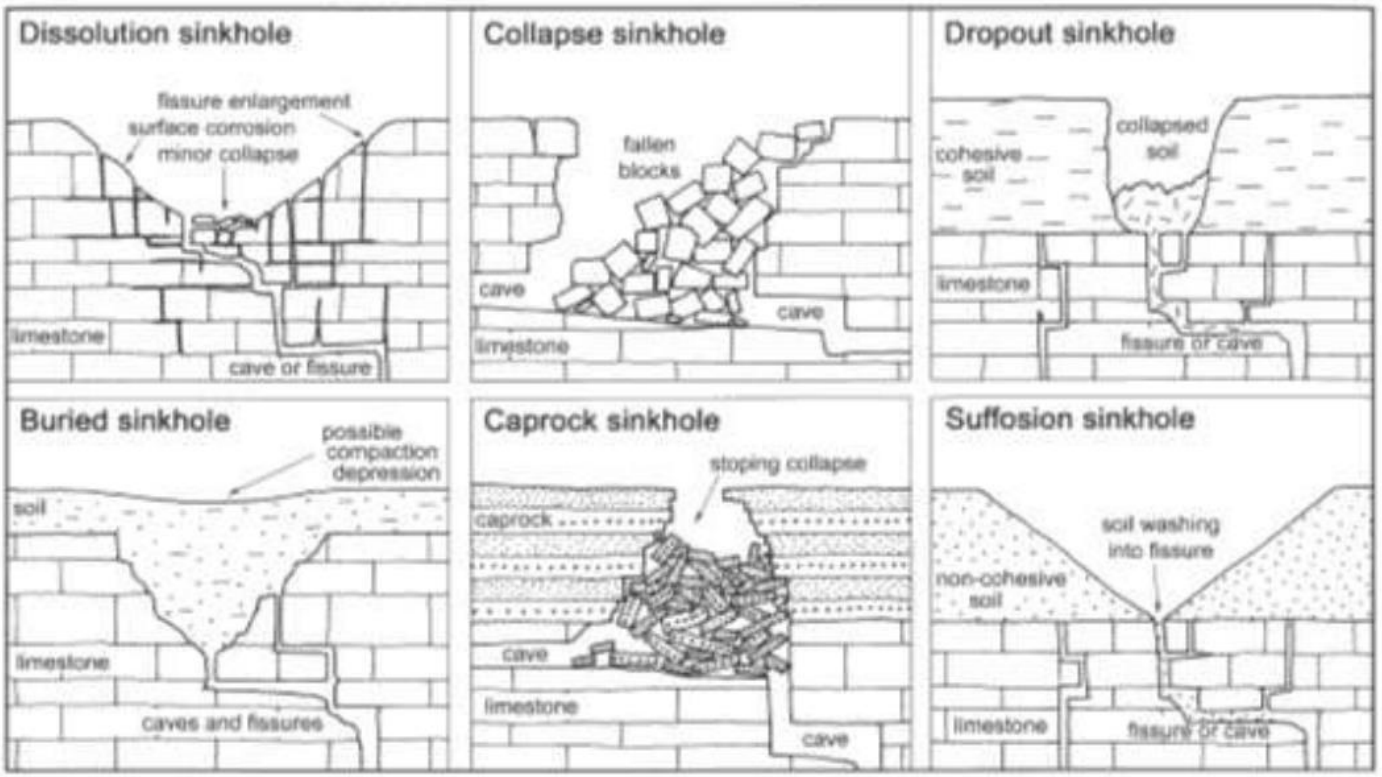
Limestone can vary significantly across short distances in composition, strength and cementation. Tamala limestones in Western Australia also have known possible geological features including:

- Caprock/calcrete – The formation of a very hard duricrust, usually due to sun exposure. Caprock may be up to 3 m thick, but typically around 1.5 m thick. Caprock is very difficult to excavate and may require the use of hydraulic rock breakers or rock saws to excavate.
- Solution features/tubes – Often initially formed due to the presence of Eucalypt and Jarrah roots during limestone formation, and often increasing in depth and size due to ongoing weathering. May be up to 500 mm in diameter. These are typically filled with very loose, unconsolidated sand.
- Pinnacles – Pinnacles are usually the limestone that is left around surrounding solution features. Often can comprise very hard limestone/caprock that can be substantially higher than surrounding areas. Pinnacles may have also been formed by surrounding erosion (i.e., wind/water).
- Karst/caves – Karst is caused by the dissolution of limestone, typically where there is interaction in low-lying areas with water and limestone. Karst manifests itself as loose near-surface sand with cavities (caves) in the underlying limestone. This can lead to sinkholes and collapse of overlying structures.

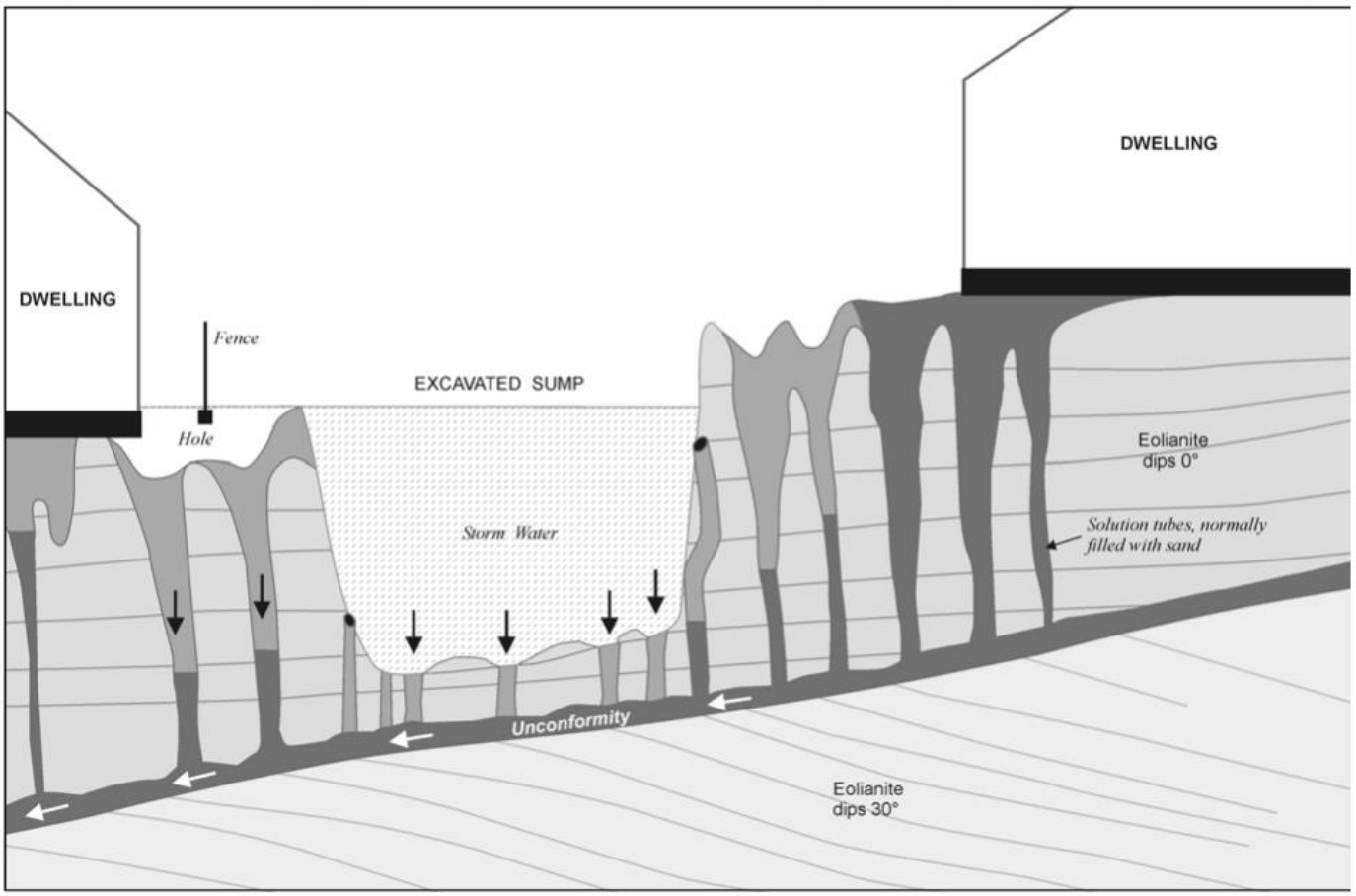
Inline images showing typical pinnacle/solution features and Karstic features follow. These are taken from:

- Gordon, R. (2003). "Coastal Limestones". Australian Geomechanics Vol.38 No. 4, The Engineering Geology of Perth.
- Waltham, A. & Fookes, P. (2003). "Engineering Classification of Karst Ground Conditions: Quarterly Journal of Engineering Geology and Hydrogeology, Vol 36.

Inline Image GDR 1 - Karstic Sinkhole Features from Waltham and Fookes (2003)



Inline Image GDR 2: Pinnacle/Solution Features from Gordon (2003)



GDR4.2 Pindan Sands and Collapsible Soils

In the Western Australian context, Pindan sands are sandy soils present predominantly across the Pilbara and Kimberley regions. Pindan sands are typically:

- Red brown in colour.
- Between 10% and 40% fines.
- Of aeolian origin, usually resulting in unconsolidated in situ conditions (nuclear density gauge testing often indicates these soils have in situ density ratios of 80%-85% of modified maximum dry density).
- Very strong when dry due to high soil suctions in the fine fraction, which create strong bonds between the sand particles.

As the grains are usually held in place by the dry fine fraction, this can lead to:

- very high settlements (i.e., “collapse”) as the grain-to-grain bonds are weakened as matric suction decreases on soaking; and
- loss of vertical and horizontal strength/stiffness as the grain-to-grain bonds weaken.

The risks associate with Pindan sands are usually quantified in terms of the collapse potential/magnitude of possible collapse events.

Other similar soils are present in Western Australia that may exhibit similar collapse potential and may not strictly be Pindan sands (i.e., have other grain-to-grain bonding mechanisms).

GDR5 SITE CLASSIFICATION

Site classification refers to the assessment of a site in reference to AS2870-2011, “Residential slabs and footings”. The method for assessing the site class is outlined in Section 2 of AS2870-2011, which indicates that this may be done by:

- assessing the characteristic surface movement, due to seasonal moisture changes in the soil profile;
- assessing the performance of existing foundations; or
- assessment of the soil profile (where there are deleterious inclusions, landfill, putrescible waste etc.).

The site classifications based on the expected characteristic surface movement are summarised in Table GDR 1.

Table GDR 1: Summary of Site Classifications (AS2870-2011)

Class	Description	Characteristic Surface Movement (y_s)
A	Most sand and rock site with little or no ground movement from moisture change	Not Defined (typically <5 mm)
S	Slightly reactive clay sites with only slight ground movement from moisture changes	0 – 20 mm
M	Moderately reactive clay sites, which may experience moderate ground movements from moisture change	20 – 40 mm
H1	Highly reactive sites, which may experience high ground movements from moisture change	40 – 60 mm
H2	Highly reactive sites, which may experience very high ground movements from moisture change	60 – 75 mm
E	Extremely reactive sites, which may experience extreme ground movements from moisture change	>75 mm
P	Sites which include soft soils, such as soft clay or silt or loose sands; landslip; mine subsidence; collapsing soils; soils subject to erosion; reactive sites subject to abnormal moisture conditions or sites which cannot be classified otherwise	Not Defined

The calculated characteristic surface movement is predominantly based on:

- the reactivity (i.e., the shrink-swell potential) of the soil (and any proposed fill);
- the design depth of soil suction change, which is the maximum expected depth of soil suction change due to seasonal soil moisture changes; and
- the depth to any bedrock and groundwater table.

The design depth of soil suction change for Western Australia has been refined using the Thornthwaite Moisture Index (TMI). We have carried out assessment using the depths as detailed in:

- Hu Y, Saraceni P, Cocks G, Zhou M (2016). "TMI assessment and climate zones in Western Australia". Australian Geomechanics Journal, Vol.51 No.3.
- Hu Y, Raj A, Cocks G, Verheyde F (2019). "Re-assessment of TMI based climate zones in metropolitan Perth, WA". ANZ Geomechanics Conference 2019, Perth Australia.

The design depth of soil suction change for Northern Territory is based on the research presented in:

- Jackson, S (2022), "Thornthwaite moisture index and climate zones in the Northern Territory", Australian Geomechanics Journal, Vol. 57 No. 3.

We highlight that AS2870-2011 does not make any reference to the fines content of a soil when assessing the site classification.

Where a site classification is provided in our reports, it is always predicated on the requirement that the recommended site preparation procedures are carried out.

We also highlight that the footing performance and shrink-swell movements of a site can be impacted by the planting or removal of trees. This should be considered where appropriate, and we refer to the CSIRO BTF 18-2011 "Foundation Maintenance and Footing Performance: A Homeowner's Guide" for further information.

AS 2870 is limited to single and double storey residential buildings with normal shallow footings with a maximum bearing pressure of 100 kPa and is not applicable where development types other than this are proposed.

GDR6 SITE PREPARATION

GDR6.1 General

The intent of the site preparation guidelines provided in the above report are to ensure that the earthworks can be constructed to meet specific requirements, i.e., minimum compaction, fill requirements, removal of unsuitable material etc. The site preparation guidelines are not exhaustive, and on-site conditions may dictate that other preparation measures may be required to meet geotechnical requirements.

GDR6.2 Site Preparation

Site preparation measures outlined in this section relate to bulk earthworks at the site in preparation for the construction of buildings, pavements and other structures.

The preparation of a site in accordance with outlined measures below or those presented in the report text does not imply that the site is suitable for heavily loaded plant or eccentric loads. This is especially applicable for working platforms for mobile plant including cranes, crawlers or the like. The site surface may still not be trafficable for mobile plant. Individual working platform assessments must be done if heavily loaded mobile plant are proposed.

GDR6.2.1 Common Measures

The common measures outlined below are to prepare standard sites in advance of proof compaction, bulk excavation and filling. These measures are applicable to most sites, however the applicability of these measures is stated in the main report.

Table GDR 2: Common Measures

Measure	Commentary
Demolish and remove structures and pavements	Demolish existing structures and pavements, including removal of all buried services and footings and dispose off-site.
Remove demolition debris and other deleterious material	Remove any demolition debris and other deleterious material from site including old footings, slabs, soak wells, buried services, paving and building rubble.
Strip uncontrolled fill (where present)	Strip any uncontrolled fill from the site (where encountered) and, if suitable, stockpile it for potential re-use as non-structural fill. If contaminated, dispose off-site. Refer to the report text for discussions on the presence of detected uncontrolled fill and its composition. It is important to realise that undetected uncontrolled fill may be present between test locations and the absence of its identification in our report does not preclude its presence. If uncontrolled fill is detected during site works, please contact us for inspection and to provide recommendations.
Remove trees	All tree roots must be removed, this may result in significant excavation in places. Where tree roots and stumps are removed, the disturbed soil must be over-excavated and replaced with controlled, compacted fill. Backfilling of over-excavations is discussed in the following sections .
Strip and stockpile topsoil.	Strip and stockpile topsoil from unpaved areas of the site for potential re-use in non-structural applications. The topsoil strip is only necessary to remove roots and we recommend a topsoil strip as necessary to remove all roots from the soil.
Carry out bulk excavation	Excavate to the required level. Stockpile suitable excavated material for potential re-use as fill (the re-use of spoil as fill , if appropriate, is discussed in the report text) and remove unsuitable or excess material off-site.
Batter edges of excavation	Excavations should be battered to a temporary slope as given in the report text where applicable and not in close proximity to adjacent structures etc. If required, construct temporary/permanent retaining walls where batters cannot be accommodated.

By following these measures, the site should have been prepared to a point where topsoil and vegetation has been removed to expose either natural soil or controlled fill. Over-excavation to the required levels may then be required for some projects. Once complete, the site is now ready for proof compaction and filling.

GDR6.2.2 Sand Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by sand.
- No collapsible soils present.
- No deep loose sand.
- Compaction of a loose upper horizon to maximum 1 m depth.
- No shallow groundwater (<1 m deep).
- No limestone or other rock present at shallow depth.
- “Common Measures” outlined in Section GDR6.2.1 have been completed (as required).

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings, pavements and any other settlement-sensitive infrastructure is proposed.

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 3: Sand Site Measures

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must **not** assume that the use of the PSP is appropriate.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.

In following this method, shallow/surficial loose sand will be compacted, and the site will be filled (where required) in preparation for supporting footings, ground slabs, pavements and the like.

GDR6.2.3 Deep Loose Sand Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by sand.
- Collapsible soils or deep loose sand present (if applicable, this is discussed in the report).
- Over-excavation, compaction and replacement of loose sand required.
- No shallow groundwater (<1 m deep).
- No limestone or other rock present at shallow depth.
- "Common Measures" outlined in Section GDR6.2.1 have been completed.

The greatest depth of compaction that can be achieved with standard compaction equipment (vibrating roller, etc) is around 1 m (for sands). As such, it is necessary to cut down the site level to a point where this compaction can be done to the lowest level needed to be improved.

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings and any other settlement-sensitive infrastructure are proposed. Not typically required for pavement subgrades, however, this is discussed in the report if required.

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 4: Deep Loose Sand Site Measures

Measure	Commentary
Over-excavate to the required depth.	Over-excavate sand soil to the depth stated in the report and, if appropriate (discussed in report) retain it for re-use as fill. Over-excavation is likely to be done in stages depending on the site area available for earthworks. Excavations must be battered to a temporary slope as given in the report text where applicable and not in close proximity to adjacent structures etc. If required, construct temporary/permanent retaining walls where batters cannot be accommodated.
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must **not** assume that the use of the PSP is appropriate.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.

Measure	Commentary
Carry out bulk filling	Where fill is required to build up levels (including restoration of the site surface level to the original level), use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction as specified in Section GDR7.1.

In following this method, deep, loose sand will be compacted to a sufficient depth to reduce settlement impacts and the site will be filled (where required) in preparation for supporting footings, ground slabs, pavements and the like.

GDR6.2.4 Clayey Sites

The preparation measures outlined below are provided for sand sites meeting the following criteria:

- Site underlain by cohesive soils (typically >12% fines, i.e., clayey enough for the fines proportion of the soil to dominate behaviour).
- No collapsible soils present.
- No deep soft soils or organic soils.
- Over consolidated clayey soils present which will not be subject to significant primary or secondary consolidation (settlements expected to be within the limit of typical seasonal movements occasioned by moisture content changes, which would be captured in assignment of an AS2870 site classification).
- No shallow groundwater (<1 m deep)
- No rock present at shallow depth.
- "Common Measures" outlined in Section GDR6.2.1 have been completed.

The applicability of these measures is stated in the main report. These measures must be carried out for all areas where structures, footings, pavement subgrades and any other settlement-sensitive infrastructure is proposed.

Unless specified otherwise in the report, the **Approved Fill** to be used is **Clay** as outlined in Section GDR8.

Table GDR 5: Clay Site Measures

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed clayey ground to achieve the density specified in Section GDR7.1 ("fine grained soils") to a depth of at least 300 mm.
Test proof compaction	Check that the density specified in Section GDR7.1 ("fine grained soils") has been achieved to a depth of at least 300 mm. The use of a penetrometer for compaction control of cohesive soils is not an appropriate substitute for in situ NDG testing.
Treat areas of loose or unsuitable material	Any areas of soft clayey soils or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill**. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where excavations are done into clayey soils (e.g. to treat soft zones, remove root balls and the like), they must not be backfilled filled with sand fill (even where a sand topping layer is proposed). Where fill is required (including backfilling of excavations to remove trees), only use **Approved Fill**, moisture conditioned, placed and compacted in layers of no greater than 300 mm loose thickness. Test moisture and compaction as specified in Section GDR7.1.
Grade completed clayey surface	Surface water control is essential for clayey sites. This also applies to control of infiltrated water into sand topping layers or the like. The surface of clayey ground must be graded at a minimum of 1% crossfall to drain. This is a general recommendation, and an appropriate civil design must be done to account for surface and subsoil drainage.
Install sand topping layer	Where a sand topping layer is proposed, this should be done as outlined in Section GDR6.2.5.

These measures do not take into account the objectives of the civil design for the site, particularly with regard to surface water drainage and groundwater control (including clay grading, subsoil drainage, thickness and composition of a sand topping layer and the like). This must be taken into account by the civil designer. General commentary on drainage control measures is presented in Section GDR14.

GDR6.2.5 Sand Topping Layer

Where a sand topping layer is required:

Unless specified otherwise in the report, the **Approved Fill** to be used is outlined in Section GDR8 (**Permeable Sand** where permeable fill is required, else **General Sand**). The specific selection is subject to the requirements of the civil designer.

Table GDR 6: Sand Topping Layer Measures

Measure	Commentary
Prepare Substrate	Prepare the clayey or other substrate as separately outlined prior to installing the topping layer.
Build up sand topping layer	Build up level to the required level with **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness to achieve the density specified in Section GDR7.1.

For the purposes of achieving the allowable bearing pressures and site classification discussed in the report, it is not necessary to have the bases of slabs and footings in the sand topping layer, i.e. if required, they may extend through the sand topping layer into clayey soil below.

GDR6.2.6 Limestone Sites

The preparation measures outlined below are provided for sites underlain by limestone (refer to Section GDR4.1), meeting the following criteria:

- Site underlain by sand overlying limestone.
- Compaction of a loose upper horizon to maximum 1 m depth, with localised deeper treatments between pinnacles if required.
- No shallow groundwater (<1 m deep)
- “Common Measures” outlined in Section GDR6.2.1 have been completed.

The site preparation measures outlined below are aimed at improvement of the site in preparation for construction of the structures including on-ground slabs, shallow footings, retaining walls and pavements.

Unless specified otherwise in the report, the **Approved Fill** may comprise one of the following as specified in Section GDR8 (the specific selection is subject to the requirements of the civil designer):

- **Permeable Sand** where permeable fill is required
- **General Sand** where permeable fill is not required
- **Mixed Sand/Limestone Fill** where permeable fill is not required

The re-use of any limestone for fill is subject to the requirements of the civil design and discussions in the report text. The use of **Mixed Sand/Limestone Fill** is discussed in Section GDR6.2.7. The preparation measures outlined in Table GDR 7 assume sand fill.

Table GDR 7: Standard Limestone Site Measures (Bulk Earthworks)

Measure	Commentary
Treat zones of loose sand	Where deep loose sand is present (particularly, but not exclusively, between limestone pinnacles), over-excavate to the depth as noted in the report . Sand should be retained for re-use as fill if recommended in the report. Limestone debris and pinnacles should be separated and only re-used if recommended in the report.
Moisture condition and proof compact.	Moisture condition and compact the exposed sandy ground to achieve the density specified in Section GDR7.1 ("sand") to a depth of at least 900 mm. Proof compaction of intact limestone is not required.
Test proof compaction	Check that the density specified in Section GDR7.1 ("sand") has been achieved to a depth of at least 900 mm. We note that the applicability of the use of the PSP for compaction control is discussed in the report. Unless specifically approved for use on the subject site, the contractor must not assume that the use of the PSP is appropriate. If refusal to the test method is encountered within the target test depth on limestone and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact limestone is not required.
Treat areas of loose or unsuitable material	Any areas of loose sand or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as approved fill.
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in limestone and specific advice may apply to the installation of soakwells in limestone areas. If not discussed in our report, please contact us for further advice.

Without further consultation with the structural designer, footings for any one structure must not be founded on a mixture of sand and intact limestone. This is due to potential differential settlements between limestone zones (relatively stiff) and soil zones (relatively soft). Where this is the case, the measures outlined in Table GDR 8 must be followed, only with guidance from the structural designer and Galt.

Table GDR 8: Standard Limestone Site Measures (Footing and Slab Preparation)

Measure	Commentary
Excavate and compact for slabs, subgrades, pad or strip footings	Excavate for pad and strip footings. Where a mix of soil and limestone is present below any one structure, one of the following must be done (to be agreed with structural designer and us): ▪ **Over-excavate limestone and replace with compacted soil:** Typically where the foundation largely comprises soil and a relatively small amount of limestone is present. Where footings and slabs are founded partly on soil and partly on limestone, over-excavate the limestone by at least 300 mm below the base of footing or slab and replace the excavated material with compacted **Approved Fill**. ▪ **Remove soil from over limestone and replace with concrete**: Typically where the foundation largely comprises limestone and a relatively small amount of soil is present. Localised zones of sand and mixed sand/limestone rubble must be removed and replaced with lean-mix concrete, e.g. 10 MPa blinding concrete. ▪ **Design the structure to accommodate differential foundation movements:** For example, include construction joints or use a more heavily reinforced footing (subject to the structural designer's requirements).
Test compaction of footing bases, slabs or subgrades.	Compact the exposed bases to achieve the density specified in Section GDR7.1 ("sand"), to a depth of at least 900 mm, or to the depth where limestone is intersected. If refusal to the test method is encountered within the target test depth on limestone and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact limestone is not required. Remove, replace and compact as required with approved fill any zone not achieving the density specified in Section GDR7.1 ("sand")

GDR6.2.7 Mixed Sand/Limestone Filling

On sites where deemed appropriate by the Civil Design, **Approved Fill** may comprise limestone rubble fill (**Mixed Sand/Limestone**, as specified in Section GDR8).

The preparation measures outlined below are provided for sites meeting the following criteria:

- No shallow groundwater (<1 m deep)
- "Common Measures" outlined in Section GDR6.2.1 have been completed.
- Substrate preparation for the relevant site type has been done in preparation for further filling (as relevant for sand, limestone or clayey sites discussed in the preceding sections).

The site preparation measures outlined below are required prior to construction of structures including on-ground slabs, shallow footings, retaining walls and pavements.

Table GDR 9: Mixed Sand/Limestone Fill Measures

Measure	Commentary
Develop a method specification for the filling	A performance specification is not appropriate for compaction control in **Mixed Sand/Limestone** fill, due to oversize limestone particles and the limitations of test methods. Therefore, a method specification is required. Development of a method specification is discussed in Section GDR7.5. A tentative method specification for **Mixed Sand/Limestone** Fill preparation is also provided.
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in accordance with the developed method specification.
Maintain Construction Records	As performance testing cannot be done, quality assurance records are limited. Therefore, the parameters mentioned in Section GDR7.5.1 must be kept in a comprehensive record of the earthworks done to the developed method specification. The use of the PSP is possible only to check for loose sand zones between limestone particles. High PSP blow counts, where limestone particles are intersected, are meaningless in terms of assessing density of the prepared fill. The primary means of validation of the earthworks is conformance with the developed method specification.
Install sand topping layer	Where a sand topping layer is proposed, this should be done as outlined in Section GDR6.2.5.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in limestone fill and specific advice may apply to the installation of soakwells in limestone fill areas. If not discussed in our report, please contact us for further advice.

GDR6.2.8 Rock Sites

The preparation measures outlined below are provided for sites underlain by rock, meeting the following criteria:

- Site underlain by shallow soil overlying rock, or outcropping rock.
- No shallow groundwater or surface water (>1 m deep).
- Common site preparation measures outlined in GDR6.2.1 have been completed. In addition to these measures, any surface cobbles/boulders will need to be removed from the site.

The site preparation measures outlined below are aimed at improvement of the site for construction of structures including on-ground slabs, shallow footings, retaining walls and pavements.

Approved Fill will be as specified in this report. The re-use of any rock for fill is subject to the civil design requirements and any other requirements noted in the report text. The preparation measures outlined below assume **Approved Fill**.

Table GDR 10: Standard Rock Site Measures (Bulk Earthworks)

Measure	Commentary
Moisture condition and proof compact.	Moisture condition and compact the exposed ground (soil above rock) to achieve the density specified in Section GDR7.1 to a depth of at least 300 mm. Proof compaction of rock is not required.
Test proof compaction	Check that the density specified in Section GDR7.1 has been achieved to a depth of at least 300 mm. in situ NDG testing is suitable to assess compaction. Compaction control of intact rock is not required.
Treat areas of loose or unsuitable material	Any areas of loose / soft or unsuitable material (including over-excavated areas of former trees and root balls) must be removed and replaced with compacted **Approved Fill** as outlined in the report or as noted above. The report will explain the suitability of site-derived materials for re-use as **Approved Fill.**
Carry out bulk filling	Where fill is required to build up levels, use **Approved Fill**, placed and compacted in layers of no greater than 300 mm loose thickness. Test compaction to achieve the density specified in Section GDR7.1.
Grade surface	Surface water control may be required for lower permeability soils/rock, or at an interface where high permeability fill is placed over relatively impermeable soils/ rock. The surface of any impermeable ground / rock must be graded at a minimum of 1% crossfall to drain. This is a general recommendation, and an appropriate civil design must be done to account for surface and subsoil drainage.

These measures do not take into account the specifics of the civil design, including the requirement (if any) for excavatable and/or free draining layers to achieve construction and drainage objectives. The civil design must take precedence and is not specifically considered in this advice.

Soakwells can perform poorly in rock and specific advice may apply to the installation of soakwells in these areas. If not discussed in our report, please contact us for further advice.

Without further consultation with the structural designer, footings for any one structure must not be founded on a mixture of sand and rock. This is due to potential differential settlements between rock zones (relatively hard) and soil zones (relatively soft). Where this is the case, the measures outlined below must be followed, only with guidance from the structural designer and Galt.

Table GDR 11: Standard Rock Site Measures (Footing and Slab Preparation)

Measure	Commentary
Excavate and compact for slabs, subgrades, pad or strip footings	Excavate for pad and strip footings. Where a mix of soil and rock is present below any one structure, one of the following must be done (to be agreed with structural designer and us): ▪ **Over-excavate rock and replace with compacted soil:** Typically where the foundation largely comprises soil and a relatively small amount of rock is present. Where footings and slabs are founded partly on soil and partly on rock, over-excavate the rock by at least 300 mm below the base of footing or slab and replace the excavated material with compacted **Approved Fill**. ▪ **Remove soil from over rock and replace with concrete**: Typically where the foundation largely comprises rock and a relatively small amount of soil is present. Localised zones of sand and mixed sand/rock rubble must be removed and replaced with lean-mix concrete (e.g. 10 MPa blinding concrete) or cement stabilised sand (minimum UCS=2 MPa at 7 days). ▪ **Design the structure to accommodate differential foundation movements:** For example, include construction joints or use a more heavily reinforced footing (subject to the structural designer's requirements).

Measure	Commentary
Test compaction of footing bases, slabs or subgrades.	Compact the exposed bases to achieve the density specified in Section GDR7.1, to a depth of at least 300 mm, or to the depth where rock is intersected. If refusal to the test method is encountered within the target test depth on rock and the results to the refusal depth are acceptable, it is not necessary to repeat compaction testing at that location. Compaction control of intact rock is not required. Remove, replace and compact as required with **Approved Fill** any zone not achieving the density specified in Section GDR7.1.

GDR6.3 Guidance on Sites with Cohesive Soils

Cohesive soils (most commonly, "clayey" soils) require careful moisture conditioning to facilitate compaction. We recommend that the moisture content of the material is between optimum moisture content (OMC) and 2% wet of OMC at the time of placement and compaction. We note that compaction to the densities specified in Section GDR7.1 can be difficult to achieve for clayey material when not appropriately moisture conditioned.

Vibratory padfoot rollers are preferred for compacting cohesive fill to promote proper kneading and interlocking of subsequent layers.

Clayey soils will drain poorly when inundated following rain events and result in saturated conditions that may inhibit compaction of the soil. In general, it is preferable to avoid trying to re-work clayey sites within several days of any substantial rainfall.

We recommend that the surfaces of clayey sites are sealed by compaction (i.e., final compaction should be with a smooth drum roller) and graded to drain (to avoid low spots where water can pond and cause softening) prior to any rain events. Stripping back of softened materials to expose competent natural or compacted clayey soil is required before continuing earthworks.

If difficulties are experienced during compaction due to water, further advice should be sought from a geotechnical engineer.

GDR6.4 Preparation and Testing of Shallow Footings

GDR6.4.1 General

It is preferable to dig all footing excavations carefully with a flat-edged bucket to minimise the disturbance of underlying foundation soil.

Where the footing base is disturbed, or compaction is required, this must be done using appropriate compaction equipment particular to the task (as evaluated by the contractor) – typically a 'jumping jack', self-propelled plate compactor or an excavator-mounted plate compactor.

All footing bases must be tested to achieve the density requirements of Section GDR7.1 unless otherwise specified. PSP testing of sand foundations is only applicable where the use of the PSP is specifically approved in the report, otherwise all testing is to be done using the NDG.

Sand Topping Layer – Where a sand topping layer is present over a different soil (i.e., clay, limestone etc.), testing of the density of the sand topping layer is only necessary within the thickness of the sand topping layer. Testing does not need to extend into the underlying compacted substrate, which is separately subjected to compaction control.

Mixed Sand/Limestone Fill – Where mixed sand/limestone fill has been installed to a method specification, no compaction control testing is required, however re-compaction of the base must be done as noted above.

In situ limestone – where in situ limestone (weakly or more cemented limestone, with no sand zones or voids) is present at a footing base and no over-excavation has been done (refer to Section GDR6.2.6 regarding over-excavation of footing bases in limestone), then no compaction control testing is required.

Where loose or soft material is encountered, one of the following actions must be taken:

- Over-excavate the loose / soft layer to expose a suitable layer that does meet the required density (Section GDR7.1) and either:
- Place and compact Approved Fill (relevant to the appropriate preparation measures outlined in Section GDR6.2) to achieve the required density (Section GDR7.1); or

- Pouring blinding concrete (f'_c>15 MPa at 28 days) from the competent layer up to the underside of the footing.

All foundations must be assessed by a competent person prior to blinding.

GDR6.4.2 Footings in Clay

Where footings are excavated into natural clay and not subject to filling, density testing (e.g., NDG testing) is not required at the base of the footings. This will be highlighted in the report text if this is relevant to the site conditions. Footing bases must be dug with a flat-edged excavator bucket and the underlying soil not disturbed by trafficking or over-excavation.

In these instances, only testing with a DCP is required in accordance with AS1289.6.3.2 at the footing base to achieve the required blow counts indicated in the report text, to a minimum depth of 0.6 m below the base of the footing, or other depth as indicated in the report text. Where the minimum blow count specified cannot be met, the following options are possible to prepare the footing base:

- Scarify, moisture condition and re-compact all zones not achieving the minimum blow counts. Re-test with a DCP to confirm that any soft zones are remediated; or
- Over-excavate and replace all zones not achieving the minimum blow counts with a suitable compacted low permeability fill (e.g., crushed limestone, clayey fill or other approved fill). This fill must be compacted to the appropriate level as specified in GDR7; or
- Over-excavate and replace all zones not achieving the minimum blow counts with blinding concrete (min. 10 MPa at 28 days) or cement-stabilised sand (min. 2 MPa at 7 days). This is typically appropriate where only the upper zones below the footing base are soft.

Measures must be taken to minimise moisture changes in clayey foundation soils at the base of footing excavations. Concrete footings are to be poured soon after excavation to minimise the potential for excessive moisture change. The use of a concrete blinding layer following foundation preparation should be considered.

GDR7 COMPACTION AND MOISTURE CONDITIONING

GDR7.1 Requirements

Any soil within the significant founding zone of structures (buildings, slabs, pavements, etc.) must be suitably moisture conditioned and compacted. These soils must be compacted to the requirements as outlined below.

Table GDR 12: Compaction and Moisture Requirements

Soil Description	Soil Particle Limits	Moisture Requirement	Density Requirement (DDR)	Possible QA/QC Test Methods
Sand	<5% fines <5% gravel *Maximum particle size 9.5 mm*	MOMC ±2%	95% MMDD	PSP NDG
Gravel	<5% fines >50% gravel *Maximum particle size 19.0 mm*	MOMC ±2%	95% MMDD	NDG
Clayey/Silty Gravel	5-35% fines >50% gravel *Maximum particle size 19.0 mm*	MOMC ±2%	95% MMDD	NDG
Sand with fines or gravel	5-35% fines; and/or 5-50% gravel *Maximum particle size 19.0 mm*	MOMC ±2%	95% MMDD	NDG Method Specification
Fine grained soils (Clayey or Silty)	>35% fines *Maximum particle size 19.0 mm*	MOMC ±2%; or SOMC ±2%[2]	92% MMDD; or 95% SMDD	NDG Method Specification
Oversize/rubbly soil	Any soils with particles >19.0 mm	MOMC ±2%	95% MMDD (Or equivalent to)	Method Specification Detailed Assessment Based on Specific Material

NOTES: ***1.*** *DDR – Dry Density Ratio*

MMDD – Modified maximum dry density (AS1289.5.2.1)
MOMC – Modified optimum moisture content (AS1289.5.2.1)
SMDD – Standard maximum dry density (AS1289.5.1.1)
SOMC – Standard optimum moisture content (AS1289.5.1.1)
PSP – Perth Sand Penetrometer
NDG – Nuclear Density Gauge

2. *Preferably OMC to OMC +2%, for ease of compaction and producing a homogenous fill*
3. *Test frequencies are specified in Section GDR7.6.*

The soil groups and definitions outlined above are generally based on AS1726-2017. Test methods are discussed in subsequent sections.

GDR7.2 Construction Recommendations

Over-excavation and replacement of loose material must be done where the minimum DDR cannot be achieved.

Fill must be placed in horizontal layers of not greater than 300 mm loose thickness. Each layer must be compacted by suitable compaction equipment, and carefully controlled to ensure even compaction over the full area and depth of each layer.

Care will need to be taken if compacting in the vicinity of existing structures, such as the adjacent properties. This is particularly important if vibratory compaction is being carried out.

- Tynan (1973), “Ground Vibration and Damage Effects on Buildings”, Australia Road Research Board, Special Report No. 11.

Tynan (1973) provides guidance on the selection of compaction equipment for use adjacent to structures. The distance of influence (i.e., the definition of “vicinity”) will vary depending on the size of compaction plant proposed for use. Where there is concern regarding the impact on nearby structures, a dilapidation study should be done.

Care must be taken when compaction is undertaken when the site surface is within 1 m of the groundwater level, as compaction (particularly with vibration) can draw the water up to the surface. In this instance, consideration should be given to:

- Static rolling only;
- Using a pioneering layer (if possible); or
- Dewatering to keep the water at least 1 m below the surface being compacted.

GDR7.3 Nuclear Density Gauge

Where applicable, a nuclear density gauge (NDG) must be used in accordance with AS1289.5.8.1. NDG tests must be done to a depth of 300 mm or as otherwise indicated in the text of the attached report.

GDR7.4 Perth Sand Penetrometer

Where clean sand is used (<5% fines and <5% gravel), a Perth sand penetrometer (PSP) may be used for compaction control in accordance with AS1289.6.3.3. Refer to the report for recommended blow counts correlating to the specified density.

Where the fines or gravel contents of a sand soil exceed the maximum contents noted above, a PSP must not be used exclusively for compaction control. As a minimum, ongoing confirmation testing with an NDG is required. If not specified in our report, please contact us for further advice regarding test frequencies.

If difficulties are experienced recording the required blow counts, a site-specific PSP correlation should be carried out to determine the PSP blow count correlating to a DDR of 95% MMDD. In addition, a particle size distribution (PSD) test should be carried out to verify that the use of a PSP is suitable for the sands being tested. A site-specific PSP correlation must:

- be done on site;
- use the nuclear density gauge (NDG) to determine density at a minimum of 5 points with varying density to a depth of 300 mm below surface;
- include at least 1 point where the dry density ratio is in excess of 95% MMDD;
- use a calibrated PSP to determine the PSP blow count from 150 mm to 450 mm at each NDG test point; and
- be plotted on a chart of PSP blow count vs DDR.

Only where specifically stated as applicable in the report and where the use of the PSP is relevant as noted above, the following values may be taken as deemed to conform to a dry density ratio of 95% MMDD for the relevant sand type.

Table GDR 13: Deemed-to-comply Values for PSP Results in Perth Sands

Depth Interval (mm)	Bassendean	Tamala	Calcareous
0-150	SET	SET	SET
150-450	7	8	12
450-750	9	10	14
750-1050	11	12	16

NOTES:

1. *Blows per 300 mm interval*
2. *Bassendean Sand is typically a white - grey, low-fines quartz sand found on the eastern part of the Perth coastal plain*
3. *Tamala / Spearwood sand is typically yellow or orange, low-fines quartz sand found on the western part of the Perth coastal plain*
4. *Calcareous sands are typically white or yellow, calcareous sand found in low-lying areas on the western fringe of the Perth coastal plain*
5. *Values derived from Galt experience on PSP correlations done on sites across Perth for the 150-450 mm interval.*

GDR7.5 Method Specifications

GDR7.5.1 General

Where proposed, a method specification should be developed by a geotechnical engineer or similarly qualified person and ratified by us (including a site visit by us). The method specification should be confirmed by the construction of a trial pad or trial area and the compaction methodology should be checked against either:

- density, as assessed using a nuclear density gauge; or
- settlement, as assessed using a dGPS.

Specific advice should be requested for the development of a method specification, taking into consideration the material being compacted.

Method specification compliance should be maintained for all areas on a minimum 20 m grid, with the compliance to include:

- Roller used (weight, style, vibration);
- Water application rate (per lift);
- Layer thickness placed; and
- Number of passes with roller.

GDR7.5.2 Indicative Method Specification – Sand/Limestone Rubble Mix

Where mixed sand/limestone is used as structural fill, a performance specification is not appropriate due to the inaccuracies of standard test methods (NDG/PSP etc.) in this type of material. A method specification can be used instead. The following indicative method specification is provided for evaluation and trial but must be trialled and ratified by us prior to widespread employment on site. The following would be typically adopted:

- Maximum particle size: 250 mm
- Maximum loose layer thickness: 350 mm
- Minimum watering rate: 10 L/m^2/100 mm thickness of loose material (e.g. 35 L/m^2 for a 350 mm thick layer)
- Minimum 8 passes with a vibrating padfoot roller, minimum static weight 10 tonnes.
- The compacted fill must comprise closely packed particles without any significant voids between the larger particles.

GDR7.6 Testing Frequency

After compaction, verify that the required density has been achieved by testing at the base of excavation and through the full depth of any fill, and to a minimum depth of:

- 900 mm where a PSP is used; or
- 300 mm where a NDG is used.

The frequency of testing (when a method specification is not used) should be as follows:

Table GDR 14: Compaction Testing Frequency Requirements

Area	Minimum Testing Frequency	Minimum Tests Per Lot
Proof Compacted Area	1 test per 1,000 m^2 (30 m grid)	2
Structural Fill Outside of Building and Pavement Footprints	1 test per 500 m^3 2 tests per layer *Whichever is greater*	2
Structural Fill Within Building and Pavement Footprints	1 test per 500 m^3 4 tests per layer *Whichever is greater*	4
Spread/Pad Footings	1 test per 9 m^2 per footing	1
Strip Footings/Retaining Wall Foundations	Minimum 2 tests At 5 m centres *Whichever is greater*	2
On-ground slabs, pavements and rafts	Minimum 2 tests At 10 m centres 1 test per 100 m^2 *Whichever is greater*	2

NOTES: ***1.*** *A 'lot' is defined in the context of this section as a section of earthworks that is undertaken in one operation where the equipment, personnel, materials and methodology are consistent throughout the entire process. This would typically be limited to operations done in one day, but this is not mandatory.*

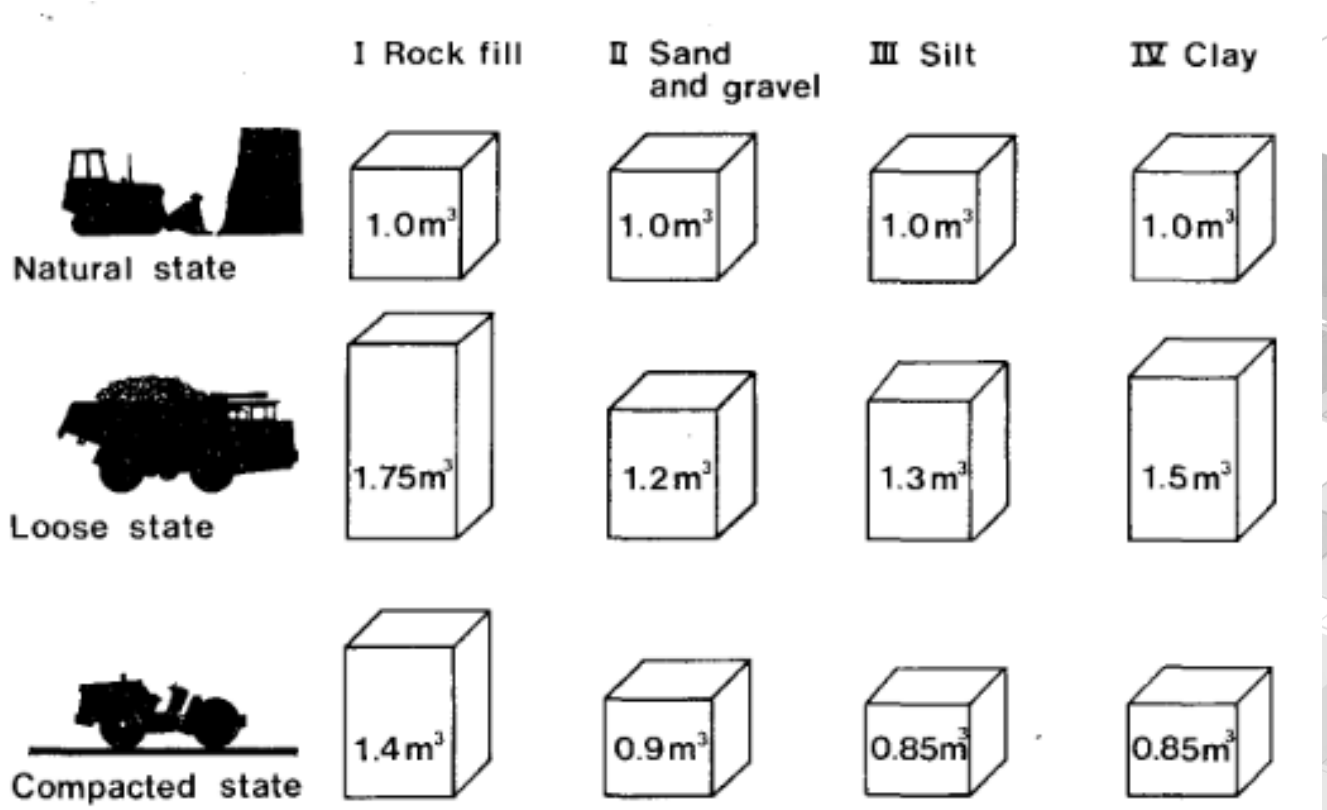
2. *There will frequently be multiple 'lots' in an earthworks process, therefore the number of tests must be adjusted according to the minimum number per lot in this table (where this is more than the frequency specified in 'testing requirements').*

GDR7.7 Bulking and Compaction Factors

All soils will "bulk" when excavated to stockpile, and "compact" when placed from stockpile to earthworks layers. Published bulk and compaction factors are presented below for conventional materials, taken from:

- Forssblad, L (1981), "Vibratory Soil and Rock Fill Compaction", Dynapac Maskin AB

Inline Image GDR 3: Volumes of Different Types of Fill Materials in Natural, Loose and Compacted State



These values are indicative only and will vary according to site specific conditions. The values provided here must not be used for commercial volume estimates or settling disputes regarding volumes.

GDR8 APPROVED FILL AND CONFORMANCE TESTING

Imported fill must comply with the material requirements as stated in AS 3798-2007, “Guidelines on Earthworks for Commercial and Residential Developments”.

Where doubt exists, a geotechnical engineer must be engaged to inspect and approve the use of potential fill materials.

The following table presents recommended material parameters for standard fill types. This does not take account of availability of materials either on site or in the local area. Refer to the report text for specific advice on fill at the subject site.

Table GDR 15: Standard Fill Recommendations

Soil Description	Application	Soil Particle Limits (%)[3]				k_{min}[1] (m/d)	OC[2] (%)	Atterberg Limits		CBR[6] (%)	Test Method[4]
		Fines	Sand	Gravel	Max.			LL (%)	PI (%)		
Permeable Sand	Permeable bulk fill Retaining wall backfill Permeable select fill	≤5	≥90	≤5	9.5	5	≤2	NP	NP	≥12	PSP NDG
General Sand	Bulk fill Select fill (permeability not required)	≤5	≥90	≤5	9.5	N/A	≤2	NP	NP	≥12	PSP NDG
Silty Sand	Bulk fill Select fill	≤35	≥55	≤10	9.5	N/A	≤2	<35	<11	≥12	NDG
Clayey Sand	Bulk fill Select fill	≤35	≥55	≤10	9.5	N/A	≤2	<40	N/A	≥12	NDG
Granular Fill	Bulk Fill	≤30[10]	Varies[10]	Varies[10]	37.5	N/A	≤2	<40	N/A	N/A	NDG
Mixed Sand/Limestone	Bulk fill (permeability not required)	≤5	≥20	≤80	250	N/A	≤2	NP	NP	N/A	NDG Method
Blue Metal Gravel[8]	Retaining wall backfill Drainage trench backfill	≤3	≤5	≥90	37.5	5	≤1	NP	NP	N/A	NDG
Clay[7]	Reinstatement of localised excavations in clay Bulk fill	≥12	Varies	≤30	19	N/A	≤2	Varies			NDG

NOTES:

1. *k_{min} – minimum saturated hydraulic conductivity (AS1289.6.7.1, remoulded to minimum DDR 100% MMDD).*
2. *OC – organic content (Walkley-Black method recommended, AS1289.4.1.1 – not loss on ignition methods)*
3. *% by mass.*
4. *Test method indicates possible compaction control methods for this material.*
   PSP – Perth sand penetrometer (AS1289.6.3.3). Where a PSP is used, a site-specific correlation must be done unless otherwise noted in the report.
   NDG – Nuclear density gauge (AS1289.5.8.1)
   Method – method specification
5. *Atterberg Limits: LL – liquid limit PI – plasticity index NP – non-plastic*
6. *CBR: California bearing ratio (for sand - remoulded to DDR 95% MMDD @ OMC, 4.5 kg surcharge). CBR values may be changed depending on the design pavement requirements.*
7. *"Clay" fill type is included for broad reference only and to illustrate preferred applications, particle size limits and recommended test method. Specific discussion on the use of clayey fills is included in the report text if applicable. Atterberg limit and CBR testing of clayey fills may be required and advice must be sought from us if not stated in the report.*
8. *"Blue metal" gravel refers to single sized, crushed, washed igneous rock gravel used for drainage purposes.*
9. *In the absence of specific test frequencies by the civil designer, the testing shown in Table GDR 16 must be done (highlights in Table GDR 15 show where the test is required).*
10. *Sand and gravel must be reasonably graded to control the risk of soil ingress from surrounding layers. Where the fines content is high (e.g. above ~15%), the gravel content should proportionally increase to meet the requirements for "granular fill". We recommend a minimum gravel content of 30% where the fines content is above 15%.*

Table GDR 16: Conformance Testing Frequency Requirements

Parameter	Frequency (m^3)	Minimum Tests per Source	AS1289 Reference
Particle size distribution	5,000	1	3.6.1
Hydraulic conductivity (permeability)	10,000	2	6.7.1
Organic content	5,000	1	4.1.1
Atterberg limits	5,000	1	3.1.1, 3.2.1, 3.3.1
CBR	10,000	2	6.1.1

NOTES: *1. Frequency is for the nominal number of cubic metres of compacted fill.*
2. Unless stated otherwise in the report text, the conformance testing must also be carried out on site-derived materials to confirm suitability.

GDR9 SHALLOW FOUNDATIONS

GDR9.1 Design

Footings and slabs may be designed in accordance with the assigned site classification in accordance with AS2870-2011. We note that AS2870-2011 is limited to single and double storey residential and commercial developments and may not be strictly applicable.

Where the report provides tables for shallow footing design, custom footings may be designed by the structural engineer using the data provided therein.

GDR9.2 Interpretation of Provided Values

BEARING PRESSURES

All settlement and bearing pressures estimates are provided on the assumption that the site preparation requirements outlined in the report are completed below all structures plus a minimum distance of 1 m beyond the outside edge of any footing or slab. It is essential that the soil below all foundations is appropriately prepared as outlined and meets the relevant compaction requirements.

Allowable bearing pressures for footings of intermediate plan dimensions (to any tabulated) can be interpolated. Footings that have a plan dimension either smaller or larger than those presented in the report will need to be considered individually along with other embedment depths.

Allowable bearing pressures, where provided, are considered to be the upper limit for shallow footings to limit total and differential settlements. Footings carrying eccentric loading, such as below retaining walls, must be assessed separately.

SETTLEMENTS

The reporting of settlements to any precision level is not intended to imply a high accuracy of settlement prediction. Settlements as reported should be considered ‘order of magnitude’.

Estimated settlements represent vertical downwards movement due to loading and do not take into account potential additional movement associated with the characteristic surface movement of the soil (which must be taken in addition to these settlements from loading, refer Section GDR5). The site classification is discussed in the report.

The actual settlement of any proposed structure will depend upon a number of factors including the applied pressures, footing size and base preparation. The estimated settlement(s) provided in this report are for the working bearing pressures as indicated. Differential settlements are likely between footings of similar sizes, loads and elevations (as stated in the report text). A proportion of the settlement is expected to occur during construction (i.e., during initial loading.

The provided settlement estimates (unless otherwise stated) do not include interaction effects from footings founded near other footings (i.e., groups of footings). Interaction effects will need to be considered if the spacing between adjacent footings is smaller than the dimension of the footings (i.e., the centre-to-centre spacing between footings is less than twice the width of the footing). This could act to double provided settlements, dependent on the footing configuration. Where an assessment of footing groups is required, a more detailed numerical or finite-element modelling analysis would need to be undertaken.

CREEP AND CONSOLIDATION

Creep settlement is an irreversible component of long-term soil settlement caused by sustained vertical stress. Consolidation is a time-dependent irreversible compression in a soil layer caused by a reduction in pore pressure between soil particles. Both creep and consolidation can occur in natural materials as a result of earthworks or the placement of loads on to soil layers. The settlements as presented for short-term loading do not include consideration for creep and consolidation settlements unless specifically stated.

GDR9.3 Raft Foundations

Where moduli of subgrade reactions are provided for the design of raft foundations, we highlight that these are an estimate of the elastic reaction of the soil. The values are provided based on an expected load and loaded area size. Soils are typically non-linear in their response and will have different stiffnesses at different levels of strain and load repetitions. This is due to the physical interaction of soil particles under different levels of stress.

The possibility of a non-linear response must be considered by the designer of any raft foundation.

GDR10 PILED FOUNDATIONS

Piles must be designed and tested in accordance with AS2159-2009, “Piling – Design and Installation”. We use the following interpretation/design methods to provide pile design parameters:

- Franki Africa Pty Ltd (2008) “A Guide to Practical Geotechnical Engineering in South Africa”. 4th ed.
- AFNOR (2012) “NF P 94-262 – Justification des ouvrages géo-techniques, Normes d’application nationale de l’Eurocode 7”, Afnor, Paris, July 2012.
- Lehane, B. (2017) “CPT-Based Design of Foundations”. E.H Davis Memorial Lecture, Australian Geomechanics Vol 54. No. 4.
- Lehane, B. et al. (2020) “A New ‘Unified’ CPT-Based Axial Pile Capacity Design for Drivel Piles in Sand”. Proceedings of the Fourth International Symposium on Frontiers of Offshore Geotechnics.
- Doan., Lehane, B. (2021) “CPT-Based Design Method for Axial Capacities of Drilled Shafts and Cast-in-place Piles.” American Society of Civil Engineers (ASCE), Journal of Geotechnical and Geoenvironmental Engineering.

The pile designer must:

- consider the possible variation in subsurface conditions at each pile location;
- consider any pile group effects based on the final piling configuration;
- assume that the unit shaft resistance in tension is less than 80% of the unit shaft resistance in compression to account for Poisson’s effect in sand;
- ignore pile resistance in the surficial 0.5 m or 1 x pile diameter (whichever is greater), if relevant;
- consider the impact of weak layers underlying stiffer layers (or vice versa) on end bearing capacity; and
- reduce the pile capacity in tension to no greater than 0.8 of the pile capacity in compression.

The piling contractor must:

- make their own assessment on the suitability of their equipment to install any piles at the subject site; and
- carry out or appoint a suitably experienced contractor to test the piles in accordance with AS2159.

Where dynamic or static testing of the piles does not occur, we consider that a design geotechnical reduction factor (ϕg) of 0.4 is applicable for the pile design. If testing of the piles is proposed by the piling contractor, a higher ϕg could be adopted.

Unless otherwise stated, providing pile design parameters does not specifically indicate the driveability of any piles into soil units.

A separate driveability study may be required and must be considered by the pile designer and installer. The given pile design parameters must not be used for driveability assessments as these parameters are likely to be un-conservative.

GDR11 EARTH RETAINING STRUCTURES

GDR11.1 General

Retaining structures may be designed in accordance with AS4678 (2002) "Earth Retaining Structures". Unless otherwise specifically stated, we recommend that all retaining walls are backfilled with free-draining soil (Permeable Sand or Blue Metal Gravel as defined in Section GDR8).

Where the cohesive soil is used as retaining wall backfill, a suitable, permanent drainage system must be placed behind the wall such that a build-up of pore pressure is prevented. A separator geotextile (Bidim A24, or similar, or heavier) must be used between the interface of any granular backfill and the cohesive soil.

Where drainage is not provided, the retaining wall must be designed to accommodate water pressure behind the wall (10 kPa per metre height).

GDR11.2 Earth Pressure Coefficients and Strength Parameters

Where earth pressure coefficients are provided for retaining walls, the wall designer must make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction. Unless otherwise stated, we have assumed a horizontal ground surface behind and in front of the retaining wall for provided parameters.

GDR11.2.1 Cohesionless Soils

Where cross-referenced for suitability in the report, the following parameters may be adopted for design of earth retaining structures in cohesionless soils (sand and gravel).

Table GDR 17: Retaining Wall Geotechnical Parameters (Cohesionless Soils)

Density	γ (kN/m^3)	ϕ' (°)	k_0	Wall Friction=0		Wall Friction=0.5ϕ		Wall Friction=0.67ϕ	
				k_a	k_p	k_a	k_p	k_a	k_p
Very Loose	17	30	0.44	0.33	3.00	0.29	4.81	0.28	5.74
Loose	17	32	0.42	0.31	3.25	0.27	5.55	0.26	6.83
Medium Dense	18	34	0.39	0.28	3.54	0.25	6.47	0.23	8.26
Dense	19	36	0.36	0.26	3.85	0.22	7.63	0.21	10.18
Very Dense (1)	19	38	0.34	0.24	4.20	0.21	9.11	0.20	12.85
Very Dense (2)	19	40	0.31	0.22	4.60	0.19	11.06	0.18	16.73

NOTES:

1. *Earth pressure coefficients are provided in this table for conditions of zero friction between the wall and the soil and with wall friction of 0.5Φ' or 0.67Φ'.*
2. *A horizontal ground surface behind and in front of the wall has been assumed.*
3. *The retaining wall designer should make an independent assessment of the parameters appropriate to the construction method to be used, including alternative values of wall friction.*
4. *γ – bulk unit weight*
   ϕ' – effective friction angle
   k_a – coefficient of active earth pressure (Coulomb – AS4678-2002, Appendix E)
   k_p – coefficient of passive earth pressure (Coulomb – AS4678-2002, Appendix E)
   k_0 – coefficient of at-rest earth pressure (Jaky)
5. *Maximum fines content 12% for applicability of this table for design purposes.*
6. *Unit weights based on Table D1 of AS4678-2002, for moist bulk weight.*
7. *Friction angle based on Equation D1 and Table D2 of AS4678-2002, based on rounded, moderately graded siliceous sand.*

GDR11.2.2 Cohesive Soils

Where cohesive soils (i.e. clayey or silty soils) are proposed for backfill, geotechnical design parameters may be provided in the form of effective strength and undrained strength parameters. We note that:

- Undrained strength parameters should be used for analysis of short-term stability, or stability under sudden loading of cohesive soils.
- The effective strength parameters should be used for analysis of free-draining soils and the long-term stability of cohesive soils.

Table GDR 18: Retaining Wall Geotechnical Design Parameters (Cohesive Soils – Undrained)

Consistency	γ_b (kN/m^3)	c_u (kPa)
Soft	17	12
Firm	18	25
Stiff	19	50
Very Stiff	20	100
Hard	20	200

NOTES:
1. *γ_b – bulk unit weight*
   c_u – undrained cohesion
   $\phi_u = 0^o$ (undrained friction angle)
2. *Unit weights based on Table D1 of AS4678-2002*
3. *Undrained cohesion based on lower end of shear strengths as define in AS1726-2017, Table 11*

Table GDR 19: Retaining Wall Geotechnical Design Parameters (Cohesive Soils – Drained)

Fines Content	PI (%)	γ_b (kN/m^3)	ϕ' (°)	c' (kPa)[5]
12-35%	All	19	32	0
>35%	10	20	30	0 – 5
>35%	20	20	26	0 – 5
>35%	30	20	23	0 – 5
>35%	40	20	21	0 – 5

NOTES:
1. *γ_b – bulk unit weight*
   c' – drained cohesion
   ϕ' – effective friction angle
   PI – plasticity index
2. *Unit weights based on Table D1 of AS4678-2002, assuming generally stiff to hard overconsolidated soils.*
3. *For fines contents <35% (silty sand and clayey sand), strength parameters based on:*
   - *Lehane, B. et al (2007) "A Laboratory Investigation of the Upper Horizons of the Perth/Guildford Formation in Perth CBD", Australian Geomechanics Vol 42. No. 3.*
4. *For fines content >35% (sandy clay), strength parameters based on:*
   - *CIVL5503 course notes (2004), "Underground Construction", University of Western Australia*
5. *c' = 0 recommended for long-term design. Table D4 of AS4678 suggests c' up to 5 kPa for 'poor' fine grained soils and 10 kPa for 'average' fine-grained soils. The use of c' for design is subject to the designer's judgement but recommended by us only for temporary works.*

Per AS4678-2002 Appendix E, horizontal earth pressures for frictional-cohesive soils may be calculated in accordance with the Rankine-Bell design model (illustrated in Figure E2 of AS4678). The earth pressures are as follows (Z = depth, all other terms have the meanings given in the above tables):

- Active: $p_a = \gamma\ Z\ tan^2\left(45 - \frac{\emptyset}{2}\right) - 2\ c\ tan\left(45 - \frac{\emptyset}{2}\right)$
- Passive: $p_p = \gamma\ Z\ tan^2\left(45 + \frac{\emptyset}{2}\right) + 2\ c\ tan\left(45 + \frac{\emptyset}{2}\right)$

GDR11.3 Design and Construction Considerations

Compaction plant can augment the lateral earth pressure acting on retaining walls. Hand operated compaction equipment is recommended within 2 m of any retaining walls to minimise compaction pressures.

Retaining walls can move and rotate under imposed soil loading resulting in settlement behind the wall. This must be considered in the design and during construction of the retaining walls in order that adjacent infrastructure is not adversely affected.

It is important to note that some ground movement will occur behind any soil retaining system, including gravity retaining walls.

GDR12 EXCAVATIONS, BATTERS AND SLOPES

GDR12.1 Excavatability

Our assessment of the excavatability of rock is based on a combination of:

- Our experience on earthworks and construction projects across Australia; and
- Figure 10 of the revised graphical method of assessing excavatability of rock by:
- Pettifer, G.S. & Fookes, P.G., "A revision of the graphical method for assessing the excavatability of rock", Quarterly Journal of Engineering Geology, 27, pp145-164, 1994.

GDR12.2 Safety

All excavations must be carried out in accordance with:

- Commission for Occupational Safety and Health (2022). "Excavation: Code of Practice", Department of Mines, Industry Regulation and Safety, 89pp, Perth.

Excavations in cohesionless soils are particularly prone to instability unless support is provided. Care must be exercised in such excavations and appropriate safety measures adopted where necessary, particularly in the vicinity of existing buildings, structures and infrastructure.

The toe of any batter must be at least 500 mm above groundwater (including perched groundwater).

Unless a specific slope stability assessment or retention design has been done, the toe of any excavation should not encroach within a line of 1V:3H to any nearby footings, pavements or other settlement-sensitive structures.

Surcharges (such as structures, plant and soil stockpiles) must not be placed at or close to the crest of unsupported excavations, without a specific slope stability assessment.

A geotechnical engineer must be consulted where there is any doubt regarding the stability or safety of unsupported excavations.

GDR12.3 Batters

Temporary batter slopes provided in the report are subject to the following conditions, unless otherwise stated:

- The maximum slope height is 2 m without specific advice and slope stability analysis.
- The groundwater level for the duration of the excavation must be at least 500 mm below the toe of the slope.
- No surcharges are present in the vicinity of the slope (i.e. must be outside a line of 1V:3H from the toe of the slope).

Unless noted specifically in the report, the following batters may be adopted (maximum height: 2 m):

Table GDR 20: Default Batter Angles

Situation	Material	Batter
Temporary	Cohesionless Soils (Sand/Gravel)	1V:2H
Temporary	Cohesive Soils – Soft	1V:2H
Temporary	Cohesive Soils – Firm, Stiff, Very Stiff or Hard	1V:1H
Temporary	Limestone – Variably Cemented	1V:1H
Temporary	Limestone – Well Cemented	1V:0.5H
Permanent	All Soils	1V:3H
Permanent	Limestone – Variably Cemented	1V:2H
Permanent	Limestone – Well Cemented	1V:1H

Where specified batters cannot be accommodated in the vicinity of existing footings, roads and services, temporary or permanent lateral support will be required.

Specific advice is required for batters higher than 2 m.

Erosion control must be considered for permanent slopes.

Rock slopes must be inspected, and all loose cobbles / boulders removed. Permanent rock slopes may require dentition works or possibly rock catch drains.

GDR12.4 Grouting

Permeation or jet grouting involves injecting a microfine cement into soil to form a grouted soil block (soilcrete) to support excavation and structures. Grouting is typically only effective where the soil has the capacity to "take" the grout and form a uniformly cemented soil mass. Permeation grouting is generally limited to relatively permeable, coarse-grained cohesionless soils (sands and gravels with <5% fines).

If grouting is proposed, we recommend the following:

- Grouting must be carried out by a suitably experienced contractor.
- Only microfine cement grout should be used (not GP or coarse cement blends) to ensure adequate penetration into the soil matrix.
- Grouting should be done on a grid of not greater than 300 m.
- Application rates must be discussed with the contractor.
- The grouted soil mass must have intimate contact with any structures it is intended to support.
- The contractor must satisfy themselves that the proposed grouting can be installed with their equipment and into the subsurface conditions encountered at the site, considering possible obstructions, groundwater, cemented layers, loose sands etc.
- Testing of the grouted soil mass must be done to ensure that the grout has adequately permeated through the soil matrix. This can be done by drilling into the soil mass to ensure the cementation is continuous.

Grouting is most effective on permeable, relatively loose natural sand. Where historical filling or other ground disturbances have occurred, the grouting process can be less effective due to the tendency of grout (or other liquids) to follow more permeable paths / zones through the disturbed soil.

GDR13 STORMWATER DISPOSAL AND DRAINAGE DESIGN

GDR13.1 Groundwater Separation – Controlled Groundwater

These recommendations ONLY apply to where regional controls on groundwater (primarily: subsoil drainage, but also surficial 'main drains') exist, i.e. only to areas where groundwater is actively controlled.

The following reference:

- IPWEA (2016), "Specification: Separation Distances for Groundwater Controlled Urban Development", Institute of Public Works Engineering Australasia

recommends the following separation distances from drainage infrastructure to groundwater:

- Underground infiltration systems: 0 mm from the 50% AEP (annual exceedance probability) phreatic surface.
- Surface infiltration systems (vegetated): 300 mm from the 50% AEP phreatic surface.

The above IPWEA reference also states that performance measures for underground infiltration systems are to have a: demonstration of acceptable volumetric capacity when groundwater is elevated above base of system and that the groundwater recedes below the invert of the system during mosquito breeding seasons (grated or partially open systems).

GDR13.2 Groundwater Separation – Uncontrolled Groundwater

These recommendations apply where regional controls on groundwater levels are not present. For infiltration into soakwells and soakage basins to be the full theoretical value, an adequate separation to groundwater must be achieved, because otherwise performance is hindered by inadequate separation to groundwater or partial submergence of the infiltrative element.

We recommend a minimum separation of 500 mm from the underside of infiltrative elements to maximum groundwater level.

- To average annual maximum groundwater level (AAMGL), where this has been defined for the site; or
- To historical maximum groundwater level, where this has been defined to the site.

GDR13.3 Design Hydraulic Conductivity Values

Where provided, the values of hydraulic conductivity (k) should be considered the maximum/upper limit design values. As discussed in Section GDR3.7, the inverse auger hole test is an unsaturated field test carried out above the groundwater table and, as such, presents the best-case conditions for drainage.

For soak wells in sand, we provide the design value taking into consideration the variability in materials and reduced permeability as a result of:

- Densification of sand during site preparation works; and
- Natural variation in sands.

Design k_{unsat} values provided for soak wells are only appropriate for the design of unsaturated soils where the base of disposal area is at least 500 mm above groundwater and 500 mm above any impermeable layer.

Where design values of k_{unsat} have been provided, clogging of the base of the soakwell / drainage basin has not been considered. Clogging will need to be controlled with maintenance over the life of the soakwell / drainage basin.

For the design of subsoil drains or modelling of saturated soil performance, a k_{sat} value must be given (in the report text) or assessed by laboratory testing (or a combination of field and laboratory testing). Unless specifically stated, k_{unsat} values presented in our report are for unsaturated conditions and intended for design of stormwater disposal elements above groundwater. If no k_{sat} value has been provided, do not use the provided k_{unsat} value for saturated drainage design. Please contact us for further advice.

For saturated or semi-saturated sands, the hydraulic conductivity must be assessed by testing of representative soil samples at a NATA accredited laboratory to determine:

- The modified maximum dry density (MMDD); and
- The constant-head permeability (AS1289.6.7.1) on a sample remoulded to at least 5% greater than the proposed specification density (i.e., sample should be remoulded to 100% MMDD if the earthworks specification requires a density ratio of 95% MMDD).

For saturated or semi-saturated clayey or silty soils, the hydraulic conductivity must be assessed by testing of representative soil samples at a NATA accredited laboratory to determine:

- The standard maximum dry density (SMDD); and
- The falling-head permeability (AS1289.6.7.2) on a sample remoulded to at least 3% greater than the proposed specification density (i.e., sample should be remoulded to 101% SMDD if the earthworks specification requires a density ratio of 98% SMDD).

GDR13.4 Soakwells

In uncontrolled groundwater environments, the base of any soakwell must be the higher of:

- At least 500 mm above the average annual maximum groundwater level (AAMGL).
- At least 500 mm above any low permeability/impermeable layers (clay, rock or otherwise).

In controlled groundwater environments (refer to Section GDR13.1), the base of any soakwell may be 0 mm above the controlled groundwater level at the location of the soakwell (as determined by the civil engineer).

Soak wells must be placed outside a line of 1V:2H extending below the edge of the nearest footing, subject to local council regulations. Discharge from soak wells has been known to promote densification of loose sandy soils, leading to settlements of footings and slabs. Soak wells should be carefully wrapped with geotextile to prevent migration of sand and fines into the soak well.

Where soak wells are proposed to dispose of water within a line of 1V:2H from any basement walls or similar, the walls must be waterproofed to prevent seepage or damp within the basement wall.

In potentially karstic terrain or areas of potentially collapsible soils, soakwells should typically be located 10 m from the nearest footing, slab or pavement.

GDR13.5 Design Groundwater Elevation

Where applicable, a recommended design groundwater elevation will be provided in the report and will be identified as such.

In the absence of a specific statement on design groundwater elevation, do not assume that:

- Absence of comments about groundwater indicates an absence of groundwater (in particular, sites that are dry in the dry season to the investigated depth may well become waterlogged in the rainy season).
- Where groundwater depths/levels are noted, that these are fixed (groundwater fluctuations occur over the course of the year and between wetter and drier years).

Where groundwater elevations are likely to be critical for a development (particularly where large-scale subdivision or large developments are proposed with substantial channelling of stormwater into on-site disposal by infiltration), a site-specific hydrology study is likely to be required to confirm design groundwater elevations.

GDR14 DRAINAGE CONTROL

In addition to the site preparation measures outlined for cohesive soils (refer Section GDR6.2.4), careful control of surface water and stormwater is essential to minimise the likelihood of cohesive soils decreasing in strength and affecting the installed infrastructure. These measures include:

- The ground surface of clayey soils should be graded to drain any seepage away from structures and prevent standing water over the cohesive soils. A grade of at least 1% is recommended.
- Pavements should be sealed to minimise water ingress.
- Stormwater disposal swales should be located at least 10 m away from buildings, retaining walls and pavements.
- Runoff from hardstandings and pavements must either be collected and discharged via pipes into discrete locations (via swales or soakage basins) at least 10 m away from structures and pavements or, alternatively, discharged over a wide area, but not allowed to collect and discharge into concentrated areas, particularly near structures and pavements.
- Spoon drains should be used to collect water at the crest of slopes to capture surface runoff and direct it away from running directly down slopes or seeping into the ground behind slopes.

These measures are general in nature only and do not take into account the civil design objectives, which must be addressed separately by the civil designer.

GDR15 DEWATERING

Dewatering may be required for excavations and construction below groundwater or perched groundwater tables. Common dewatering methods are summarised below:

Table GDR 21: Dewatering Recommendations

Material	Recommended Methods
Sandy Soils	Spears Deep Well Point
Impermeable Clay	Sump Pumping

Dewatering spears are typically suitable for small scale excavations below groundwater, with a typical recommendation for spears to be installed at 1 m below the base of any excavation. Dewatering spears may not be suitable where there are impermeable/cemented/strong transition layers, i.e., it may not be possible to extract water near an impermeable layer (rock/clay), or the spear may not be readily driven through a hard clay/cemented layer (i.e., coffee rock).

Sump pumping can be done by grading a clayey excavation to drain (i.e., by using spoon drains), and excavating a sump in the excavation. A sump can typically be backfilled with a blue metal gravel, with a pump wrapped in a geofabric (i.e., Bidim A14 or similar), with disposal of water away from the excavation.

Deep well point dewatering is typically suitable for larger excavations, where there are transitional layers or where the aquifer is confined. It may not be suitable where there are impermeable layers within the profile. It involves the installation of a deep filtered well to a depth required to draw down the groundwater level at the entire site. A deep well dewatering system must be designed by a suitable designer to provide design flow rates, draw down depths etc.

GDR16 PAVEMENT SUBGRADES

Unless otherwise specified, the provided subgrade California bearing ratio (CBR) is not a pavement design, but an assessment of the subgrade as an input into any required pavement designs.

Provided design values are based on the assumption that the relevant site preparation measures are completed for all pavement subgrades, including the use of appropriate approved fill and adequate compaction. We highlight that specific requirements such as those outlined by Main Roads WA (MRWA) or the local council in their construction specifications may have different requirements.

The provided design value is based on laboratory testing (where done), local experience, and the advice as outlined in:

- Main Roads Western Australia (2013). “Engineering Road Note 9 – Procedure for the Design of Road Pavements”. Western Australia Supplement to the Austroads Guide to Pavement Technology Part 2: Pavement Structural Design, East Perth.

Where the subgrade differs from that described in the text, the subgrade CBR must be confirmed.

The performance of any pavement is highly dependent on the surface and subsurface drainage provided (also considering factors like capillary rise from seasonally high groundwater tables). Adequate drainage must be provided to any pavements, and capillary rise must be considered by the designer.

GDR17 SOIL CORROSIVITY AND AGGRESSIVITY

The relevant exposure classifications for concrete and steel piles in soils based on the exposure conditions are presented in Table GDR 22 and Table GDR 23 respectively.

The relevant exposure classifications for concrete in sulfate soils based on the exposure conditions are presented in Table GDR 24.

Table GDR 22: Exposure Classification for Concrete Piles in Soil

Exposure Conditions				Exposure Classification	
Sulfates (expressed as SO_4)[1]					
In Soil (ppm)	In Groundwater (ppm)	pH	Chlorides in Groundwater (ppm)	Soil Conditions A[2]	Soil Conditions B[3]
< 5,000	< 1,000	> 5.5	<6000	Mild	Non-aggressive
5,000 – 10,000	1,000 – 3,000	4.5 – 5.5	6,000-12,000	Moderate	Mild
10, 000 – 20,000	3,000 – 10,000	4 – 4.5	12,000-30,000	Severe	Moderate
> 20,000	> 10,000	< 4	>30,000	Very Severe	Severe

NOTES:
1. *Approximately 100 ppm SO_4 = 80 ppm SO_3*
2. *Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater*
3. *Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater*
4. *Table reproduced from Table 6.4.2(C) of AS2159-2009*

Table GDR 23: Exposure Classification for Steel Piles in Soil

pH	Chlorides		Resistivity (ohm.cm)	Exposure Classification	
	In Soil (ppm)	In Water (ppm)		Soil Conditions A[2]	Soil Conditions B[3]
> 5	< 5,000	< 1,000	> 5,000	Non-aggressive	Non-aggressive
4–5	5,000-20,000	1,000–10,000	2,000 – 5,000	Mildly aggressive	Non-aggressive
3–4	20,000-50,000	10,000–20,000	1,000 – 2,000	Moderately aggressive	Mildly aggressive
< 3	> 50,000	> 20,000	< 1,000	Severely aggressive	Moderately aggressive

NOTES:
1. *1 ppm (parts per million) is equivalent to 1 mg/kg*
2. *Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater*
3. *Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater*
4. *Table reproduced from Table 6.5.2(C) of AS2159-2009*

Table GDR 24: Exposure Classification for Concrete in Sulfate Soils

Exposure Conditions			Exposure Classification	
Sulfates (expressed as SO_4)[1]				
In Soil (ppm)	In Groundwater (ppm)	pH	Soil Conditions A[2]	Soil Conditions B[3]
< 5,000	< 1,000	> 5.5	Mild	Non-aggressive
5,000 – 10,000	1,000 – 3,000	4.5 – 5.5	Moderate	Mild
10, 000 – 20,000	3,000 – 10,000	4 – 4.5	Severe	Moderate
> 20,000	> 10,000	< 4	Very Severe	Severe

NOTES:
1. *Approximately 100 ppm SO_4 = 80 ppm SO_3*
2. *Soil Conditions A – high permeability soils (e.g. sands and gravels) which are in groundwater*
3. *Soil Conditions B – low permeability soils (e.g. silts and clays) or all soils above groundwater*
4. *For disturbed soils, the assumption of soil A conditions where accelerated corrosion is possible should be considered.*
5. *Table reproduced from Table 4.8.1 of AS3600-2018*

GDR18 LIQUEFACTION

Soil liquefaction can occur when loose, granular, Holocene age material below the groundwater table is subjected to a seismic event (typically within 15 m of the ground surface). This can cause a loss of strength and result in vertical and lateral movements of the site surface.

Where a liquefaction analysis is carried out and outlined in the report, this has been done in accordance with consideration to the design earthquake details as presented in AS1170.4-2007:

- The hazard factor is taken from Figure 3.2 (C) and Table 3.2. The Hazard Factor (Z) for Western Australia represents the 1 in 500-year annual probability of exceedance of ground motions measured in gravity (g).
- The probability factor (k_p) is taken from Table 3.1.

Unless otherwise stated, an earthquake magnitude of 7.5 for the south-west of WA is based on research by:

- Dhu T., Sinadinovski C., Edwards M., Robinson D., Jones T., Jones A. (2004) “Earthquake Risk Assessment for Perth, Western Australia”. 13th World Conference on Earthquake Engineering, Vancouver, B.C., Canada. Paper No. 2748.

GDR19 EXPECTATIONS OF THE REPORT

The following sections have been prepared to clarify what is and is not provided in your report. It is intended to inform you of what your realistic expectations of this report should be and how to manage your risks associated with the conditions on site.

Geotechnical engineering and environmental science are less exact than other engineering and scientific disciplines. We include this information to help you understand where our responsibilities begin and end. You should read and understand this information. Please contact us if you do not understand the report or this explanation. We have extensive experience in a wide variety of projects and we can help you to manage your risk.

GDR20 THIS REPORT RELATES TO PROJECT-SPECIFIC CONDITIONS

This report was developed for a unique set of project-specific conditions to meet the needs of the nominated client. It took into account the following:

- the project objectives as we understood them and as described in this report;
- the specific site mentioned in this report; and
- the current and proposed development at the site.

It should not be used for any purpose other than that indicated in the report. You should not rely on this report if any of the following conditions apply:

- the report was not written for you;
- the report was not written for the site specific to your development;
- the report was not written for your project (including a development at the correct site but other than that listed in the report); or
- the report was written before significant changes occurred at the site (such as a development or a change in ground conditions).

You should always inform us of changes in the proposed project (including minor changes) and request an assessment of their impact.

Where we are not informed of developments relevant to your report, we cannot be held responsible or liable for problems that may arise as a consequence.

Where design is to be carried out by others using information provided by us, we recommend that we be involved in the design process by being engaged for consultation with other members of the project team. Furthermore, we recommend that we be able to review work produced by other members of the project team that relies on information provided in our report.

GDR21 DATA PROVIDED BY THIRD PARTIES

Where data is provided by third parties, it will be identified as such in our reports. We necessarily rely on the completeness and accuracy of data provided by third parties in order to draw conclusions presented in our reports. We are not responsible for omissions, incomplete or inaccurate data associated with third party data, including where we have been requested to provide advice in relation to field investigation data provided by third parties.

GDR22 SOIL LOGS

Our reports often include logs of intrusive and non-intrusive investigation techniques prepared by Galt. These logs are based on our interpretation of field data and laboratory results. The logs should only be read in conjunction with the report they were issued with and should not be re-drawn for inclusion in other documents not prepared by us.

GDR23 THIRD PARTY RELIANCE

We have prepared this report for use by the client. This report must be regarded as confidential to the client and the client's professional advisors. We do not accept any responsibility for contents of this document from any party other than the nominated client. We take no responsibility for any damages suffered by a third party because of any decisions or actions they may make based on this report. Any reliance or decisions made by a third party based on this report are the responsibility of the third party and not of us.

GDR24 CHANGE IN SUBSURFACE CONDITIONS

The recommendations in this report are based on the ground conditions that existed at the time when the study was undertaken. Changes in ground conditions can occur in numerous ways including anthropogenic events (such as construction or contaminating activities on or adjacent to the site) or natural events (such as floods, groundwater fluctuations or earthquakes). We should be consulted prior to use of this report so that we can comment on its reliability. It is important to note that where ground conditions have changed, additional sampling, testing or analysis may be required to fully assess the changed conditions.

GDR25 SUBSURFACE CONDITIONS DURING CONSTRUCTION

Practical constraints mean that we cannot know every minute detail about the subsurface conditions at a particular site. We use professional judgement to form an opinion about the subsurface conditions at the site. Some variation to our evaluated conditions is likely and significant variation is possible. Accordingly, our report should not be considered as final as it is developed from professional judgement and opinion.

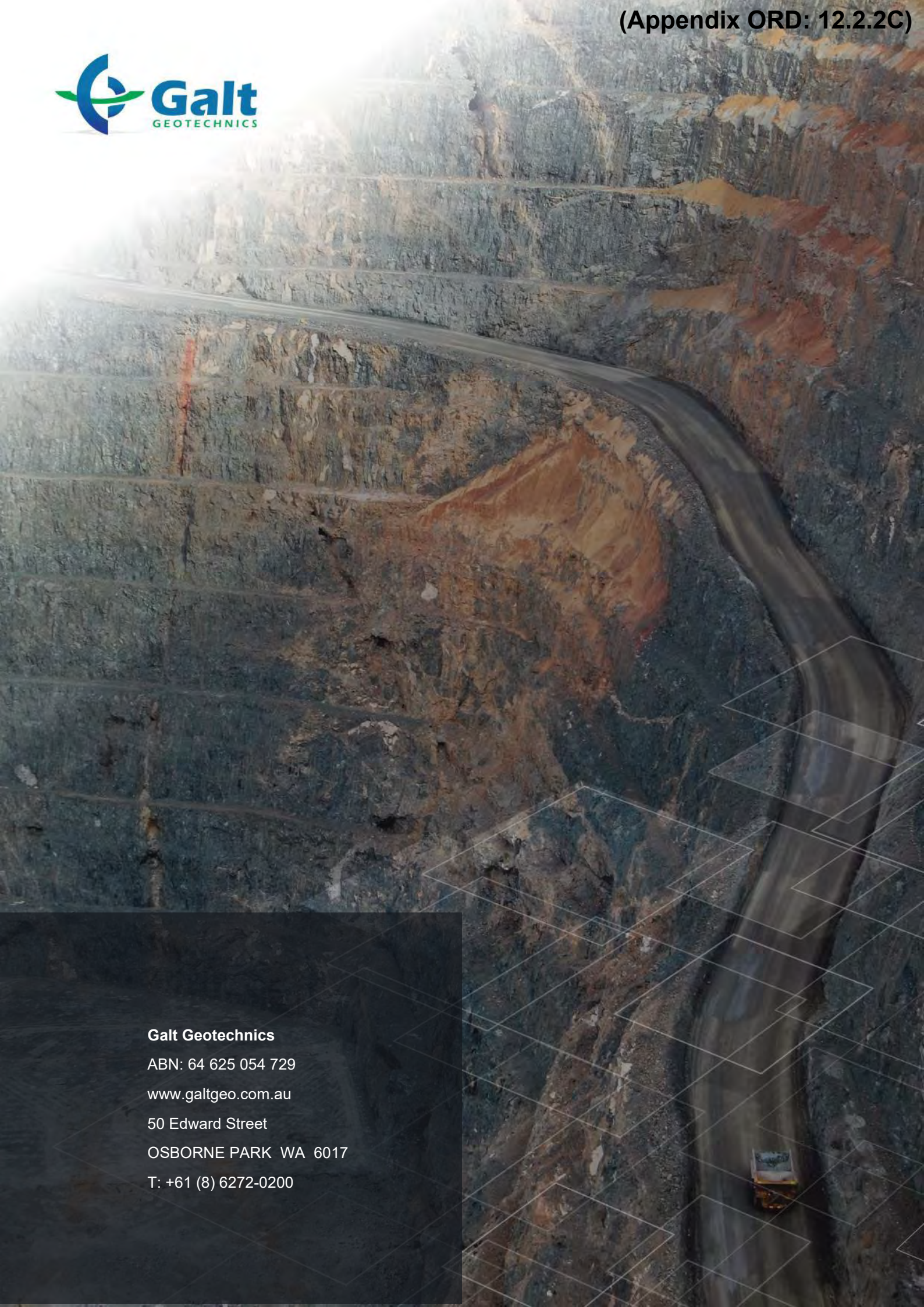
The most effective means of dealing with unanticipated ground conditions is to engage us for construction support. We can only finalise our recommendations by observing actual subsurface conditions encountered during construction. We cannot accept liability for a report's recommendations if we cannot observe construction.

GDR26 ENVIRONMENTAL AND GEOTECHNICAL ISSUES

Unless specifically mentioned otherwise in our report, environmental considerations are not addressed in geotechnical reports. Similarly, geotechnical issues are not addressed in environmental reports. The investigation techniques used for geotechnical investigations can differ from those used for environmental investigations. It is the client's responsibility to satisfy themselves that geotechnical and environmental considerations have been taken into account for the site.

Geotechnical advice presented in a Galt Environmental report has been provided by Galt Geotechnics under a sub-contract agreement. Similarly, environmental advice presented in a Galt Geotechnics report has been provided by Galt Environmental under a sub-contract agreement.

Unless specifically noted otherwise, no parties shall draw any inferences about the applicability of the Western Australian state government landfill levy from the contents of this document.



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APPENDIX H | LANDSCAPING CONCEPT PLANS

MILLBRIDGE ESTATE

LEGEND

- Proposed Street Tree *Agonis flexuosa*
- Managed Vegetation
- Grass / mulch
- Soft Fall Surface with play equipment
- Verge
- Bollards
- Footpath
- Potential Habitat Tree

Notes:

Rubbish to be removed from site

Informal nature play encouraged with climbing logs, walk tracks and seating

Bollards to prevent vehicle access

Potential habitat trees to be retained

Vegetation to be managed - thinning or branch removal to achieve and overall averaged crown density of ≤.15% cover







LANDSCAPING CONCEPT PLAN
Nature Park

PARKRIDGE

Date	12/09/2025
Drawn	KS
Checked	
Base Data	Landgate
Projection	MGA94
Plan No.	22294-33
Rev.	A

Scale: 1:500 @A3

0 5m 10m 15m

N

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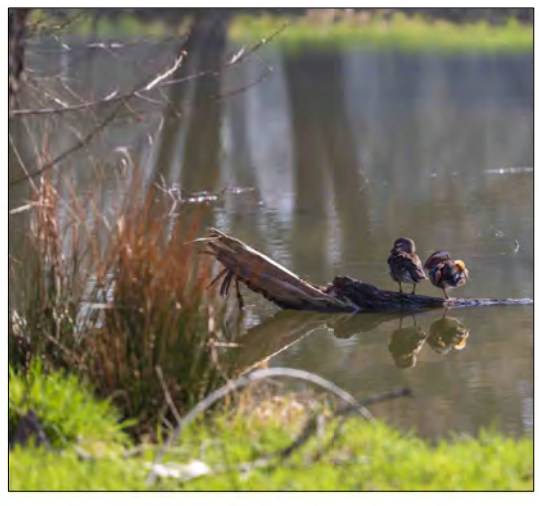
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NOTE: This plan has been prepared for planning purposes. Areas, contours and dimensions shown are subject to survey

LEGEND

- Proposed Street Tree *Agonis flexuosa*
- Existing Vegetation to be Retained
- Grass / mulch
- Verge
- Drainage Basin
- Bollards
- Footpath
- Residential







LANDSCAPING CONCEPT PLAN - AREA D
Public Open Space and Drainage

PARKRIDGE

Date	19/09/2025
Drawn	KS
Checked	
Base Data	Landgate
Projection	MGA 94 Z50
Plan No.	22294-34
Rev.	A

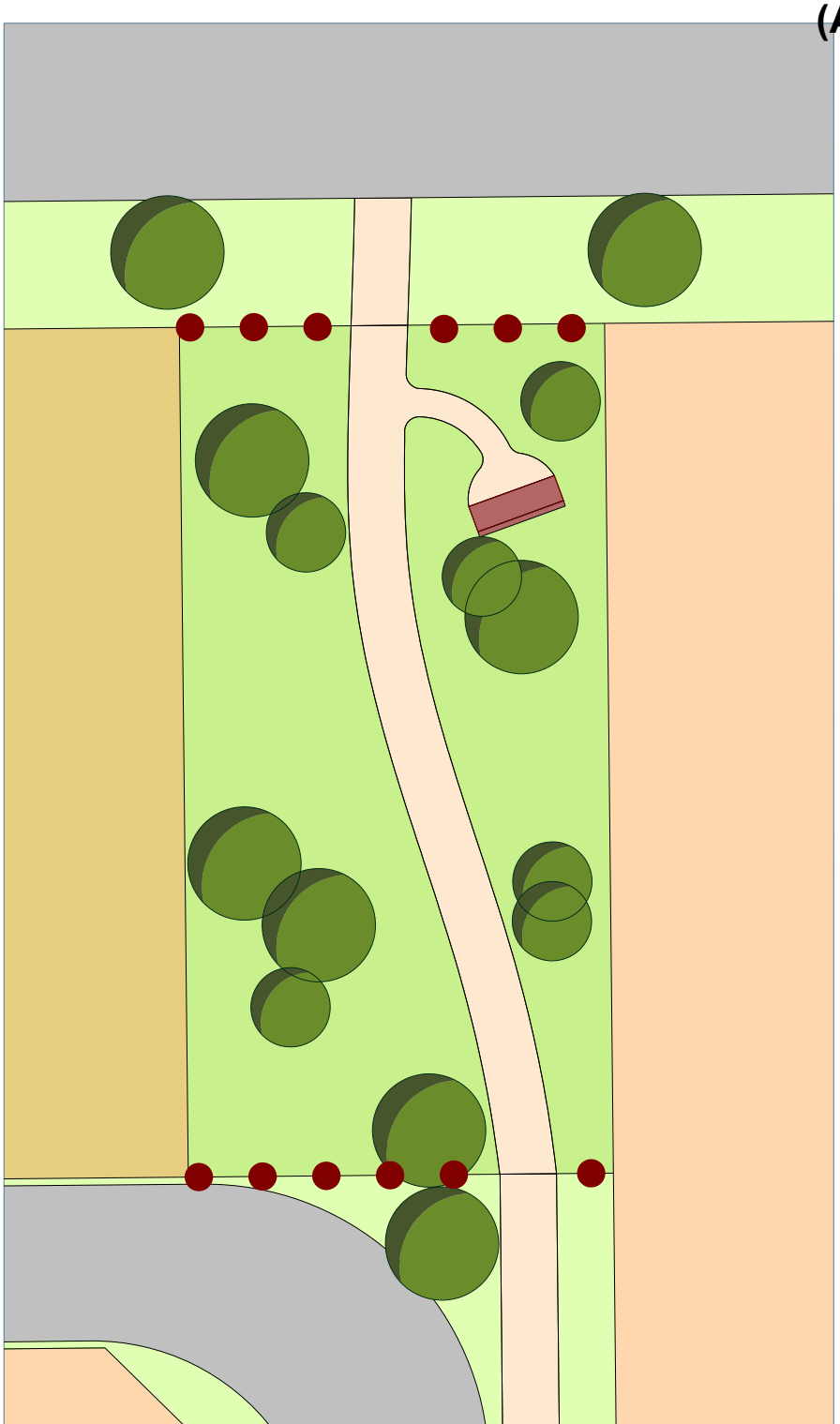
Scale: 1:750 @A3

0 10m 20m

N

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LEGEND

- Proposed Street Tree *Agonis flexuosa*
- Existing Vegetation to be Retained
- Grass / mulch
- Park Bench
- Verge
- Bollards
- Footpath
- Residential

LANDSCAPING CONCEPT PLAN
Pocket Park

PARKRIDGE

Date	19/09/25
Drawn	KS
Checked	
Base Data	Landgate
Projection	MGA 94
Plan No.	22294-35
Rev.	A

Scale: 1:250 @A4

0 5m

N

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