

Local Structure Plan Amendment (Busselton Airport North Structure Plan & Provence Structure Plan)

Lots 2 and 9034 Bussell Highway and
Lot 9032 Cable Sands Road, Yalyalup

Prepared for Yolk Property Group

September 2026

Taylor Burrell Barnett

Document Information

Local Structure Plan Amendment
(Busselton Airport North Structure Plan & Provence Structure Plan)

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4.6	Final	J McCallum	J Ross	17/09/2026

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Endorsement page

This Structure Plan Amendment (Amendment 2 - Embark Estate) is prepared under the provisions of the City of Busselton Local Planning Scheme No. 21.

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

21 OCTOBER 2026

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 24 of the Planning and Development Act 2005 for that purpose,

Date

23 OCTOBER 2026

Date of expiry

23 OCTOBER 2036

Table of Amendments

TABLE 1: TABLE OF AMENDMENTS

Amendment No.	Title	Summary	Date of Approval
1.0	**Provence Structure Plan**	**Provence Estate Provence Structure Plan**: Refine structure plan to reconfigure the locations of local/ village centre, public open space and primary school site. Detailed structure planning completed eastwards of the site.	14 August 2023
2.0	Local Structure Plan Amendment (Busselton Airport North Structure Plan & Provence Structure Plan)	Embark Estate: Refine Structure Plan to modify zoning, public open space, road network and local centre.	21 OCTOBER 2026

Executive Summary

This report has been prepared as an Amendment to Busselton Airport North Structure Plan and Provence Structure Plan (PSP) to guide the subdivision and development of the land contained within the inner edge of the line denoting the Structure Plan Amendment area on **Plan 1**.

The subject site is:

- located on Lots 2 and 9034 Bussell Highway and Lot 9032 Cable Sands Road, Yalyalup, and is located approximately 2.5km south-east of Busselton Town Centre and approximately 220km south/south-west of the Perth CBD;
- contained within the jurisdiction of the City of Busselton and forms part of Provence Structure Plan area;
- bound by residential development to the west, future industrial land uses to the south, future residential development to the east and existing rural residential development to the north; and
- located south of Bussell Highway and encompasses an area of approximately 129.6 hectares.

The Amendment is minor in nature as it retains the established land use framework and overall structure of the endorsed Provence Estate Structure Plan, while refining the internal layout of land uses, roads and public open space.

Land Use

The structure plan amendment has been divided into three different land use zones to facilitate development as follows:

- **Residential:** The residential precinct is intended to provide a diverse range of lot sizes for differing lifestyles and residents needs, with a density coding range of R25-R40 provided across the areas to facilitate flexibility in lot product design at the time of subdivision.
- **Local Centre:** The local centre precinct is proposed as a key focal point when entering the estate, and will be the intersection of primary entry roads to the estate. The local centre is proposed to accommodate a broad range of services to the local community, and is anticipated to include retail shops, childcare, restaurants/cafes and other commercial floorspace.
- **Residential (Lifestyle/Retirement Village):** The residential (lifestyle/retirement village) precinct is intended to facilitate a lifestyle village for retirees and older persons. The precinct is anticipated to be developed and managed by a single lifestyle village operator, and is designed to integrate with the adjacent local centre and surrounding community facilities and open space.

Built Form

Built form throughout the precinct is anticipated to be managed via a combination of the SPP 7.3 (Residential Design Codes) and Local Development Plans prepared for specific sites.

Public Open Space

The proposal provides the required minimum 10% of the gross subdivisible area as public open space in accordance with the guidance provided by *Liveable Neighbourhoods*. This includes:

- **Conservation areas** which provide the opportunity to retain and enhance native vegetation and provide residents and visitors extensive passive recreation opportunities;
- **District open space,** providing community facilities and active open space to meet the needs of the broader district area;
- **Neighbourhood open space** which will provide for passive and active recreation, in addition to the retention of key strands of native vegetation;
- **Local open space,** which provides opportunities for respite and recreation to the local community; and
- **Landscape buffer areas** which provide passive recreation opportunities to residents and assists in visual and acoustic screening of the adjacent regional roads.

Movement Network

The proposed movement network has been designed as a highly functional and efficient system which encourages walking and pedestrian movements throughout the precinct.

This network comprises of a range of access and local roads specifically designed to accommodate the proposed development, and a highly integrated network of pedestrian and cyclist paths to ensure a high level of connectivity.

Implementation

The proposed implementation of the subdivision and development is intended to occur in multiple stages, each of which includes extension of public infrastructure and delivery of residential and/or commercial development.

TABLE 2: STRUCTURE PLAN

Item	Data/ Supporting Comments
Total area covered by the Structure Plan	129.6102 ha
Area of each land use proposed:	
Residential	50.1501ha
Primary School	4.500 ha
Commercial	1.2046 ha (Commercial/Retail/Child-Care)
Public Purpose	0.0 ha
Public Open Space (Credited)	10.9265 ha
Public Open Space (Uncredited)	23.2215 ha (Conservation, Waterbody, Landscape Buffer)
Estimated lot yield	
Residential zoned land	Estimated 875 lots
Residential (Lifestyle/Retirement Village) zoned land	Estimated 300 sites
Estimated Residential Site Density	
Gross Urban Zone Land (Structure Plan)	129.6102 ha
Gross Urban Zone Density	~9 Dwellings/ha
Net Residential Land	~64.5955 ha
Net Residential Zone Density	~18 Dwellings/ha
Estimated population	~ 1750 people
Number of primary schools	1
Estimated commercial/ retail floor space	3,180m^2
Percentage of credited Public Open Space	11.37%

Part 1.0

Implementation

1.0 Structure Plan Amendment & Operation

This report is an Amendment to the Busselton Airport North and Provence Structure Plan (August 2022) and applies to Lots 2 and 9034 Bussell Highway and Lot 9032 Cable Sands Road, Yalyalup, being the land contained within the inner edge of the line denoting the Structure Plan Amendment area on **Plan 1**.

This Structure Plan Amendment ('the Amendment') is identified as Amendment 1 - Embark Estate, Provence Structure Plan.

This plan is in effect for a 10 year period commencing from the date of approval by the Western Australian Planning Commission (WAPC).

This report replaces provisions within the Busselton Airport North Structure Plan and Airport Provence Structure Plan (August 2022) as they relate to land within the Amendment area on **Plan 1**.

Refer to **Appendix K** for the applicable Local Structure Plan locations.

2.0 Purpose

This Amendment is intended to provide comprehensive guidance on subdivision and development within the Amendment area.

The guidance provided in this Amendment supersedes guidance provided by the Busselton Airport North Structure Plan and Provence Structure Plan in consideration of any subdivision application, development application or local development plan within the Amendment area on **Plan 1**.

3.0 Staging

The staging of subdivision and development will progress based on market demand and the logical extension of service infrastructure and the public road network, and is generally anticipated to align with the staging plan outlined in **Part 2**

4.0 Land Use

The zones and reservations applicable to the Structure Plan Amendment are identified in **Plan 1**. Land use permissibility within the Amendment shall be in accordance with the corresponding zone or reserve under the Scheme, or as otherwise outlined in this Amendment.

4.1 Residential Zone

Land use permissibility for sites identified as 'Residential' on Plan 1 is to accord with the designated land use permissibility for the Residential zone in the City of Busselton *Local Planning Scheme No. 21.*

4.1.1 Residential (Lifestyle/Retirement Village)

The purpose of the site identified as 'Residential (Lifestyle/Retirement Village)' is to facilitate an area suitable for the development of retirement living opportunities which are integrated with the Local Centre and surrounding recreation and community facilities.

Development within this site is designated for the purposes of the Lifestyle / Retirement Village development (as a 'use not listed') and the development density, built form controls and site layout is to be guided by an endorsed Local Development Plan in accordance with clause 47(d) of the Deemed Provisions under the *Planning and Development (Local Planning Scheme) Regulations 2015*.

Other uses which are related or incidental to the Lifestyle/Retirement Village (i.e. clubhouse and private recreation) may also be contemplated where they are demonstrated to be incidental and support the primary purpose of retirement living.

In the event that the Lifestyle / Retirement Village does not ultimately proceed within the designated site, residential development may be facilitated subject to a residential density code range of R25-R40 in accordance with the provisions of Section 5.2 and 5.3.

4.2 Local Centre

Land use permissibility for sites identified as 'Local Centre' on **Plan 1** is to accord with the designated land use permissibility for the Local Centre zone in the City of Busselton *Local Planning Scheme No. 21.*

Development within the Local Centre is to be guided by an endorsed Local Development Plan in accordance with clause 47(d) of the deemed provisions under the *Planning and Development (Local Planning Scheme) Regulations 2015*.

5.0 Subdivision and Development Requirements

5.1 Residential Density Target

In accordance with the requirements of *Liveable Neighbourhoods*, subdivisions are to achieve an average residential density of 22 dwellings per site hectare across the Amendment area.

5.2 Residential Density Code Ranges

The residential density code ranges that apply to sites zoned Residential are outlined in **Plan 1.**

Residential density within the structure plan area is guided by *State Planning Policy 7.3 Residential Design Codes (Volume 1 and Volume 2)*, inclusive of variations to deemed to comply standards via this Structure Plan and/or subsequent Local Development Plans, and in accordance with the following provisions:

5.2.1 Density Code Plan Preparation

Plan 1 identifies the broad residential density which applies to areas within the Structure Plan. Lot specific residential densities based on this plan are to be subsequently assigned in accordance with a Residential Density Code Plan prepared by the applicant/proponent and approved by the WAPC.

The Residential Density Code Plan is to be submitted at the time of subdivision to the determining authority and shall indicate the Residential Density Coding applicable to each lot within the subdivision and shall be generally consistent with the provisions of this Amendment.

In the event that retirement opportunities do not occur, single house or grouped dwellings can occur and to be assessed in accordsance with an R25-R60 densiy code under the Residential Design Codes, with a Residential Density Code Plan to be prepared in accordance Section 5.2.

5.2.2 Density Code Plan Consideration and Approval

Approval of the Residential Density Code Plan shall be undertaken at the time of determination of the subdivision application by the determining authority.

The approved Residential Density Code Plan shall thereafter form part of the Amendment and shall be used for the determination of future development applications.

Amendments to the Residential Density Code Plan will require further approval of the determining authority.

Residential Density Code Plans are not required if the WAPC considers that the subdivision is for one or more of the following:

- The amalgamation of lots;
- The creation of superlots for the purpose of land assembly and future subdivision/ development;
- The purposes of facilitating the provision of access, services or infrastructure;
- Where land is proposed for subdivision not intended for residential purposes;
- Where a Residential Density Code Plan already exists for the subdivision area and the subdivision accords with the approved Residential Density Code Plan.

5.3 Local Development Plans

Local Development Plans shall be required, where applicable, as a condition of subdivision approval, or as a prerequisite to development, for land within the following zones, as detailed below:

5.3.1 Residential Zone

5.3.1.1 R25-R40 Coding Range

A Local Development Plan is to be required as a condition of subdivision approval where the subdivision proposes:

- Lots with access from a laneway;
- Lots fronting a Neighbourhood Connector A or Neighbourhood Connector B;
- Lots proposed immediately adjacent the Local Centre or Lifestyle/Retirement Village; and
- Lots directly abutting public open space or pedestrian access ways.

For single house or grouped dwellings development on the site identified for Lifestyle/ Reitrement Village, the R-Code provisions may be varied in accordance with an approved Local Development Plan or as otherwise specified in a development approval.

5.3.1.2 Small Dwelling Sites / Precincts

Development of Small Dwellings may be guided by the preparation of a Local Development Plan which addresses beneficial variations to:

- Visitor car parking allocation and provision of landscaping;
- Building design elements;
- Streetscape / dwelling orientation;
- Setback requirements;
- Fencing controls between dwellings;
- Private open space; and
- Incidental development (storage/clothes drying/outbuildings/controls on caravan/ trailer/boat locations)

5.3.2 Local Centre Zone

Major development within the Local Centre zone should generally be guided by an approved Local Development Plan which outlines:

- Indicative land use patterns and subdivision layout (if applicable);
- Built form, including building height and setback considerations; and
- Site design, including access, open space, parking and landscaping/drainage considerations.

5.3.3 Lifestyle / Retirement Village Precinct

Any development for the use of 'Lifestyle / Retirement Village' (Use not Listed) is to be guided by an approved Local Development Plan.

5.4 Movement Network

The indicative location of roads for the purposes of subdivision is depicted in **Plan 1** and **Plan 2**. The specific location of roads will be confirmed as a component of a subdivision application, but for the purpose of informing subdivision design the roads will be designed to a maximum width as follows:

- Integrator B - 25m
- Neighbourhood Connector A - 23m
- Neighbourhood Connector B - 20m
- Access Street Type B - 18m
- Access Street Type D - 15m
- Liveable Street - 15m
- Abutting POS - 13m

Detailed designs for these roads will be required as a condition of subdivision approval, inclusive of landscaping standards and pedestrian safety requirements.

Lyddy Road is to be closed prior to the construction commencement of Access B and once internal road access/frontage is available from Embark Estate.

Cable Sands Road is to be closed prior to the construction commencement of the proposed new instersection off Tuart Drive and once internal access/frontage is available from development on Lot 22 on DP 415584.

5.5 Public Open Space

The provision of a minimum 10% open space is provided in accordance with the principles of the WAPC's Liveable Neighbourhoods for the Provence Structure Plan area. Public open space is to be provided generally in accordance with **Plan 1**, with an updated open space scheduled to be provided at the time of subdivision.

5.5.1 Public Open Space Provision

A total of 27.9729 hectares of open space is provided in accordance with **Figure 10** and **Figure 11**, in addition to a further open space provision of approximately 15.9979ha relating to conservation and surplus restricted open space. Of this, a total of 10.9265 hectares of creditable (restricted and unrestricted) open space has been provided in accordance with the requirements of Liveable Neighbourhoods, which equates to 11.37% as outlined in **Table 3**.

These calculations are based on the following deduction assumptions:

- Local centre as it is not anticipated to include any residential development at the time of preparing this report;
- Primary school;
- Bussell Highway Bypass Buffers;
- Conservation, water body and surplus restricted open space areas; and
- 1:1 year drainage estimates to be accommodated in POS areas (up to 2% of the 10% requirement only).

Open space areas will be identified as part of the proposed subdivision application and ceded to the Crown as a condition of subdivision approval.

TABLE 3: PUBLIC OPEN SPACE SCHEDULE

Site Area (Ha)		**129.6102**
Deductions		
1:1 Year Drainage (Taken from LWMS)	1.0485	
Primary School	4.5000	
Bussell Highway - Bypass Buffer	5.6690	
Pump Station	0.0000	
Local Centre	2.9161	
Conservation - Non Credited	14.1296	
Water Body - Non Credited	3.3929	
Surplus Restricted Open Space	1.8683	
Total Deductions		**33.5244**
Net Subdivisible Area		96.0858
Required Public Open Space (10%)		**9.6086**
Public Open Space Requirements		
Unrestricted public open space - minimum 80%	7.6869	
Restricted public open space - maximum 20%	1.9217	
Public Open Space Provision		
Credited Unrestricted Public Open Space		
POS District	0.9769	
POS Local	0.2708	
POS Neighbourhood	7.7571	
Total Credited Unrestricted POS		**9.0048**
Restricted Public Open Space		
1:5 yr storm event	3.7900	
POS Conservation (refer deduction - in excess of 20% restricted)	0.0000	
POS Waterbody (refer deduction - in excess of 20% restricted)	0.0000	
Total Restricted POS	3.7900	**1.9217**
Total Restricted and Credited Unrestricted POS		**10.9265**
Percentage of Credited POS (Restricted and Credited Unrestricted POS Contribution)		**11.37%**

6.0 Other Requirements

6.1 Vegetation Survey

As a component of subdivision design proponents are required to identify native trees suitable for retention, where possible and practicable, within public open space, road verges and other publicly accessible areas.

6.2 Bushfire Management

A notification, to be placed on the Certificate(s) of Title(s), will be required as a condition of subdivision approval where land or lots are deemed to be affected by a Bushfire Hazard as identified in the Bushfire Management Plan (BMP) contained within **Appendix G**, or as amended thereafter.

Building setbacks and construction standards to achieve a Bushfire Attack Level (BAL) of BAL-29 or lower in accordance with *Australian Standards (AS3959-2009): Construction of Buildings in Bushfire Prone Areas* shall be complied with for land or lots that are deemed to be affected by a Bushfire Hazard as identified in the Bushfire Management Plan.

A detailed Bushfire Management Plan will be prepared and submitted for each subsequent subdivision stage.

6.3 Noise Management

An acoustic assessment may be required to accompany any subdivision application which is considered likely to be affected by noise generated from abutting regional roads or by aircraft noise associated with Busselton - Margaret River Airport.

Where lots are deemed to be affected by noise within an acoustic assessment the following may be recommended as conditions of subdivision and/or development approval:

a) A notification may be required to be placed on the Certificate of Title advising owners and prospective purchasers of the noise impacts;

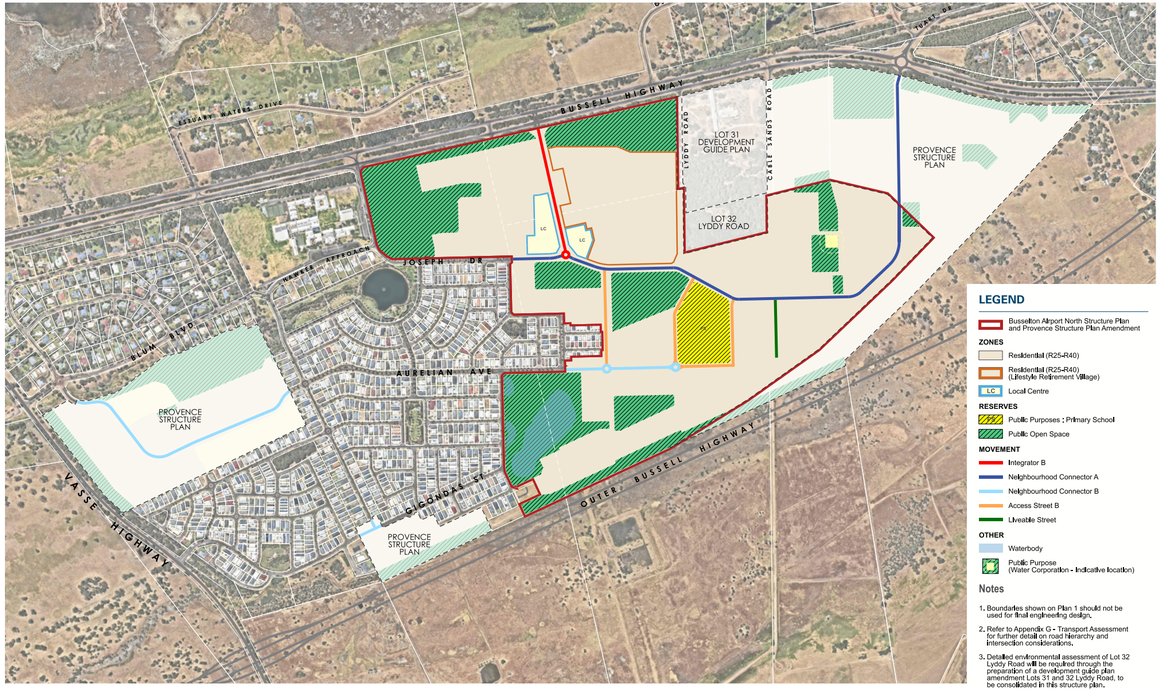
b) Construction standards to achieve quiet house design in accordance with *State Planning Policy 5.4 - Road and Rail Noise* may be applied in the context of noise generated from abutting regional roads.

6.4 Mosquito and Midge Breeding Mitigation

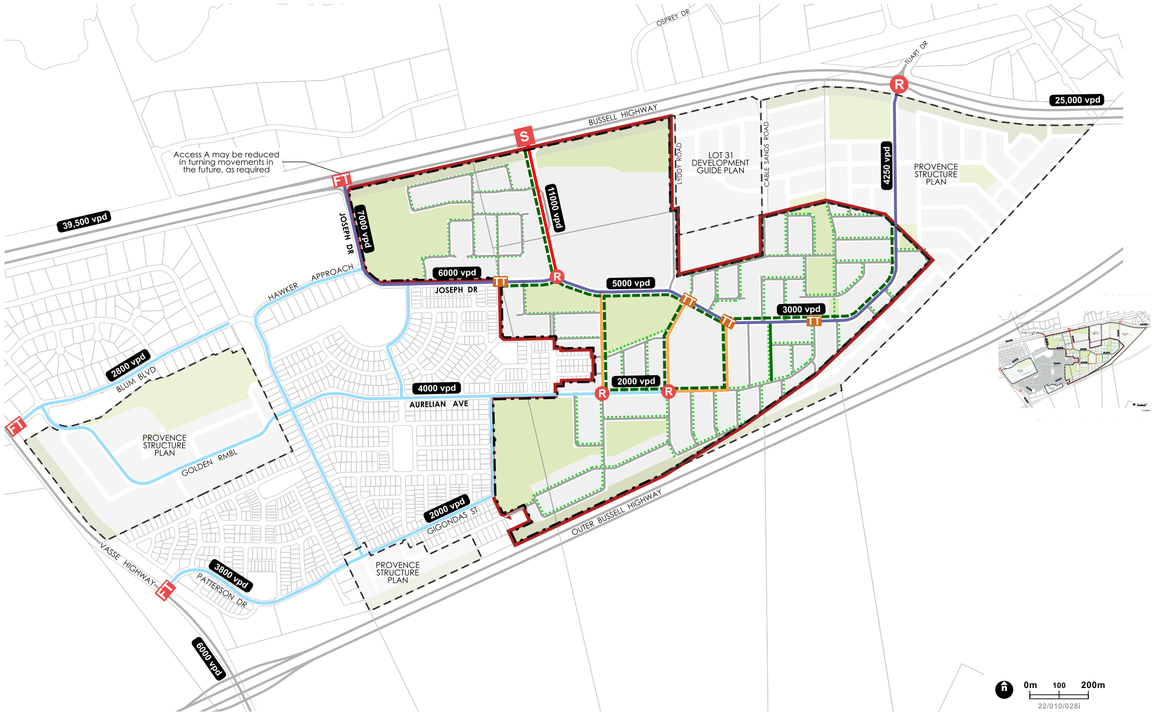
The preparation of a mosquito and midge breeding mitigation plan may be required for subdivision applications which include or abut drainage areas and/or other water bodies.

6.5 Wastewater Pump Station

A indicative wastewater pump station is identified on the **Plan 1** which will be further confirmed as subdivision progresses and in consultation with service providers. An indicative 30 metre odour and noise buffer has been identified. It is recommended that no residential dwellings are located within the ultimate buffer area required.



PLAN 1: STRUCTURE PLAN AMENDMENT



PLAN 2: MOVEMENT NETWORK PLAN

Part 2.0

Explanatory Report

1.0 Introduction

This Structure Plan Amendment report has been prepared on behalf of Almond Estate Pty Ltd with respect to Lots 2 and 9034 Bussell Highway and Lot 9032 Cable Sands Road, Yalyalup. The subject land is identified within the Busselton Airport North Structure Plan and Provence Estate Structure Plan area, which is envisioned to provide a variety of housing choice adjacent to high quality public open space, community facilities, employment and retail/commercial opportunities and local amenity.

The Amendment will facilitate the future subdivision and development of the subject land for residential, retirement living and mixed-use purposes, with areas of public open space and a well-designed movement network.

The Amendment has been prepared to address the requirements of the City of Busselton *Local Planning Scheme No. 21*. The Amendment has also been prepared in accordance with the *Planning and Development (Local Planning Schemes) Regulations 2015* and the Western Australian Planning Commission's (WAPC) *Structure Plan Framework* (August 2015).

The Amendment will guide subdivision and development of the site with the determining authorities to give due regard in the assessment of development and subdivision applications.

The project team responsible for preparing the information contained within this report is included outlined as follows:

- **Taylor Burrell Barnett** | Town Planning & Urban Design
- **Stantec & JDSi** | Servicing Report
- **JBS&G** | Bushfire Management
- **Hyd2o** | Hydrology
- **RPS** | Environmental Management
- **LD Total** | Landscape Design
- **Transcore** | Transport and Traffic Analysis
- **KPA** | Architecture
- **Herring Storer Acoustics** | Acoustic Analysis
- **Economic Analysis** | Lease Equity and Location IQ
- **Deep End Services** | Retirement Living Analysis

1.1 Site Location

The subject site is located on Lots 2 and 9034 Bussell Highway and Lot 9032 Cable Sands Road, Yalyalup, and is located approximately 2.5km south-east of the Busselton Town Centre (**Figure 1**). The lot details are contained in **Table 4** and provided in **Appendix A**.

The site is contained within the jurisdiction of the City of Busselton and forms part of the Provence Estate development area.

The site is bound by residential development to the east, future residential land uses to the south and west, and the Bussell Highway reservation to the north.

The site is located north of the future Outer Bypass Road and encompasses an area of approximately 129.6102 hectares.

1.2 Site Conditions

An overview of the relevant site conditions related to the Structure Plan Area is contained within the Provence Estate Structure Plan Report (August 2022).

TABLE 4: LAND OWNERSHIP DETAILS FOR THE SUBJECT SITE

Lot Description	Volume/Folio	Area	Proprietor(s)
Pt Lot 9034 Bussell Highway, Yalyalup (excludes portion 6.1166ha)	2969/911	23.034Ha	Almond Lake Pty Ltd
Lot 2 Bussell Highway, Yalyalup	1791/729	20.141 Ha	Almond Lake Pty Ltd
Lot 9032 (45) Cable Sands Road, Yalyalup	2891/698	86.481 Ha	Almond Lake Pty Ltd
Total		**129.6102ha**	

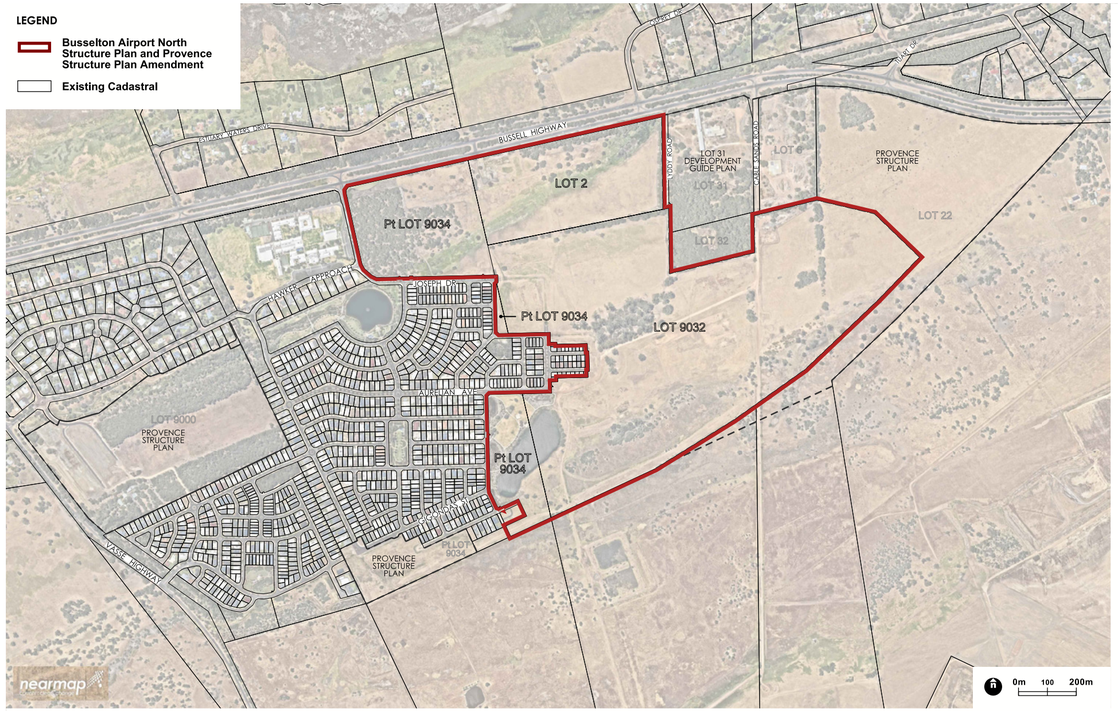


FIGURE 1: LOCATION PLAN

1.3 Planning Framework

The key planning framework relevant to this amendment is focused on the City of Busselton Local Planning Scheme No. 21 (LPS21) and the endorsed Provence Estate Structure Plan (August 2022) which are outlined in the following sections. A more comprehensive overview of the broader planning framework related to the Structure Plan Amendment is contained within the Provence Estate Structure Plan Report (August 2022).

1.3.1 City of Busselton Local Planning Scheme No. 21

The Amendment area is zoned 'Urban Development' under LPS21 as shown in **Figure 2**. The site is also identified as Special Provision Area 23 (SP23).

It is considered that the proposed Amendment is in accordance with LPS21, as discussed below.

1.3.1.1 Urban Development Zone

The objectives of the 'Urban Development' zone are described as follows within the Scheme:

- To designate land for future urban development and provide a basis for more detailed structure planning in accordance with this Scheme.
- To provide for a range of residential densities to encourage a diversity of residential housing opportunities.
- 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 pro-actively plan for vibrant and attractive activity centres in urban areas developed along 'main-street' lines with activated public spaces, high levels of pedestrian and civic amenity and a mix of public spaces including retail, commercial, cafe, restaurant, bar, entertainment, tourism and community uses.
- To provide for a range of recreational, community, cultural and social facilities to meet the needs of a growing and diverse population.
- To provide for the protection of natural areas and habitats within urban areas.

The proposal provides a flexible approach to residential density and quality of housing within the Amendment area. Furthermore, the proposal enables the improved provision of civic amenities, provides a diverse mixture of land uses to meet the needs of the future population. As such, it is considered that the proposal is compatible and aligns with the objectives of the Urban Development zone.

1.3.1.2 Land Use Permissibility

In accordance with the requirements of the Zoning Table contained within Table 1 and Clause 3.4.3 of LPS21, which states:

If the zoning table does not identify any permissible uses for land in a zone that government may, in considering an application for development approval for land within the zone, have due regard to any of the following plans that apply to the land -

a) a structure plan;
b) an activity centre plan;
c) a local development plan.

As the Amendment and the approved Provence Structure Plan satisfy the requirements of (a) above, collectively the two documents define land use permissibility for the area, as defined in **Plan 1**, and referenced in Clause 4.0 of Part 1 Implementation.

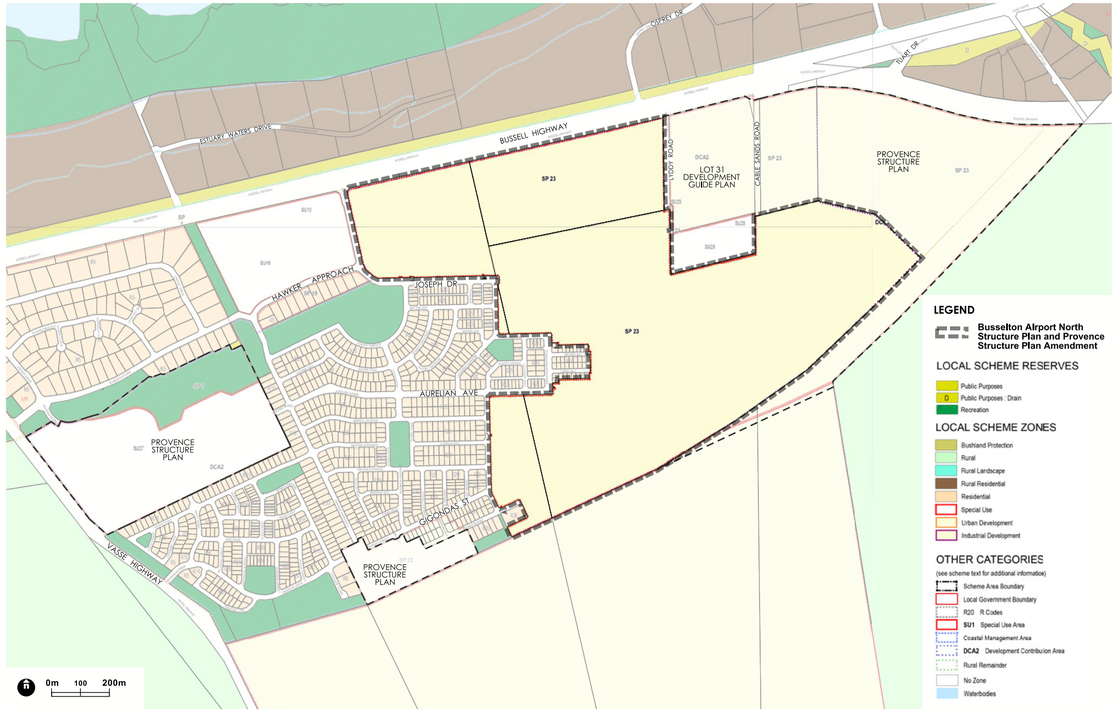


FIGURE 2: CITY OF BUSSELTON LOCAL PLANNING SCHEME NO. 21

1.3.1.3 Special Provision Area 23

As identified in Schedule 3 of LPS21, the provisions of SP23 apply to a portion of the Amendment area contained within Lot 9032 (45) Cable Sands Road and Lot 9034 Joseph Drive.

The provisions of SP23 stipulate that:

1. *The local government has prepared a draft Noise Management Plan for Busselton Regional Airport, which requires approval by the Environmental Protection Authority. The local government may recommend conditions on the subdivision and development of land requiring noise amelioration measures consistent with the Noise Management Plan as finally approved by the Environmental Protection Authority.*
2. *Notwithstanding the requirement for a Structure Plan for land in a Development Zone a single integrated Structure Plan shall be required for the whole of Special Provision Area 23.*

The existing endorsed Structure Plan for the Provence Estate and the broader Busselton Airport Structure Plan, satisfy the requirements of SP23. The Amendment simply replaces the provisions of the existing Provence Estate Structure Plan relevant to the Amendment Area, thereby maintaining the planning framework in place to address SP23.

As such, it is considered that the Amendment maintains compliance with the requirements of SP23.

1.3.2 Busselton Airport Structure Plan (Revised 2005)

The Busselton Airport Structure Plan was endorsed in 2006 and establishes the future land use and development framework for land identified in proximity to the Busselton Airport. The Structure Plan aims to ensure that the subject land will be developed in a consistent and coordinated manner with regard to ongoing airport operations.

The Structure Plan consists of a broad mix of land uses with specific land uses segregated by the proposed Busselton Outer Bypass route. Land uses north of the proposed Busselton Outer Bypass consist of predominantly residential land uses.

The Structure Plan applies to land within the amendment area, which has since been superseded by the Provence Estate Structure Plan (August 2022).

1.3.3 Provence Estate Structure Plan (August 2022)

The Provence Estate Structure Plan (PSP) establishes the future land use and development framework for land identified within the identified structure plan area. The PSP ensures that the land will be developed in response to the existing site features while reflecting the local character of the surrounding locality. Notably, the PSP will guide a development with a mix of uses predominantly consisting of residential land with other uses including commercial, retail, education, community and open space uses.

The PSP was prepared in accordance with LPS21, and has been endorsed by the City of Busselton and approved by the WAPC.

The modifications specifically requested by the Statutory Planning Committee (SPC) at their meeting on 12 October 2021 have been implemented, and on this basis other matters which have evolved since the SPC decision, including land ownership and zoning, have been retained as a component of the approved version of the Provence Structure Plan.

The purpose of this Amendment is to replace the Structure Plan and provisions within the PSP as they relate to land within the Amendment area identified on **Plan 1.** This report demonstrates integration with the balance of the PSP and therefore compliance with the guidance the PSP provides to the Amendment area.

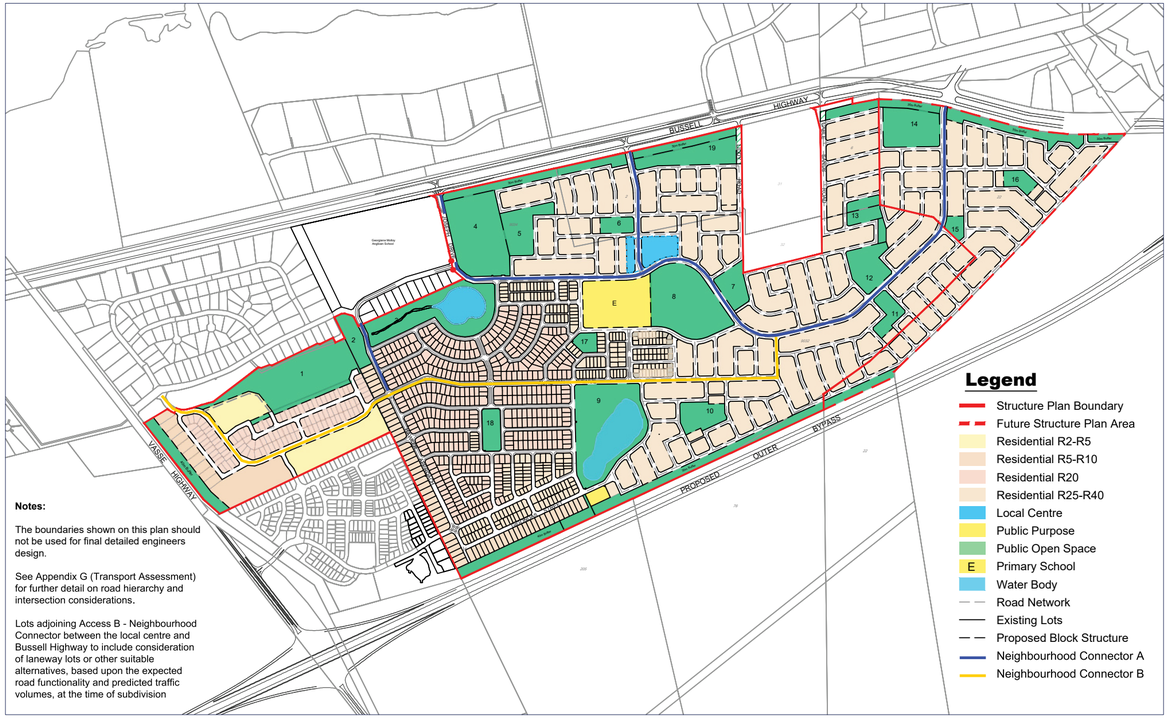


FIGURE 3: PROVENCE ESTATE STRUCTURE PLAN

2.0 Structure Plan Amendment

2.1 Opportunities and Constraints

An opportunities and constraints analysis has been undertaken for the Amendment area based on the natural features, surrounding development, existing infrastructure and the future vision.

The analysis has been separated into considerations of built form, land use, public realm and movement network, and is outlined as **Figure 4.**

LAND USE | OPPORTUNITIES

- Optimise residential density within close proximity to areas of higher amenity
- Opportunity within Commercial area to provide a local destination hub including a possible outdoor cinema within piazza
- Opportunity for a mix of commercial uses within the centre to promote and maximise activation and surveillance, including but not limited to child care, medical, café and integrated retirement living
- Opportunity for Retirement Living surrounding centre providing an adjacent catchment of people
- Opportunity for Main-Street development outcome along new north-south oriented road
- Opportunity for future school co-located with open space area

LAND USE | CONSTRAINTS

- Noise attenuation requirements may apply certain restrictions to proposed land uses. Consider mitigation strategies and requirements

BUILT FORM | OPPORTUNITIES

- Opportunity to incorporate residential development directly abutting proposed POS for passive surveillance and to optimise product diversity
- Proposed streets to respond to site topography and optimise potential for solar access and view corridors
- Opportunity to provide a variety of housing types and density
- Opportunity for retirement living buildings to orientate and integrate with the surrounding development

BUILT FORM | CONSTRAINTS

- Building noise attenuation requirements may be required for residential and retirement living built form in close proximity to Bussell Highway

PUBLIC REALM | OPPORTUNITIES

- All new streets to provide street trees improving amenity, streetscape appeal, shade canopy and improved walkability conditions
- Provide areas of public open space in locations that maximise existing tree retention, activation, passive surveillance and safety. POS and drainage areas located to maximise catchment, utilisation and efficiency
- Opportunity for potential Retirement Living site development to enhance activation of centre
- Opportunity for Retirement Living development to provide open space linkages within site integrating with the wider area

PUBLIC REALM | CONSTRAINTS

- Landscaped bunding along southern boundary adjacent future Outer Bussell Highway to address acoustic requirements

MOVEMENT | OPPORTUNITIES

- Opportunity to connect new roads to the surrounding existing and proposed roads to complete road networks and provide for enhanced legibility and permeability locally
- Provide full movement intersections to Bussell Highway
- Opportunity to deliver liveable street in key location providing for a unique streetscape outcome

MOVEMENT | CONSTRAINTS

- Access and egress to Bussell Highway limited
- Bussell Highway and future Outer Bussell Highway generate need for noise attenuation requirements for residential development in accordance with SPP 5.4

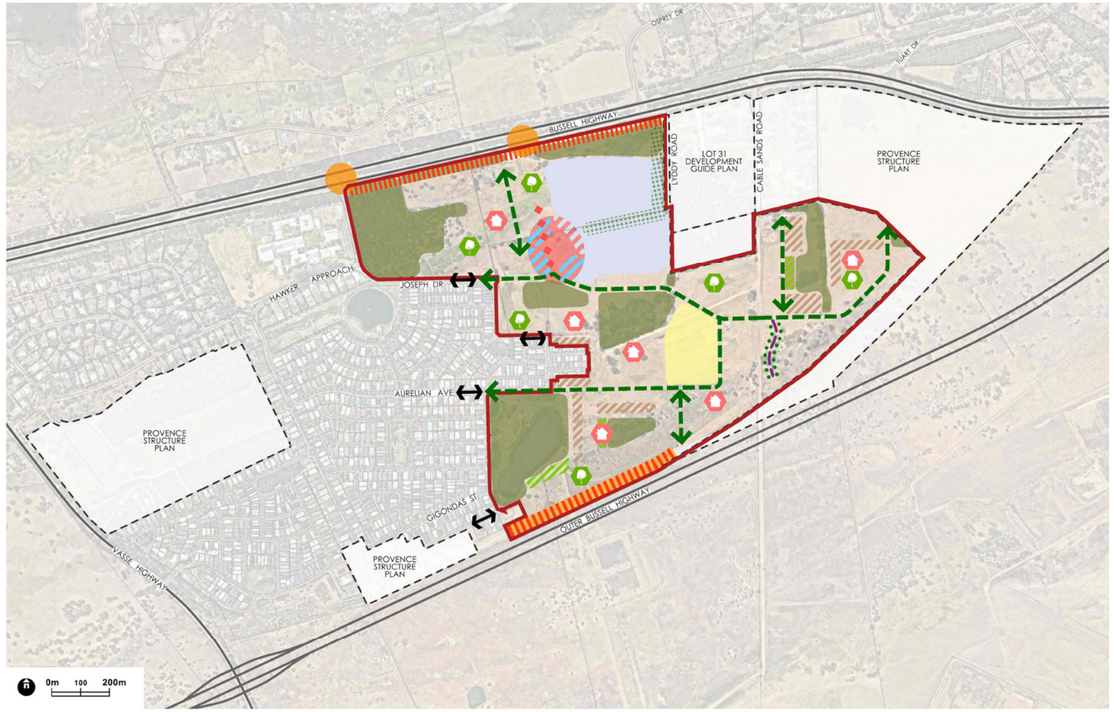


FIGURE 4: OPPORTUNITIES AND CONSTRAINTS PLAN FOR AMENDMENT AREA

2.2 Development Concept Plan

A development concept plan has been prepared to spatially depict the vision for the SP Amendment area.

The precinct is envisioned to grow into a thriving community which integrates diverse residential living opportunities with a new local centre to complement the residential and recreational uses of the surrounding area.

The development concept plan focuses on:

- The creation of a diverse range of residential living opportunities through varied lot sizes and dwelling types to encourage families, young couples, down-sizers and retirees into the community;
- The integration of high quality parkland and open space facilities in close proximity to residents whilst complementing the recreational uses existing and proposed within the existing Provence Estate;
- The creation of a thriving local commercial precinct accommodating restaurants and cafes, speciality shops and child care facilities, in addition to an alfresco area and children's play area.

The Development Concept Plan is illustrated in **Figure 5.**

Indicative concept plans have also been prepared for the Local Centre and Lifestyle / Retirement Precincts below.

1. Location of public open space is generally consistent with the Endorsed Structure Plan. Public open space areas have been located to retain vegetation in accordance with the EPBC Approval requirements.
2. 30m landscape buffer adjacent Bussell Highway providing ecological linkages and protection of remnant vegetation. This approach will protect amenity and landscape values of the eastern entrance/gateway to the Busselton townsite.
3. Proposed first stage of development. This first stage is consistent with the Endorsed Structure Plan to facilitate its determination ahead of this Structure Plan Amendment.
4. Proposed Display Village fronting Joseph Drive as part of the first stage subdivision to establish built form quality and high amenity adjacent the future focal point of the Neighbourhood Centre.
5. Road connection to Bussell Highway adjusted eastwards to provide improved intersection spacing's to Bussell Highway.
6. Reconfiguration and strengthening of the 'heart' - the Neighbourhood Centre provides an integrated mix of uses including commercial and retail opportunities, retirement living, open space, community facilities and child care.
7. Cafe located within Local Centre with adjacent shopping and child care facilities.
8. Potential Retirement Living precinct. Opportunity for communal facilities including kitchen and lawn bowls etc to be utilised by the Embark community.
9. Proposed Retirement Living clubhouse location to integrate with Neighbourhood Centre.
10. Potential Child Care facility adjacent Retirement Living providing opportunity for inter-generational synergy and to support neighbourhood centre.
11. Integration of POS and associated community facilities within the 'heart' to facilitate activation.
12. Landscape buffer adjacent future Outer Bussell Highway.
13. Proposed Primary School site (4.5ha). On site playing field to be provided. Co-located adjacent public open space.
14. Provision of diverse residential typologies through the eastern area of Embark Estate.
15. Key east-west connector road through Embark Estate ultimately intersecting with Bussell Highway and providing connection with Joseph Drive and Provence Estate.
16. Provides for extension of road infrastructure and integration with development within Lots 6, 22, 31 and 32.

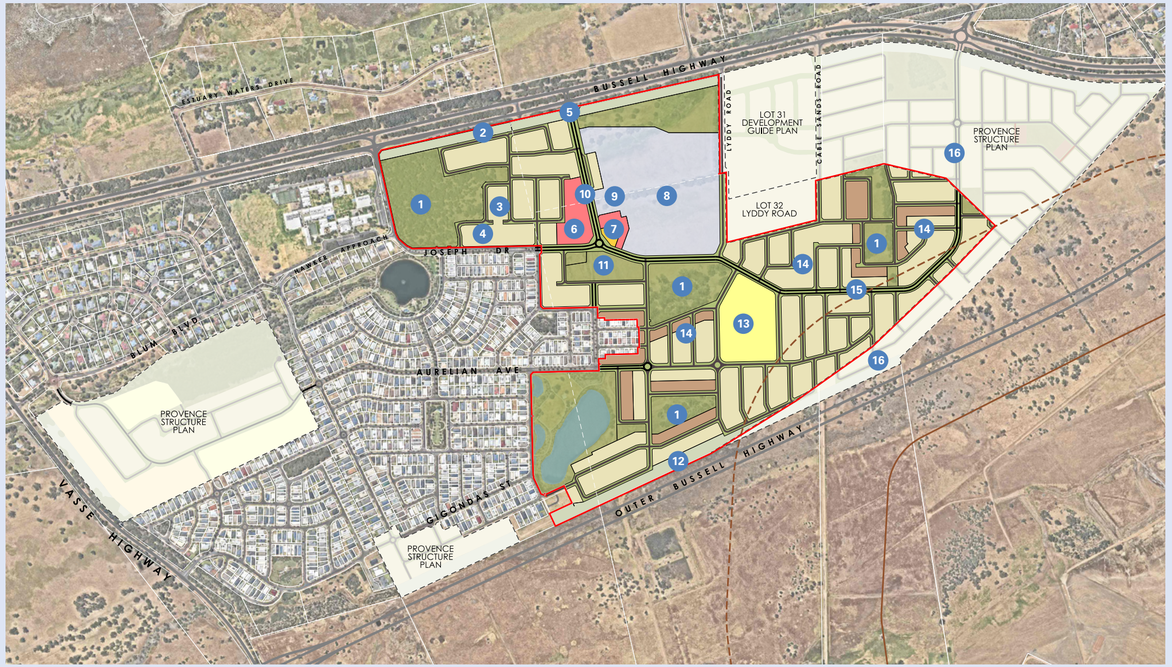


FIGURE 5: DEVELOPMENT CONCEPT PLAN FOR AMENDMENT AREA

2.2.1 Local Centre Precinct

The Local Centre Precinct is anticipated to accommodate a range of commercial, retail, restaurant/cafe and community uses, as outlined in the Development Concept Plan (**Figure 6**). A market potential assessment has been prepared by Location IQ and is provided at **Appendix B**, and provides the following key recommendations:

- An anchor supermarket tenant, with the final size to be dictated by operator demand and requirements.
- Retail speciality floorspace is likely to be convenience focussed, and comprise of food retailers (i.e bakery, liquor store); food catering (cafes and takeaway foods); general retail (pharmacy, speciality shop) and retail services (hairdresser, barber, nail salon or other beauty).
- Non-Retail Floorspace is likely to comprise of non-retail shop fronts (real estate agent, delivery collection facilities); Medical (medical centre and ancillary professionals); a small gym operator; a Childcare Centre; a Bar/Tavern and potentially small commercial suites (conveyancer).

The ultimate design of the Local Centre Precinct, inclusive of the site layout, land use mix and built form, is to be confirmed via an approved Local Development Plan prior to the progression of any major development application for the precinct.

1. Mixed use development proposed to western side of main north-south street providing a built form edge and framing of Local Centre.
2. Key pedestrian movement across main north-south street providing for safe ease of movement.
3. Proposed child care centre building providing built form edge and outlook to main north-south street.
4. Child care playground/outdoor area located behind main building and screended from piazza.
5. Vehicular access/egress to child care centre and gym.
6. Two-way vehicular circulation between access/egress points of centre and car parking areas.
7. Lifestyle village clubhouse building and communal facilities located adjacent the Local Centre providing an address as an alternative access to the village, and passive surveillance to the piazza.
8. The 'heart' of the Local Centre, the piazza includes play ground, public art and alfresco dining to facilitate activation and passive surveillance throughout the day. and into the evening
9. Cafe and restaurant offerings located on the eastern side of the piazza encouraging and inviting patrons through the piazza and activation of the space.
10. Supermarket site located to the southern western side of the main north-south street, providing a continuous built form edge to the stree, shade from rain and sun, and interfacing with the street.
11. Speciality retail sites integrated with the supermarket site providing for enhanced activation opportunities and variation in built form.
12. Supermarket main carpark located screened by surrounding built form and landscaping.
13. Supermarket loading bay screened by built form, landscaping and boundary treatments

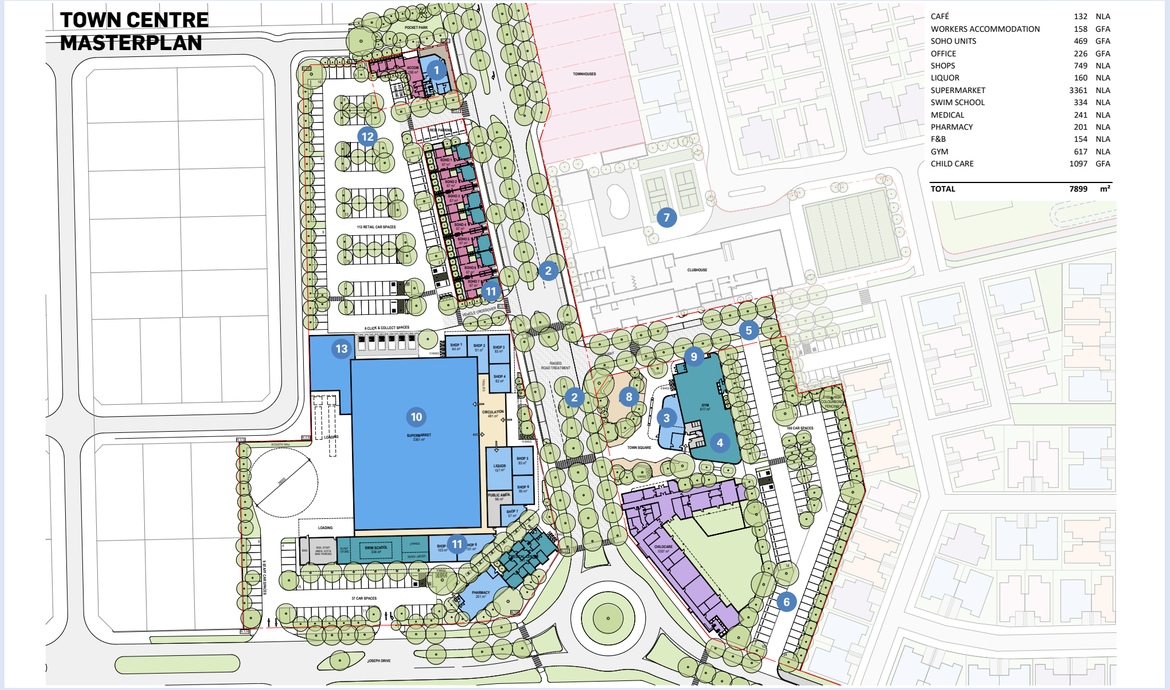


FIGURE 6: DEVELOPMENT CONCEPT PLAN - LOCAL CENTRE

2.2.2 Lifestyle / Retirement Village Precinct

An approximate 15 hectare site has been identified within the Structure Plan as a Lifestyle / Retirement Village following an assessment undertaken by Deep End Services (refer **Appendix C**), which identifies the need for retirement living opportunities within the local area and broader region.

The Indicative Lifestyle Village Concept Plan, illustrated in **Figure 7** focuses on:

- the creation of a diverse range of retirement living opportunities through varied dwelling types and sizes;
- the integration of high quality open spaces in close proximity to residents, which optimises tree retention, where possible;
- Clubhouse facilities that are open to all residents within the community and may comprise dining and meeting spaces, pool, gym etc.

The ultimate site layout, density and built form for the Lifestyle / Retirement Village precinct will be determined via an approved Local Development Plan prior to the progression of any major development within the precinct.

In the event the Lifestyle / Retirement Village development does not proceed, the precinct is capable of other development in accordance with the permissibility and requirements of the 'Residential' zone under LPS21, and subject to a density code range of R25-R40.

1. Lifestyle / Retirement Village site of approximately 15ha located adjacent future Town Centre in the 'heart' of the Embark Estate
2. Communal retirement lifestyle / retirement village (including club house) located adjacent piazza promoting integration with town centre and increased activation
3. Lifestyle / Retirement Village site bounded by future residential development ensuring public realm consistency and change of use at the back boundary
4. Primary access/egress entry statement to be highly landscaped and provide for an inviting entry address to the retirement living site
5. Secondary northern access in close proximity to Bussell Highway for ease of access/egress for residents
6. Retirement community of approximately 300 sites offering a diverse and higher end residential park/lifestyle option
7. Two dedicated parking storage sites located within retirement living site providing areas for resident boat and trailer parking
8. Proposed internal east-west green links providing for ease of pedestrian movement through the site for residents
9. Key green link including potential retained existing mature trees providing a key, direct and well shaded pedestrian link to the communal facilities, town centre and wider Embark Estate.
10. Private open space proposed to the edge of the site providing a consolidated area for passive recreation that seamlessly connects to the wider Embark Estate open space network. Area also provides a landscaped buffer to the future residential development and facilitates drainage requirements.



FIGURE 7: RETIREMENT LIFESTYLE VILLAGE

2.3 Land Use and Development Considerations

2.3.1 Land Use

Land use permissibility within the precinct is controlled by the City of Busselton LPS21 for the purpose of:

1. Sites identified as 'Residential' on Plan 1, which shall accord with the designated land use permissibility for the Residential zone in LPS21; and
2. Sites identified as 'Local Centre' on Plan 1, which shall accord with the designated land use permissibility for the 'Local Centre' zone in LPS21.
3. For the purpose of land identified as 'Residential (Lifestyle / Retirement Village)' on Plan 1, it is noted that this site will be subject to and developed in accordance with an approved Local Development Plan to permit and control the use of 'Residential (Lifestyle / Retirement Village)' as a 'Use not Listed'.

   Other uses which may be undertaken within the 'Residential Zone', including 'Single House', 'Grouped Dwelling' or 'Multiple Dwelling', may be approved subject to consideration against an R25-R40 density code, and in accordance with an approved Local Development Plan.

2.3.2 Development

The proposed development of the precinct is described in the following sections and outlined spatially within **Table 4.**

TABLE 5: ESTIMATED DWELLING / LOT YIELD FOR AMENDMENT AREA

Use Category	Estimated Dwelling / Lot Yield
R25 - R40 Residential - Single and Grouped Dwellings	Approximately 800-900 dwellings/lots
Lifestyle / Retirement Village Precinct	~300 dwellings (anticipated across 1 superlot)
Local Centre - mixed use	~20 dwellings (survey strata)
Indicative Total Dwelling / Lot Yield	**1120 - 1220 dwellings (800-900 lots)**

2.3.2.1 Residential Precinct (R25 - R40)

The Residential zoned area is anticipated to accommodate a range of residential development under the allocated density coding of R25 - R40 in accordance with **Plan 1.**

The application of these codings is intended to be flexible to allow subdivision design in response to market and site considerations as development of the precinct progresses.



It is anticipated that residential development will be predominantly 'Lower Density' in the form of single dwellings at the R25 and R30 coding ranges (**Figure 8**). More intensive 'Medium Density' residential development may be progressed within the R40 coded areas (**Figure 8**), which may include:

- Multiple Dwellings (Apartments); or
- Single and/or Grouped Dwellings.

The preparation of Local Development Plans (LDP's) will be required to facilitate specific residential development on lots as a condition of subdivision where the subdivision proposes:

- Lots directly abutting public open space, with the LDP to address dwelling orientation, primary street entrance/address and uniform/permeable fencing.
- Lots fronting a Neighbourhood Connector A or Neighbourhood Connector B;
- Small dwellings (Grouped Dwellings);
- Lots proposed to immediately abut the Local Centre or Lifestyle/Retirement Village.

The proposed residential precinct is anticipated to yield approximately 800 - 900 lots, as outlined in **Table 5**.

TABLE 6: ESTIMATED /DWELLING YIELD FOR RESIDENTIAL PRECINCT

Use Category	Estimated Lot/Dwelling Yield
Low (R25)	~455
Low (R30)	~300
Medium (R40)	~120
Indicative Total Lot/Dwelling Yield	~875 lots

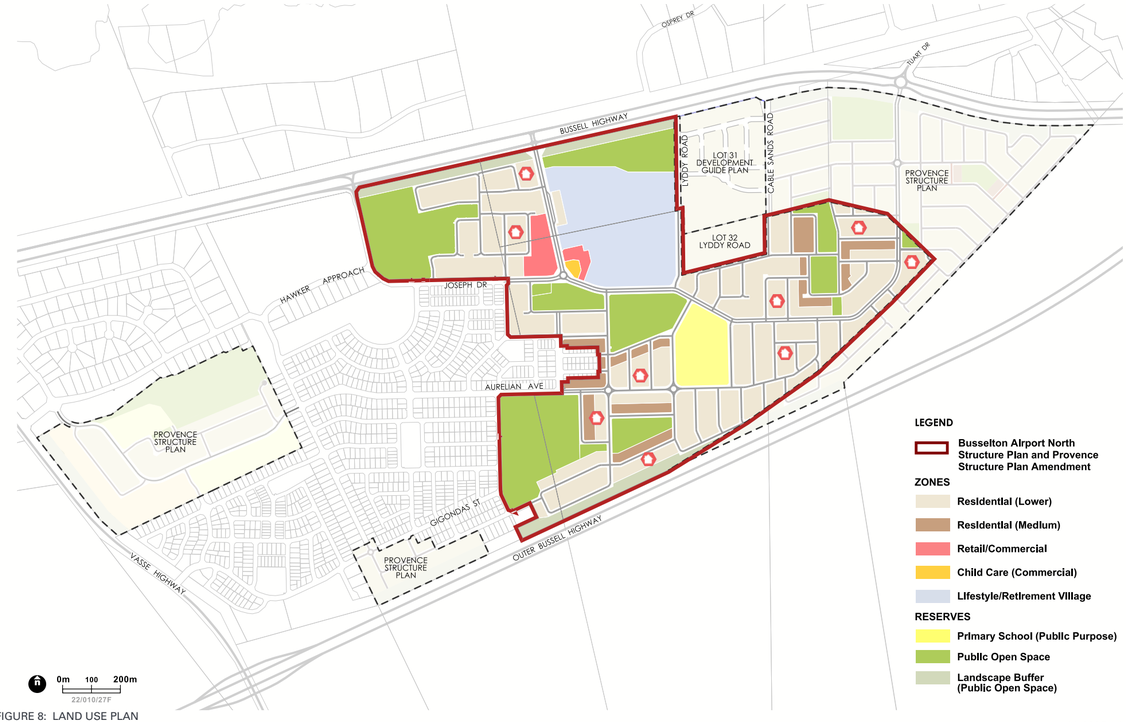


FIGURE 8: LAND USE PLAN

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2.3.2.2 Local Centre Precinct

The Local Centre Precinct is anticipated to accommodate a range of commercial, retail, restaurant/cafe and community uses, in accordance with Plan 1 and Section 4.2 (Part 1). A market potential assessment has been prepared as **Appendix B**, and provides the following key recommendations:

- An anchor supermarket tenant, with the final size to be dictated by operator demand and requirements.
- Retail speciality floorspace is likely to be convenience focussed, and comprise of food retailers (i.e bakery, liquor store); food catering (cafes and takeaway foods); general retail (pharmacy, speciality shop) and retail services (hairdresser, barber, nail salon or other beauty).
- Non-Retail Floorspace is likely to be supportable and indicatively comprise of non-retail shopfronts (real estate agent, delivery collection facilities); Medical (medical centre and ancillary professionals); a small gym operator; a Childcare Centre; a Bar/Tavern and potentially small commercial suites (conveyancer).

There is likely to be suitable demand for a local centre with 4,000m^2 - 5,000m^2 retail and non retail GLA in the short term (2026-2031), expanding to 8,250m^2 - 9,500m^2 in the medium-long term (2036 - 2041).

The indicative tenancy mix is outlined in **Table 7**.

The subdivision and/or development will be guided by the preparation of a Local Development Plan for the precinct which addresses:

- Indicative land use patterns and subdivision layout (if applicable);
- Built form, including building height and setback considerations; and
- Site design, including access, open space, parking and landscaping/drainage considerations.

Of critical importance to the preparation of the LDP, consideration will be given to the following:

- Activation of the precinct via uses and site design that creates opportunities for outdoor dining and passive recreation associated with the adjacent recreational facilities;
- Interface between the commercial precinct and surrounding uses, including the residential precinct and retirement living precinct, to ensure that this interface presents an attractive frontage and does not include uses, activities or built form which impacts the amenity or enjoyment of the surrounding areas; and
- Site design and access to ensure that the precinct is highly accessible and permeable.

TABLE 7: INDICATIVE TENANCY MIX

Use Category	Estimated Floorspace
Medical	315m^2
Pharmacy	272m^2
Childcare	1460m^2
Mixed Use	300m^2
Supermarket	3628m^2
Liquor Shop	240m^2
Specialty Retail	1202m^2
Cafe	120m^2
Health & Wellbeing	300m^2

2.3.2.3 Lifestyle / Retirement Village Estate

This area is proposed to accommodate retirement living opportunities and associated community and recreation facilities which cater for the needs of over 50's residents.

The subdivision and/or development of this precinct will be guided by the preparation of a Local Development Plan for the Lifestyle / Retirement Village precinct which addresses:

- Site density and design for the permissible uses, including but not limited to private accessways, communal facilities, private open space, landscaping, parking and administrative/service areas;
- Built form considerations for permissible uses, including but not limited to building height, interface and setback considerations. -

State Planning Policy 7.3 (Residential Design Codes) will not apply to the use not listed of 'Lifestyle / Retirement Village', as all built form and site guidance will be provided by the Local Development Plan.

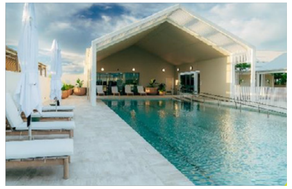
Of importance to the preparation of the Local Development Plan will be consideration of the:

- Integration of the site with the surrounding residential community;
- Site design and access to ensure that the precinct is highly accessible and permeable;
- Integration with the commercial precinct to assist in activation and provide local opportunities for residents to socialise and recreate within the community; and
- Provision of open space and communal facilities on site to ensure residents are within walking distance of quality parkland and recreational facilities.

An indicative Local Development Plan is provided in **Figure 9** to indicate the built form vision and intent.

The Lifestyle / Retirement Village precinct is anticipated to yield in the order of 300 dwellings. In the event that the Lifestyle / Retirement Village does not ultimately proceed within the designated site, residential development may be facilitated subject to a residential density code range of R25-R40 in accordance with the provisions of Part 1 (Section 5.2 and 5.3).







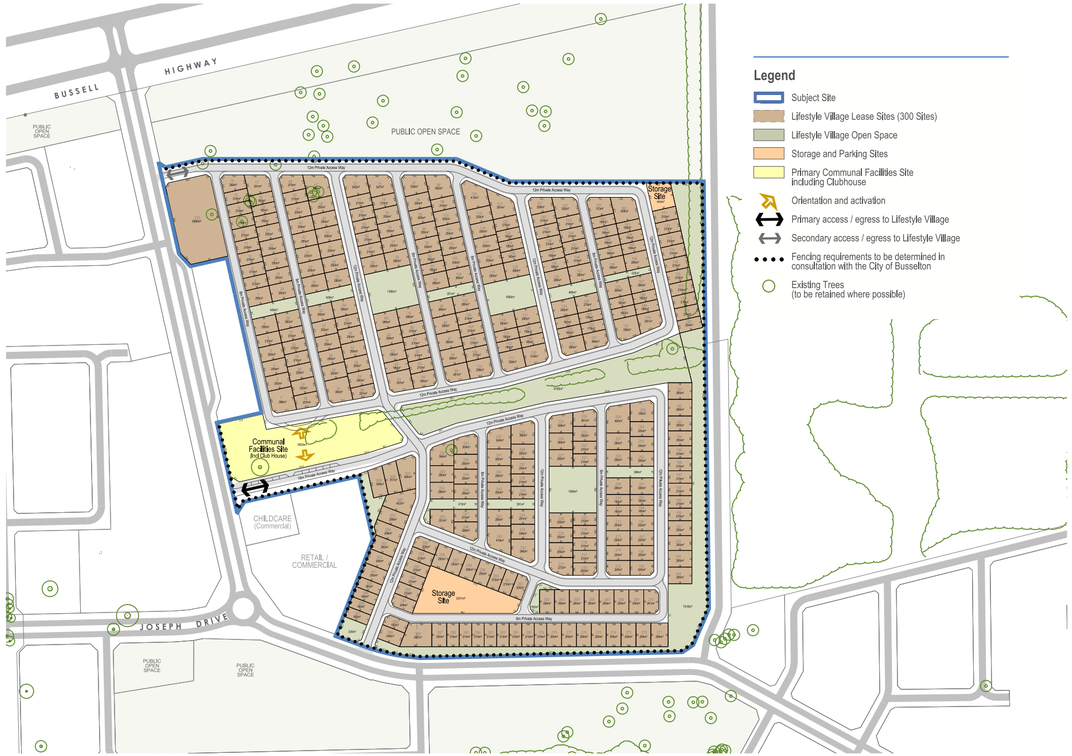


FIGURE 9: DRAFT LOCAL DEVELOPMENT PLAN

2.3.2.4 Small Dwellings (Grouped Dwellings)

The structure plan establishes the intent to investigate and develop Small Dwellings consistent with their inclusion in Part C of State Planning Policy 7.3 (Residential Design Codes Volume 1).

The concept is being investigated as a means to provide for affordable rental properties.

The proposal identifies two concepts to be investigated for the structure plan area:

- **Small Dwelling Four Pack** - deliver four (4) small residential dwellings on a single lot. The dwellings are envisaged to accommodate 1-2 people (4-6 residents per four pack); and
- **Small Dwelling Precinct** - small residential dwellings within a defined precinct. The dwellings are envisaged to accommodate 1-2 people.

It will be important to ensure the sites integrate into the existing suburban built form and do not detrimentally impact the streetscape.

Development of the small dwellings four packs and precinct may be guided by the preparation of a Local Development Plan which addresses any beneficial variations to:

- Visitor car parking allocation and provision of landscaping;
- Building design elements;
- Streetscape/dwelling orientation;
- Setback requirements;
- Fencing controls between dwellings;
- Private open space;
- Incidental development (storage/clothes drying/outbuildings/controls on caravan/trailer/boat locations).





2.4 Open Space

Fourteen areas of public open space have been identified within the structure plan, as show in Landscape Master Plan prepared by LD Total and provided at **Appendix J**.

2.4.1 Public Open Space Types

Public Open Space (Type) and are outlined in **Figure 10** and briefly described as follows:

- Conservation areas which provide the opportunity to retain and enhance native vegetation and provide residents and visitors extensive passive recreation opportunities;
- District open space, providing community facilities and active open space to meet the needs of the broader district area;
- Neighbourhood open space which will provide for passive and active recreation, in addition to the retention of key strands of native vegetation;
- Local open space, which provides opportunities for respite and recreation to the local community; and
- Landscape buffer areas which provide passive recreation opportunities to residents and assists in visual and acoustic screening of the adjacent regional roads.



FIGURE 10: PUBLIC OPEN SPACE TYPE PLAN

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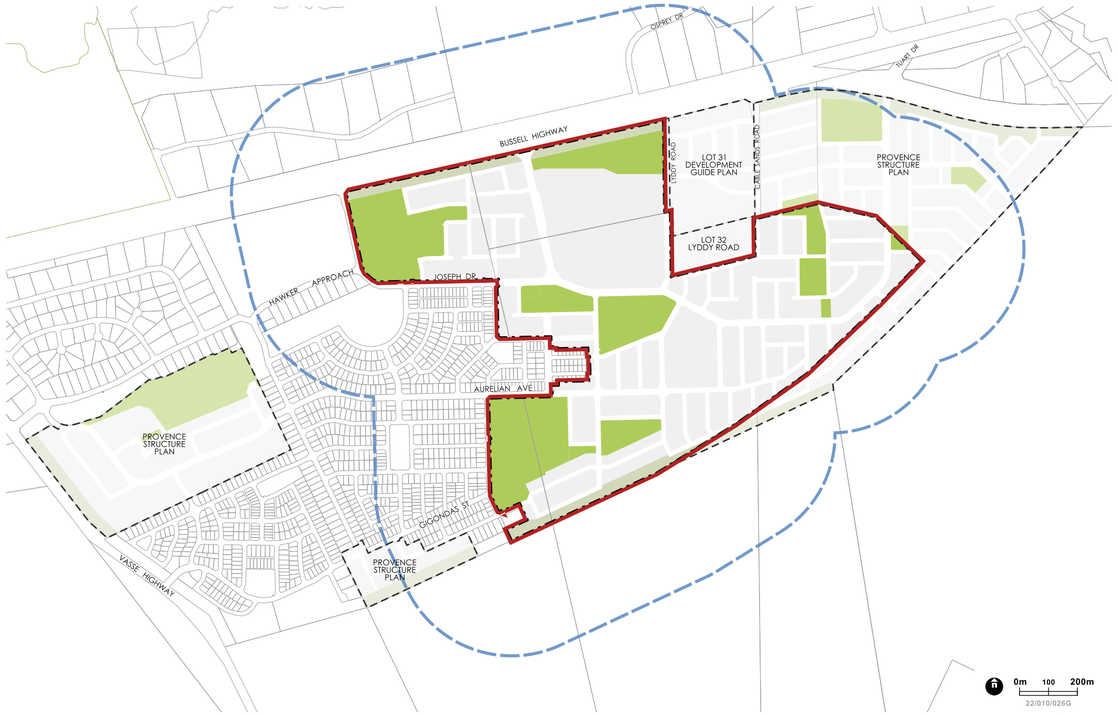


FIGURE 11: PUBLIC OPEN SPACE PROVISION PLAN

2.5 Movement Network

A Transport Impact Assessment prepared by Transcore is attached as **Appendix D** and provides detail regarding the traffic generation and distribution of the proposed Amendment. The components of the report regarding the proposed internal transport network and analysis of the transport network are outlined below.

2.5.1 Proposed Road Hierarchy

The indicative location of roads for the purposes of subdivision is depicted in **Plan 2** and **Figure 13**. The specific location of roads will be confirmed as a component of a subdivision application, but for the purpose of informing subdivision design the roads will be designed to a maximum width as follows:

- Integrator B - 32.5m
- Neighbourhood Connector A - 23m
- Neighbourhood Connector B - 20m
- Access Street Type B - 18m
- Access Street Type D - 15m
- Liveable Street - 15m
- Abutting POS - 13m

Detailed designs for these roads will be required as a condition of subdivision approval, inclusive of landscaping standards and pedestrian safety requirements.

2.5.1.1 Liveable Street

Figure 12 identifies a proposed "Liveable Street". The forecast low volume nature of the road facilitates the investigation of the innovative road design of the 'Liveable Street' concept, the focus of which will be on ensuring safer slower speeds are obtainable to create a more pedestrian friendly environment. The use of additional street trees and greening will also provide for a much more pleasant environment. The proposed indicative cross section is shown in Figure 12.

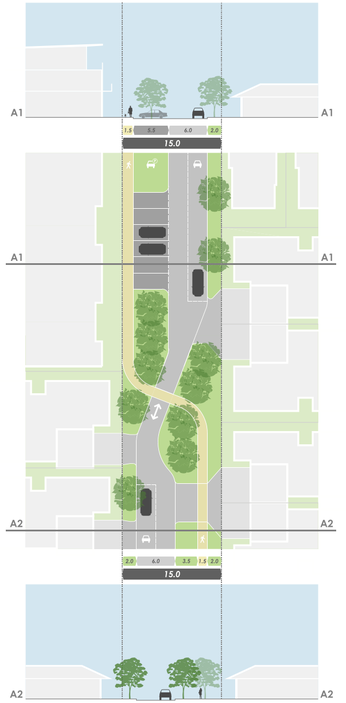


FIGURE 12: INDICATIVE LIVEABLE STREET

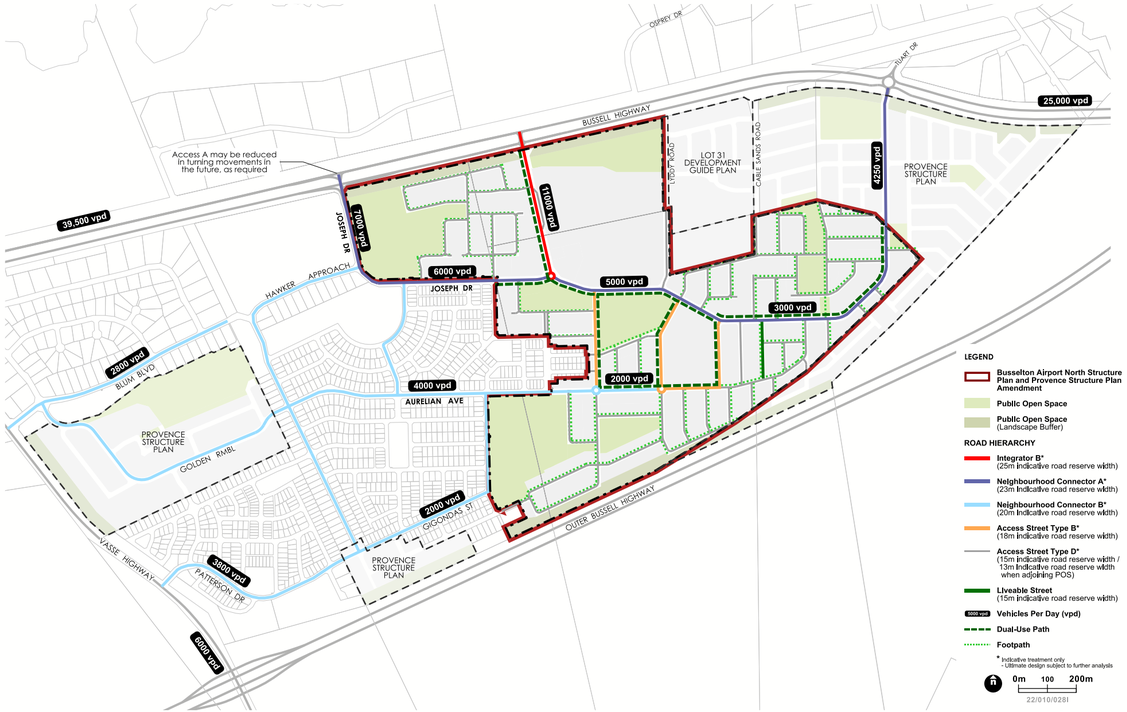


FIGURE 13: PROPOSED MOVEMENT NETWORK AND ROAD HIERARCHY

2.5.2 Pedestrian and Cyclist Facilities

The proposed pedestrian network connects the Amendment area and the wider LSP area with the town centre and other points of attraction or amenity. Additionally, the pedestrian network establishes links to the existing developments to the west and future developments to the east. Footpaths are proposed on at least one side of all Access Streets within the Amendment area.

2.5.3 Roads and Intersections

The Amendment area is currently accessed by the existing T-intersection between Joseph Drive and Bussell Highway. A central give way T-intersection provided on Bussell Highway is proposed in alignment with the approved Provence Estate LSP. The location of the new intersection is proposed to be slightly further east on Bussell Highway to provide a separation distance of approximately 360m from the existing T-intersection at the Bussell Highway/Osprey Drive to enable the provision of turn pockets at the intersection.

Roundabouts are proposed at the Integrator B intersection with Bussell Highway and the 4-way Neighbourhood Connector roads to manage the circulation of traffic flows and assist with speed management. Roundabouts are also proposed at other four-way intersections on low-traffic volume roads (see **Figure 14**).

2.5.4 Intersection Analysis

An analysis of the key intersections along Bussell Highway was undertaken and found that the T-Intersection of Bussell Highway/Joseph Drive will satisfactorily operate during the AM peak house with marginal delays and queues at the intersection while some level of delay is expected for the right turn movement from Bussell Highway to Joseph Drive.

A new signalised intersection will be provided at the intersection between Bussell Highway and Central SP amendment access road. This signalised intersection will provide sufficient capacity to accommodate traffic movements that is created as part of this amendment and is expected to operate satisfactorily during the AM and PM peak hours.

Furthermore, the analysis found that the proposed roundabout intersection at Bussell Highway/Tuart Drive/Future access road would operate satisfactorily and well within capacity during the AM and PM peak hours with marginal delays and queues at the intersection.

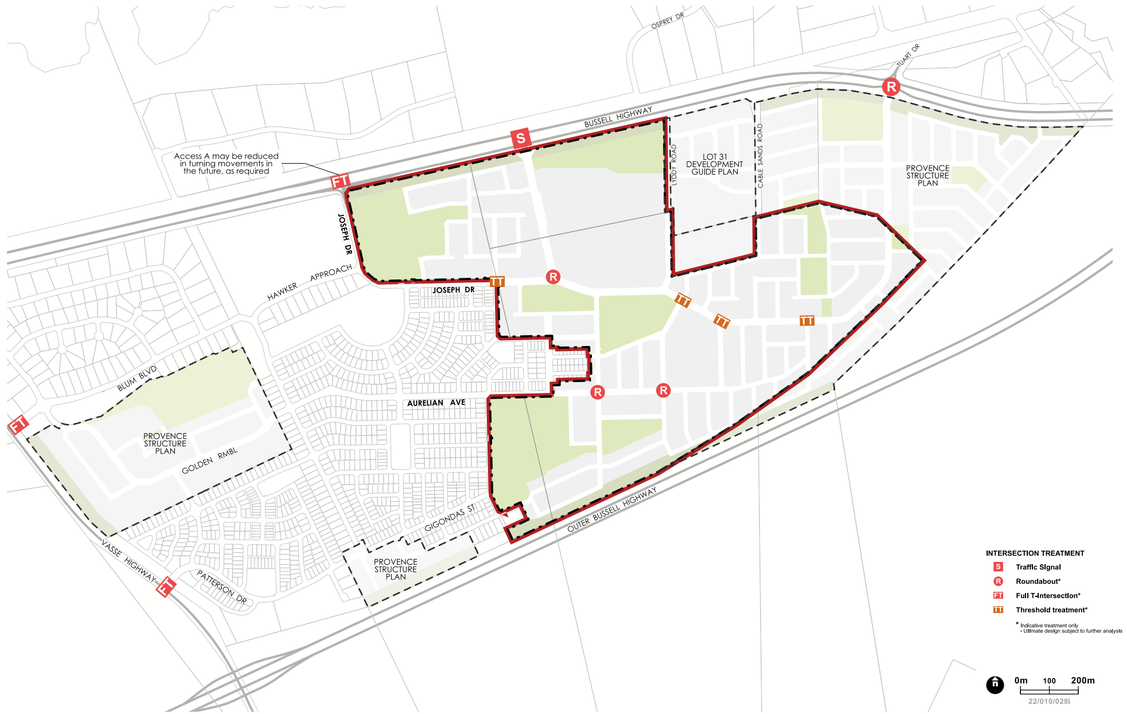


FIGURE 14: INTERSECTION TREATMENTS PLAN

2.6 Site Works and Infrastructure

An Engineering Servicing Report that details the civil, electrical and communications considerations for the proposal is contained in **Appendix E** and is summarised as follows:

2.6.1 Sewerage

A gravity sewerage network operated by the Water Corporation exists in the area surrounding the subject site. Gravity sewer exist at the majority of points adjacent to the western boundary of the site which provides numerous points of connection to the existing reticulated network. However, there is no existing sewerage infrastructure to the north, east and south of the site.

As the subject site as it is located within the Water Corporations SD090 Busselton Long Term Sewer Planning scheme boundary, allowance has been made to service the Site with reticulated gravity sewerage.

The Water Corporation's SD090 identifies that the subject site is located across three sewer pump station catchments, two of which currently exist while the third is planned for future construction. The two existing pumps will service the western and southern portions of the subject site, while the third pump is planned to be located adjacent to Lyddy Road and will service the central and eastern portions of the site.

2.6.2 Potable Water

Busselton Water operates a reticulated potable water network in the area surrounding the subject site. Busselton Water has advised that their 2017 hydraulic review identified 300mm (DN300) trunk mains extend through the subject site from the existing mains that run along Bussell Highway and Joseph Drive, and then continue south to future development areas south of the site. Busselton Water noted that it does not contribute to new water mains within Development Areas.

2.6.3 Gas

As the operators of the reticulated gas network in the surrounding area, ATCO have advised that the existing network has capacity to service the proposed development. It is advised that if the development occurs in an orderly manner from west to east with construction abutting existing stages of development, extensions and/or upgrades to the gas network are not likely to be required.

It is noted that ATCO are likely to fund the installation of gas mains throughout the development as long as a trench is provided for their mains to be installed into. However, this will require confirmation from ATCO on a case-by-case basis.

2.6.4 Underground Power

The existing power network surrounding the subject site is operated by Western Power and consists of:

- High Voltage (HV) underground cable terminated at the Eastern end of Joseph Drive;
- HV underground cable terminated at the Eastern end of Antibes Way;
- HV overhead service in Cable Sands Road (outside of the structure plan area, south of Bussell Highway)
- HV overhead service extending from Uligugalup Road (North of Bussell Highway), across Bussell Highway and South into the area to the North of the Eastern end of the land under consideration.

Based on the proposed development of approximately 950 residential lots and 300 lifestyle lots, the anticipated site power demand will be in the vicinity of 5.4MVA. To service the demand of the proposed development, it is likely that a new underground HV cable will be installed from the existing points on Joseph Drive and Antibes Way. Additional HV switches will also be installed within the subdivision stages and will supply transformers for the development, which in-turn, will provide low voltage power to individual lots and street lighting. Transformers are to be installed in POS areas to maximise the usable space within residential lots.

2.6.5 Communications

OptiComm Pty Ltd has confirmed that the fibre ready telecommunications facilities via a fibre to the premise network will be delivered to all lots within the proposed development. Additionally, OptiComm will be delivering Free to Air and Foxtel services to each home over the same fibre network.



2.7 Environmental Management

An Environmental Assessment Report (EAR) has been prepared by RPS and is provided in **Appendix F**. The EAR identifies the key requirements and initiatives to manage environmental assets and considerations across the Amendment area (see **Figure 15**). These are summarised as follows:

- **Flora and vegetation:** remnant vegetation is to be retained within POS and road reserves, where possible.
- **Acid Sulfate Soils (ASS):** An Acid Sulfate Soil Dewatering Management Plan (ASSDMP) has been prepared for the site. ASS are to be managed in accordance with the provided ASSDMP to ensure soil and dewatering effluent treatment measures, environmental monitoring requirements and contingency measures to minimise any environmental impacts.
- **Native Fauna**: A Construction Management Plan will be prepared by the contractor and implemented during the development of the site to ensure management measures to reduce impacts to native fauna during vegetation clearing works are implemented.
- **Inland waters**: A Water Management Strategy is to be prepared and implemented during development of the site in accordance with the conditions of the EPBC approval. Urban Water Management Plans are to be prepared at the subdivision stage and approved by the City of Busselton to ensure development of the site does not significantly impact surface or ground water.
- **Aboriginal Heritage and Culture:** A Construction Management Plan will be prepared and implemented by the construction contractor and will include an unexpected finds protocol. In the event any Aboriginal objects are identified or unearthed then construction will be stopped, and the findings are to be reported to the Department of Planning, Lands and Heritage.
- **Noise:** Subdivision specific Traffic Noise Assessments have been undertaken in accordance with SPP5.4, Acoustic assessments are to be undertaken in support of the Provence Estate LSP (inclusive of the proposed Amendment) at the subdivision stage, with noise mitigation measures to be incorporated into the subdivision design and the constructed development.
- **Mosquitoes:** A Mosquito Management Plan that details the management measures is to be implemented to mitigate health risks and nuisance considerations to future residents.
- **Bushfire:** A Bushfire Management Plan has been prepared and is provided at **Appendix G**, that details all fire protection requirements for issues including fire suppression response, development design, access, water supply, building locations and other relevant performance criteria to be achieved.

Overall, the environmental attributes and values of the site can be accommodated within the proposed design, or can be managed appropriately through future subdivision and development phases in line with the relevant state and local government legislation, policies and guidelines and best management practices.



FIGURE 15: ENVIRONMENTAL ASSETS AND CONSIDERATIONS ACROSS THE AMENDMENT AREA

2.8 Bushfire Management

The majority of the site is identified as a 'bushfire prone area' under the state-wide Map of Bushfire Prone Areas prepared by the Department of Fire and Emergency Services (2021). The identification of the site within an area declared as bushfire prone necessitates that a further assessment of the determined bushfire risk affecting the site be undertaken (in accordance with Australian Standard 3959-2018).

A Bushfire Management Plan (BMP) prepared by JBS&G is provided at **Appendix G** that details the construction of buildings within bushfire prone areas and the satisfactory compliance of the proposal with the policy measures described in State Planning Policy 3.7 Planning in Bushfire Prone Areas (SPP 3.7).

As part of assessing the bushfire risk, the vegetation within the Amendment area and adjoining 150m (the assessment area) has been classified in accordance with AS 3959 and the pre and post-development vegetation extents have been assigned a bushfire hazard level. The assessment of the bushfire hazard levels found that the anticipated post-development bushfire levels on the land (see **Figure 16**) will either be assigned a low or moderate bushfire hazard level and are capable of habitable development.

On the basis of the information contained within the BMP, it is considered that the bushfire hazards within and adjacent to the Amendment area and the associated bushfire risks are readily manageable through standard management responses. With the implementation of the management measures contained within the BMP, the project area will be able to be developed with a manageable level of bushfire risk whilst maintaining compliance with the Guidelines for Planning in Bushfire-Prone Areas Version 1.4 and AS 3959.

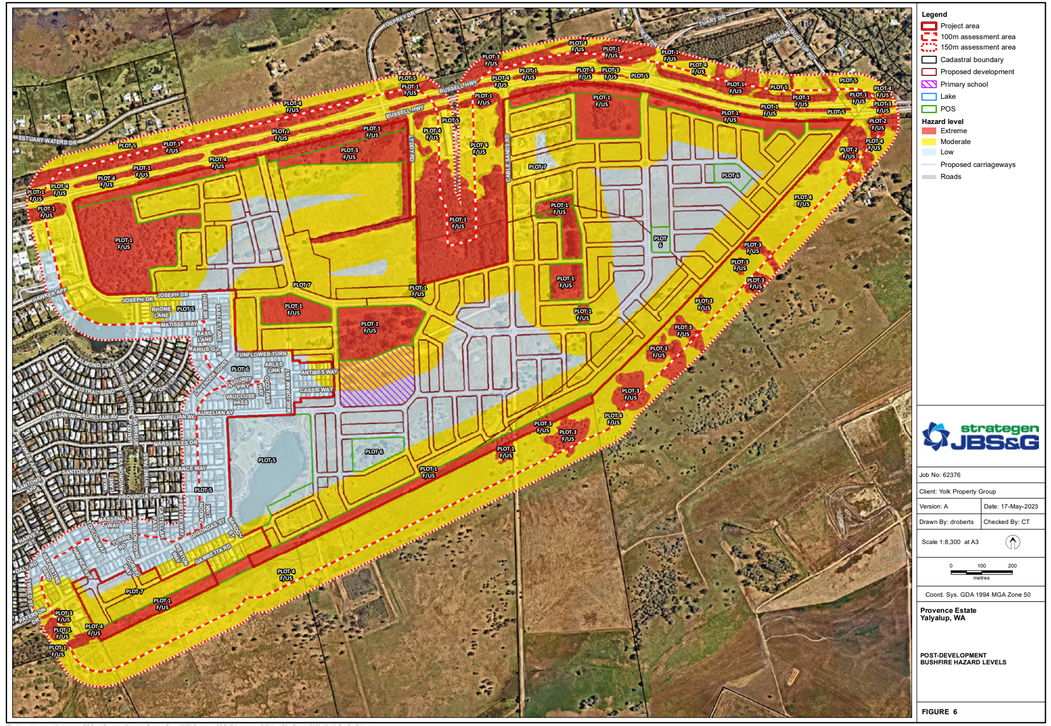


FIGURE 16: MAP OF BUSHFIRE PRONE AREAS

2.9 Local Water Management Strategy

A Local Water Management Strategy (LWMS) has been prepared by Hyd2o and is provided at **Appendix H**.

As identified within the LWMS, the subject area is located within the catchment of the Sabina River, which flows to the Vasse Wonnerup Estuary. Flow from the site occurs via a set of culverts under Bussell Highway near Osprey Drive which direct flow to a watercourse running through rural properties in Reinscourt. It is noted that the watercourse is not within a designated easement and the need to maintain post development flows and volumes to Reinscourt at pre-development levels is therefore a key factor governing the design of the subject site water management system.

Key elements of the overall stormwater management system for the subject area are as follows:

- Conveyance of stormwater runoff will occur via a series of pipes, swales, and road reserves to convey local catchment runoff and regional flows to its required management area.
- For small events and water quality management, stormwater will be retained and infiltrated within the subject site.
- For larger events and flood management, predevelopment flow rates and volumes from the subject site are applied as the key criteria to govern the size of stormwater infrastructure within the subject site and allowable discharges post development for events up to the 1% Annual Exceedance Probability (AEP) event.
- A subsoil system to control and manage groundwater levels post development and reduce large scale trucking of fill. All subsoil system flow will be treated in biofiltration systems.

With respect to water quality management, the proposal adopts a treatment train approach is adopted which seeks to use a range of measures to achieve improved water quality outcomes for the site in comparison to current land use. This approach considers the application of appropriate urban residential zonings and POS landscaping to reduce nutrient input as well as implementing biofiltration systems and other engineered structures to reduce outputs.

All irrigation of POS will be undertaken using recharged local groundwater and existing DWER groundwater licencing. With respect to Footprint Lake, a Lake Management Plan (LMP) is to cover ongoing management and implementation of the lake in perpetuity and will detail the final preferred option. The measures / actions to be undertaken to inform the LMP will take several years and does not enable the LMP to be prepared and finalised in the short to medium term.

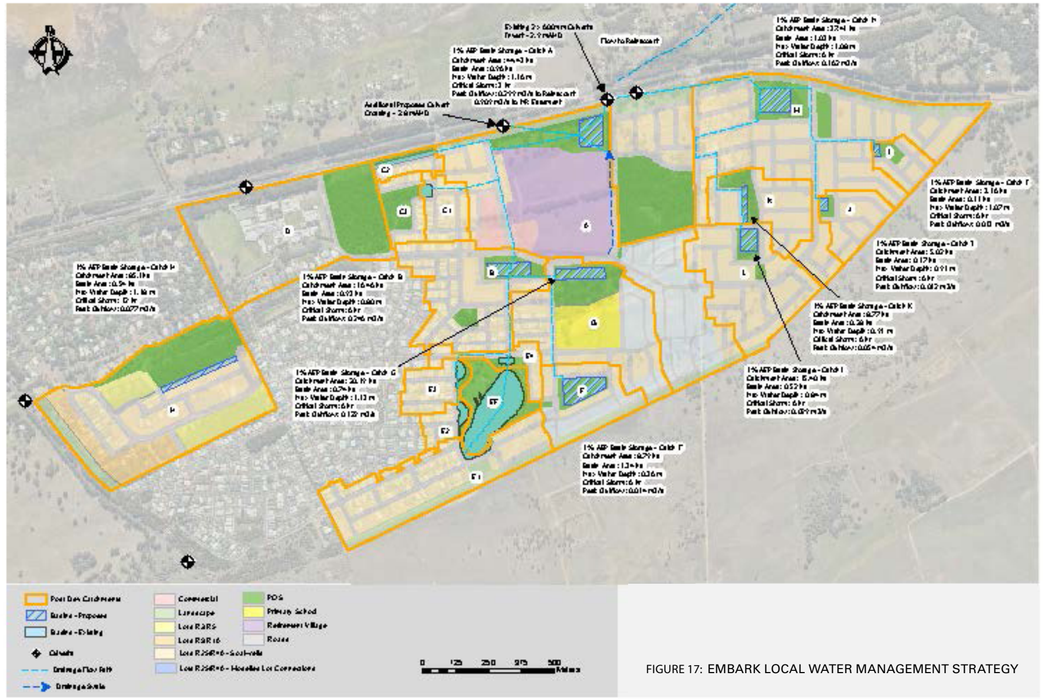


FIGURE 17: EMBARK LOCAL WATER MANAGEMENT STRATEGY

2.10 Noise Management

Herring Storer Acoustics was commissioned to undertake an acoustical assessment of noise received within the subject site and prepare a Noise Management Plan, which is provided in **Appendix I**. The assessment comprised of the following elements:

- Determine the noise levels that would be received at proposed residences within the subject area from vehicles travelling on the Bussell Highway and the proposed outer bypass in the future;
- Assess the predicted noise levels for compliance with the appropriate criteria;
- Provide detailed information as to noise control requirements such as Quiet House Design packages, noise walls and future Notification on Titles.

Under the Western Australian Planning Commission (WAPC) Planning Policy 5.4 Road and Rail Noise (SPP 5.4), the appropriate criteria for the proposal are:

External

- LAeq(Day) of 55 dB(A); and
- LAeq(Night) of 50 dB(A).

Internal

- LAeq(Day) of 40 dB(A) in living and work areas; and
- LAeq(Night) of 35 dB(A) in bedrooms.

Further to the above requirements, noise received at an outdoor living area should also be reduced as far as practicable, with an aim of achieving an LAeq of 50 dB(A) during the night period.

To ensure compliance with SPP 5.4, the following noise attenuation measures have been provided:

- 3.0m bund at the boundary of the development, facing Bussell Highway and the Outer bypass.
- Noise bund, Quiet House Design Package A and Notifications on Title for lots facing Bussell Highway.

It is noted that all future lots exceeding 55 dB(A) will require a Notification on Titles.

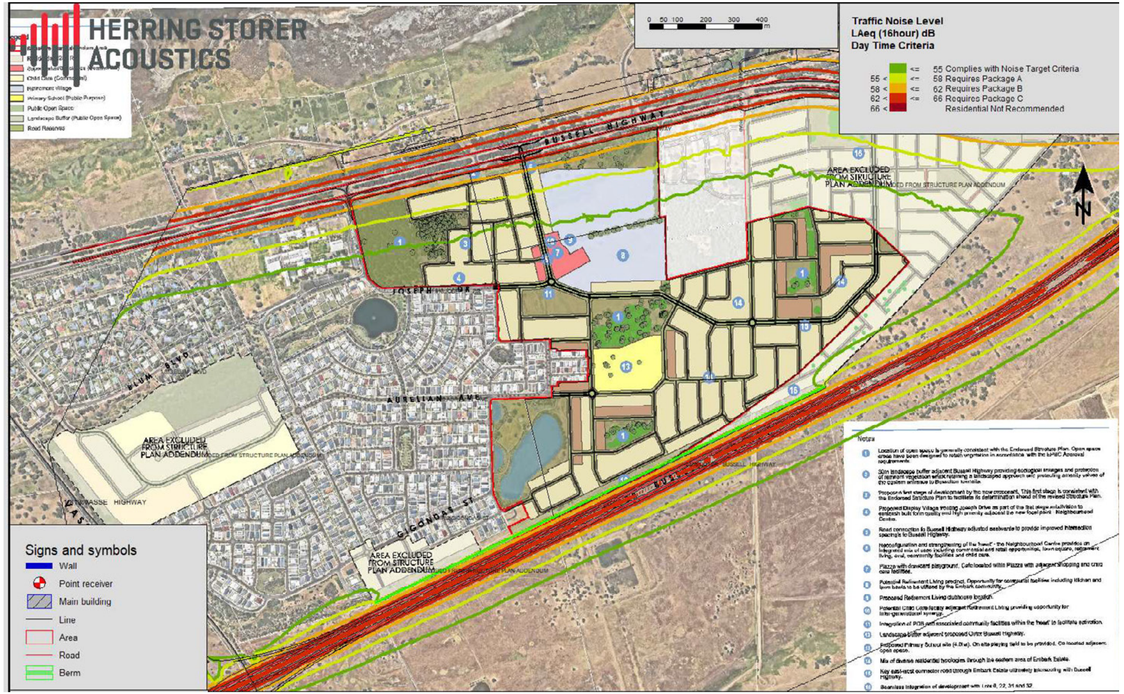


FIGURE 18: NOISE MANAGEMENT

3.0 Implementation and Staging

An implementation and staging plan has been prepared based on the anticipated staging of development and infrastructure as shown in **Figure 19.**

It should be noted that this staging plan is intended to be indicative only, and may not accord with the ultimate staging of subdivision and development, as the actual staging will be dependent on many factors which can fluctuate, including market demand, infrastructure availability and unanticipated site constraints. Flexibility in the implementation and staging will be essential to the efficient and cost effective delivery of the Estate.

The eight stages are summarised as follows:

Stage 1

Stage 1 will incorporate the construction of single residential lots and the creation of the first stage of public open space.

Stage 2

Stage 2 will incorporate the delivery of a new intersection at Bussell Highway and form the primary entry point into Embark Estate, with the new Neighbourhood Connector A providing linkage to the Local Centre and ultimately through to the primary school and District Open Space. Stage 2 will also facilitate the creation of the Retirement Living Precinct and a variety of single residential lots throughout.

Stages 3, 4 and 5

Stages 3, 4 and 5 will primarily deliver single residential lots and public open space as market demand grows, and will also facilitate the delivery of the District Open Space consistent with the vision for the precinct outlined in the Structure Plan and the Development Contributions Plan.

Stage 6-8

Stages 6-8 will primarily deliver a consolidated block of single residential lots along the interface with Outer Bussel Highway to generate the future demand of the primary school and assist with the delivery of the Local Centre.

Stages 9+

Stages 9-14 are anticipated to complete the estate, and will focus on the delivery of the primary school, delivering a variety of single residential lots and finalise the remaining areas of public open space.

It is anticipated the Estate will unfold over 8 - 10 years, assuming an indicative annual take up rate of 60 lots per annum (subject to market conditions).

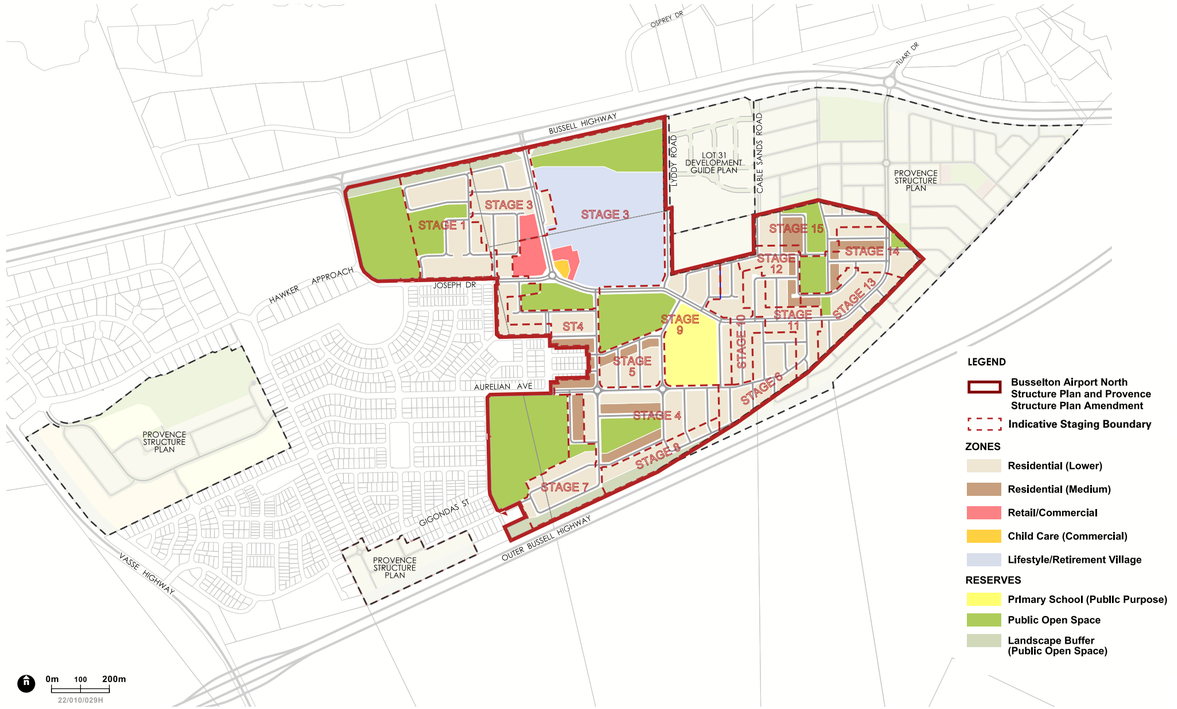


FIGURE 19: INDICATIVE STAGING

Appendix A

Certificate of Title

Appendix B

Commercial Analysis

WESTERN AUSTRALIA

REGISTER NUMBER	
9032/DP406716	
DUPLICATE EDITION **3**	DATE DUPLICATE ISSUED **2/2/2022**

VOLUME **2891** FOLIO **698**

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 9032 ON DEPOSITED PLAN 406716

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ALMOND LAKE PTY LTD OF LEVEL 21 90 COLLINS STREET MELBOURNE VIC 3000
(TP P065342) REGISTERED 4/3/2022

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

1. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO SHIRE OF BUSSELTON - SEE DEPOSITED PLAN 406716 AS CREATED ON DEPOSITED PLAN 60344.
2. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO LOCAL AUTHORITY - SEE DEPOSITED PLAN 406716
3. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR SEWERAGE PURPOSES TO WATER CORPORATION SEE DEPOSITED PLAN 406716
4. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER PURPOSES TO WATER CORPORATION SEE DEPOSITED PLAN 406716
5. EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR ELECTRICITY PURPOSES TO ELECTRICITY NETWORKS CORPORATION SEE DEPOSITED PLAN 406716
6. N199278 EASEMENT TO CITY OF BUSSELTON FOR PUBLIC ACCESS PURPOSES SEE DEPOSITED PLAN 406716. REGISTERED 11/12/2015.
7. *P065343 MORTGAGE TO PERPETUAL CORPORATE TRUST LIMITED OF LEVEL 13 123 PITT STREET SYDNEY NSW 2000 REGISTERED 4/3/2022.
8. *P065344 CAVEAT BY MINISTER FOR EDUCATION AS TO PORTION ONLY LODGED 4/3/2022.

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

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

STATEMENTS:

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

SKETCH OF LAND: DP406716

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REGISTER NUMBER: 9032/DP406716 VOLUME/FOLIO: 2891-698 PAGE 2

PREVIOUS TITLE: 2734-827
PROPERTY STREET ADDRESS: 45 CABLE SANDS RD, YALYALUP.
LOCAL GOVERNMENT AUTHORITY: CITY OF BUSSELTON

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING P065343

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WESTERN AUSTRALIA

REGISTER NUMBER	
9034/DP416577	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
N/A	**N/A**

VOLUME **2969** FOLIO **911**

RECORD OF CERTIFICATE OF TITLE

UNDER THE TRANSFER OF LAND ACT 1893

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BGRoberts

REGISTRAR OF TITLES

REGISTRAR OF TITLES WESTERN AUSTRALIA

LAND DESCRIPTION:

LOT 9034 ON DEPOSITED PLAN 416577

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ALMOND LAKE PTY LTD OF LEVEL 21 90 COLLINS STREET MELBOURNE VIC 3000
(TP P065342) REGISTERED 4/3/2022

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

1. *EASEMENT BURDEN CREATED UNDER SECTION 27A TP&D ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 35179.
2. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 50074.
3. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 54275.
4. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 60344.
5. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR SEWERAGE PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 75743.
6. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 75743.
7. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 403664.
8. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR WATER PURPOSES TO WATER CORPORATION - SEE DEPOSITED PLAN 416577 AS CREATED ON DEPOSITED PLAN 403664.
9. *M330459 EASEMENT TO CITY OF BUSSELTON FOR PUBLIC ACCESS PURPOSES - SEE SKETCH ON DEPOSITED PLAN 416577. REGISTERED 11/7/2013.
10. *EASEMENT BURDEN CREATED UNDER SECTION 167 P. & D. ACT FOR DRAINAGE PURPOSES TO CITY OF BUSSELTON SEE DEPOSITED PLAN 416577
11. *O191272 EASEMENT TO CITY OF BUSSELTON FOR PUBLIC ACCESS PURPOSES. SEE DEPOSITED PLAN 416577 REGISTERED 10/7/2019.
12. *P065343 MORTGAGE TO PERPETUAL CORPORATE TRUST LIMITED OF LEVEL 13 123 PITT STREET SYDNEY NSW 2000 REGISTERED 4/3/2022.
13. *P065344 CAVEAT BY MINISTER FOR EDUCATION AS TO PORTION ONLY LODGED 4/3/2022.

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----------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:	DP416577
PREVIOUS TITLE:	2908-309
PROPERTY STREET ADDRESS:	NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY:	CITY OF BUSSELTON

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING O191273

WESTERN AUSTRALIA

REGISTER NUMBER	
2/D28764	
DUPLICATE EDITION	DATE DUPLICATE ISSUED
4	9/8/2010

VOLUME 1791 FOLIO 729

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 2 ON DIAGRAM 28764

REGISTERED PROPRIETOR:
(FIRST SCHEDULE)

ALMOND LAKE PTY LTD OF LEVEL 21 90 COLLINS STREET MELBOURNE VIC 3000
(TP P065342) REGISTERED 4/3/2022

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

1. TITLE EXCLUDES THE LAND SHOWN ON DIAGRAM 28764 AS DEDICATED.
2. *K739466 MEMORIAL. CONTAMINATED SITES ACT 2003 REGISTERED 13/10/2008.
3. *P065343 MORTGAGE TO PERPETUAL CORPORATE TRUST LIMITED OF LEVEL 13 123 PITT STREET SYDNEY NSW 2000 REGISTERED 4/3/2022.

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.
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----------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: 1791-729 (2/D28764)
PREVIOUS TITLE: 1271-236
PROPERTY STREET ADDRESS: NO STREET ADDRESS INFORMATION AVAILABLE.
LOCAL GOVERNMENT AUTHORITY: CITY OF BUSSELTON

NOTE 1: DUPLICATE CERTIFICATE OF TITLE NOT ISSUED AS REQUESTED BY DEALING P065343

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1791 729

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Volume 1271 Folio 236 WESTERN AUSTRALIA

CERTIFICATE OF TITLE

UNDER THE "TRANSFER OF LAND ACT, 1893" AS AMENDED

VOL. 1791 FOL. 729

Page 1 (of 2 pages)

I certify that the person described in the First Schedule hereto is the registered proprietor of the undermentioned estate in the undermentioned land subject to the easements and encumbrances shown in the Second Schedule hereto.

REGISTRAR OF TITLES

Dated 2nd March, 1988

ESTATE AND LAND REFERRED TO

Estate in fee simple in portion of Sussex Location 1 the subject of Diagram 28764, delineated on the map in the Third Schedule hereto.

FIRST SCHEDULE (continued overleaf)

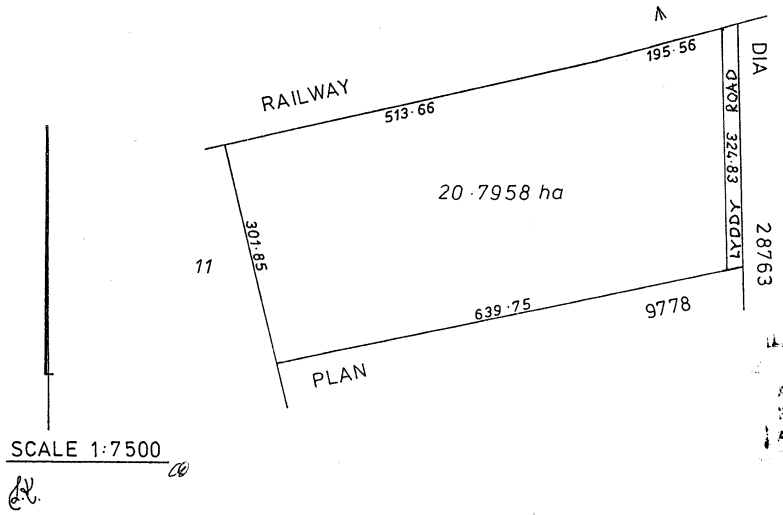
Busselton Meats Pty. Ltd., of care of Unmack & Unmack, Ninth Floor, Australian Bank Building, 190 Saint George's Terrace, Perth.

SECOND SCHEDULE (continued overleaf)

~~1. MORTGAGE D686842 to Westpac Banking Corporation. Registered 2.3.88 at 9.18 hrs~~

Discharged G244986 2.8.96

THIRD SCHEDULE



SUPERSEDED BY DIGITAL REGISTER

LOCAL GOVERNMENT ACT
ALL ROADS WITHIN GREEN BORDER ON DIA. 28764 ARE NOW DEDICATED

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

72009/12/77–45M–S/2860

PERSONS ARE CAUTIONED AGAINST ALTERING OR ADDING TO THIS CERTIFICATE OR ANY NOTIFICATION HEREON

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FIRST SCHEDULE (continued)

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

REGISTERED PROPRIETOR	INSTRUMENT NATURE	INSTRUMENT NUMBER	REGISTERED	TIME	SEAL	INITIALS
The correct address of the registered proprietor is now Lot 2 Bussell Highway Busselton.	By	G244989	2.8.96	15.38	Office of Titles Western Australia	

SECOND SCHEDULE (continued)

NOTE: RULING THROUGH AND SEALING WITH THE OFFICE SEAL INDICATES THAT AN ENTRY NO LONGER HAS EFFECT. ENTRIES NOT RULED THROUGH MAY BE AFFECTED BY SUBSEQUENT ENDORSEMENTS.

INSTRUMENT NATURE	INSTRUMENT NUMBER	PARTICULARS	REGISTERED	TIME	SEAL	INITIALS	CANCELLATION	NUMBER	REGISTERED OR LODGED	SEAL	INITIALS
Caveat	D687634	Lodged 3.3.88 at 9.09 hrs.			Office of Titles Western Australia		Withdrawn	E555692	27.2.91	Office of Titles Western Australia	
Mortgage	E555695	to Westpac Banking Corporation	27.2.91	10.34	Office of Titles Western Australia		Discharged	G244987	2.8.96	Office of Titles Western Australia	
Caveat	E555696	Lodged 27.2.1991 at 10.35 hrs.			Office of Titles Western Australia		Withdrawn	G244988	2.8.96	Office of Titles Western Australia	
Mortgage	G244989	to Newpark Nominees Pty. Ltd.	2.8.96	15.38	Office of Titles Western Australia		Discharged	G971569	7.12.98	Office of Titles Western Australia	

CERTIFICATE OF TITLE VOL. 1791 729

Appendix B

Commercial Analysis

LEASE EQUITY

20th ANNIVERSARY



DRAFT

Provence Estate Busselton

Leasing Strategy & Methodology Report

Prepared for Yolk Property Group | July 2022

YOLK PROPERTY GROUP

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1.0 Introduction
Page 4 - 5

2.0 Opportunities & Inhibitors
Page 6 - 8

3.0 Leasing Methodology & Strategy
Page 9 - 29

4.0 Contact Details
Page 30

5.0 Disclaimer
Page 31

Annexure

Fee Submission I
Leasing Feasibility II
Gap Analysis III



1.0 INTRODUCTION

1.1 EXECUTIVE SUMMARY

Lease Equity have been engaged by Yolk Property Group to provide a Leasing Strategy and Feasibility for the proposed Shopping Centre, main street and Day Care Centre development at Provence Estate, Busselton.

The report details the following information.

1. Proposed tenancy areas;
2. Recommended uses and tenancy mix;
3. Rental rates;
4. Incentives and/or concession periods;
5. Projected occupancy costs;
6. Forecast turnovers
7. Key commercial terms;
8. Brief on Building services requirements;
9. Opportunities and inhibitors.

Once design review and tenancy mix is completed, further to this report, a more detailed analysis of the following, but not limited to will be undertaken;

1. Curated Target Tenant List for prospective operators

2. Comprehensive Marketing Strategy, requirements, strategy, timeline and budget



2.0 OPPORTUNITIES & INHIBITORS



2.1 Opportunities & Inhibitors

Opportunities

Destination	Provence Estate has the opportunity to create a compelling and unique destination to draw beyond its primary catchment.
Competition	• There is no major shopping centre / supermarket located within 3.5km of the site. The proposed retail has the opportunity to service the immediate catchment. • There is no IGA supermarket within the immediate catchment/suburb, which means there may be an opportunity to secure an IGA operator and other businesses. • The closest is located 7km and 8.2km away at Busselton and Geographe, respectively.
Location	Located just off Bussell Highway which averages nearly 5 million vehicles passing per day (Main Roads 2021/22). This is the major highway when travelling between Perth and Dunsborough / Margaret River.
Busselton Margaret River Airport Upgrade	Located less than 5km away, the airport is proposed to undergo significant upgrades. Once completed, the airport will be able to service international and major interstate locations such as Melbourne and Sydney.
Tourism & Visitors	Over 865,000 overnight visitors in the Busselton LGA over the 2017 - 2019 period. Total spending from these tourists and visitors exceeds $479 million each year.

Inhibitors

Destination	Both an Opportunity and Inhibitor, Provence Estate is a destination location that will need to create a compelling and unique offering to draw beyond its primary catchment. The established retail and food and beverage offering already in Busselton provides significant competition to attract customers beyond the primary catchment to Provence Estate.
Location	Being located off Bussell Highway, this development will not benefit from being located on or have visual exposure to a major thoroughfare. Provence Estate faces the prospect of being 'missed' by tourists and visitors focused on their drive to and from Busselton and further down south.
Primary Trade Area	The primary sector of the main trade area is estimated at 3,510 people and anticipates to grow to 4,633 by 2026. This primary sector population is limited and will deter a number of retailers to consider Provence Estate.
Market conditions	Busselton has a tight labour market for quality workers in the supermarket, retail and food and beverage industry. This will add additional pressure to securing tenants and their ability to secure appropriate staffing of their stores.
Tavern	The population of Provence Estate does not a tavern. While the aspiration is to secure a family tavern for this development, the Tavern offering should be treated as a 'nice to have' with the expectation that may not be deliverable in the immediate future.



3.0 LEASING STRATEGY & METHODOLOGY

3.1 Design Concept

The design outcome for the Provence Estate retail and community hub is to efficiently utilize the high street in a manner that will create activation and act as a centre piece to Province Estate, whilst providing amenity to its local population and drawing beyond its Provence Estate primary catchment. The goal is to create a retail mix that not only caters to the needs and wants for the Provence Estate residents, but also create an environment with the aspiration to pull customers residing in Busselton and neighbouring areas and ideally people travelling between the Southwest and Perth.

We have identified on the next page areas to establish key tenants within the proposed retail and community hub of Provence Estate. This includes town square, supermarket and specialty retail, Tavern, and child care centre. This will assist as a "mud map" to articulate with the architects on elements to consider on the design of this commercial precinct.

The guiding principles for the architect to follow are

- Condense a portion of Joseph Drive as the high street – estimated linear meter the high street to cover on Joseph Drive to range between 70m to 100m depending on whether a tavern will be secured and if it will sit on the high street. This is based on the Tavern having around 30m of frontage. Condensing the overall linear frontage allows greater ability to have an active high street and not disbursing customer traffic
- Active high street – dual fronting commercial will provide a more 'authentic' and active high street along Joseph Drive
- Synergy between the town square / greenspace and food and beverage operators – have the food and beverage operators including tavern form part of the green space / town square. This community space needs to be positioned to compliment and not compete with the food and beverage offering.
- Parking –the high street should be designed with street parking as well as the core parking areas behind the retail. Sufficient and convenient parking needs to be provided to prevent customer dissatisfaction during peak trading periods, however designed in a way to find the balance to avoid customers bypassing the specialty retailers to enter the supermarket.
- Road width - Tightening the width of the roads and reduce traffic speed to 40km/hr creates a more intimate environment for the dual fronting shops
- Place pharmacy and medical centre on opposite side to supermarket – both these operators have less reliance on the supermarket traffic and can be placed on the opposite side without the detriment to the rental achieved by these two tenants.
- Childcare can be placed in secondary location not facing the high street. Preference for the same side as the supermarket to provide parents and children not having to cross the high street to enter the supermarket.
- Mixed use townhouses – consideration to add "live-work" hybrid properties along the high street that may suit small scale service retail / offices. This will help achieving the desirable linear meter of the high street.

3.2 Look and Feel

An area that developers in WA have fallen short when attempting to create a high street environment are on the design elements on what makes an authentic high street feel 'authentic'. While aspects such as dual fronting high streets, street front parking and tenancy mix are important in creating a high street, the look and feel of a purpose-built high street is an important factor to replicating the authentic high street experience.

This primarily consists of avoiding the use of uniform anodised aluminium shopfronts throughout the whole high street and having each shopfront designed differently. To further strengthen the authentic high street feel will be to design the shopfront heights at different levels to give the perception each tenancy is its own individual building.

These design elements create a unique identity for each shop and enhances the experience to the customer that they are on a bustling and active high street. Additional design elements to consider for the high street are on the level of greenery and paving finishes provided through the high street and town centre.







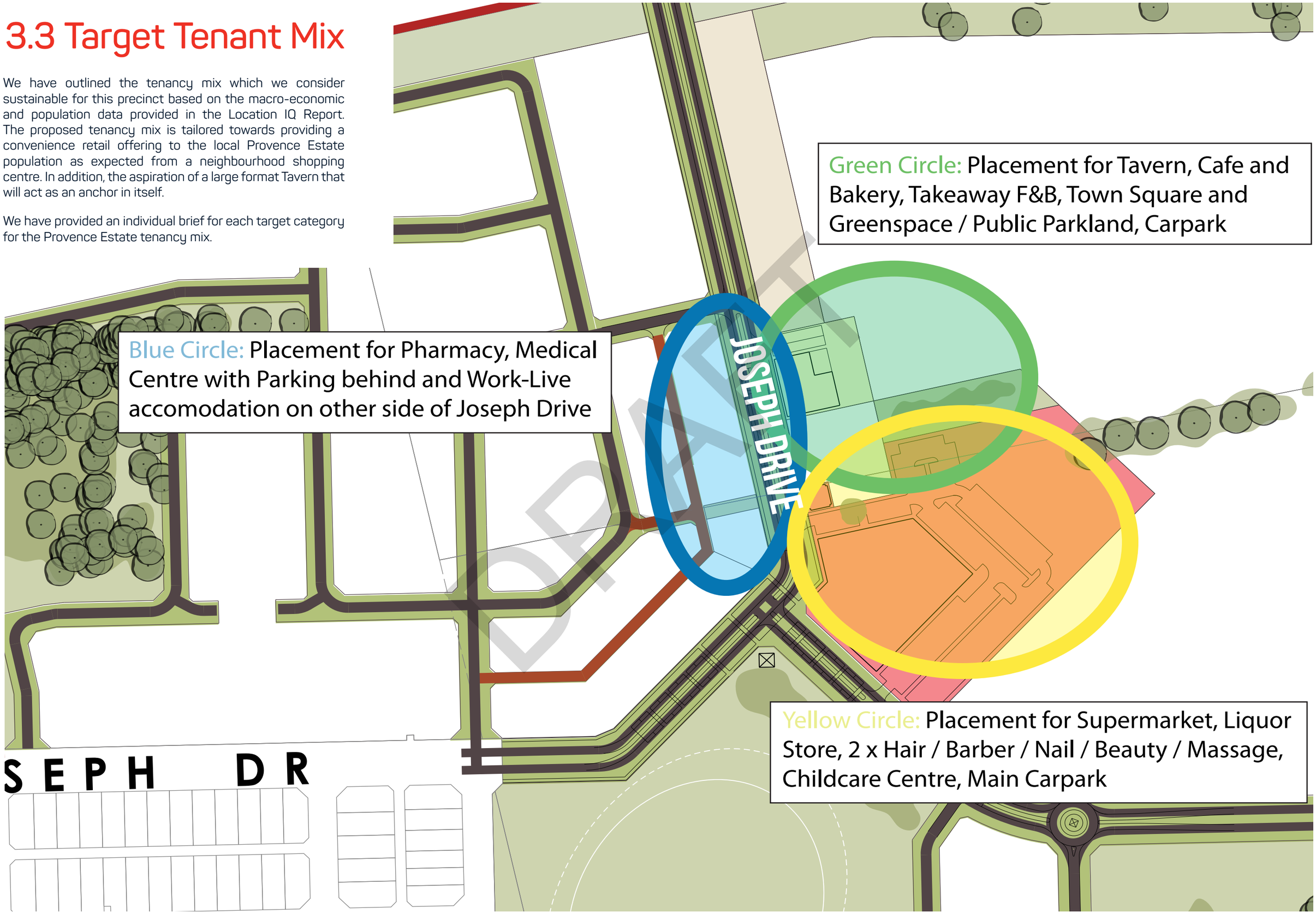




3.3 Target Tenant Mix

We have outlined the tenancy mix which we consider sustainable for this precinct based on the macro-economic and population data provided in the Location IQ Report. The proposed tenancy mix is tailored towards providing a convenience retail offering to the local Provence Estate population as expected from a neighbourhood shopping centre. In addition, the aspiration of a large format Tavern that will act as an anchor in itself.

We have provided an individual brief for each target category for the Provence Estate tenancy mix.



IGA SUPERMARKET

Estimated Area	1,200m²
Estimated Frontage	13m - 15m
Trading Hours	Monday to Friday - 8am to 9pm Saturday - 9am to 5pm Sunday - 11am to 5pm
Lease Term	10 years + 10 years
Budgeted Gross Rent	$300,000 ($250/m²)
Percentage Rent	2% above an unnatural breakeven of $10,000,000 excluding GST
Estimated MAT	$4,500,000
Rent Reviews	Fixed 3%
Incentive	$1,000,000 plus Landlord Works
Landlord Works	As per attached National IGA Design Brief 2020 (Annexure IV)
Budgeted Occupancy Cost	6.7%
Leasing Strategy	The supermarket is the first tenant to secure for this development. The supermarket will act as the marketing tool and drawcard to securing the specialty retail mix. The size of the supermarket box should be around 1,200m2 which will be best suited in attracting a IGA Supermarket. The strategy will be two-fold in approaching both Metcash and individual IGA operators in the Perth market. From experience while Metcash will approach their network to take this site, we've found directly approaching individual IGA operators been beneficial to securing an IGA operator for various projects. While the expected outcome will be to secure a southwest IGA operator, our canvassing will include Perth metro-based operators. We envision the appropriate operator will have a store manager that lives within Provence Estate or at least the Busselton catchment to provide a sense of familiarity and rapport with local customers. The benefit of securing a local operator will be the already established logistics and supply chain to easily accommodate this store, however, Perth based operators will be capable of operating this store as long as they secure the appropriate staff to operate the store which may either be securing a local manager or relocating a Perth metro based operator drawn to the appeal of a lifestyle change. Due to the size of the Provence Estate catchment and proposed size of this supermarket tenancy 1,200m2, the site will be more suited to an IGA. Coles and Woolworths have not established a 'express' supermarket model in WA and do not believe they will consider this site at Provence Estate. We will still approach both supermarket operators as part of our supermarket procurement process however the likelihood of a supermarket operator will be IGA.
Leasing Strategy (Continuted)	The Supermarket operator will likely be drawn to Provence Estate by being offered the liquor store as a packaged leasing deal, however established under two separate leases. While in first instance the liquor store will not be offered to prospective supermarket operators, this will be a topic of discussion for any prospective supermarket operator looking to maximise their return on this development. On the basis the supermarket is an IGA, the likely brand will be a Celebrations
Design Strategy	The supermarket site will need to be positioned in a way to provide suitable walking distance from the carpark and allow the specialty retailers to have the opportunity to feed off the supermarket customer traffic. We do not wish to provide the carpark right next to the supermarket entry as a direct route from the carpark into the supermarket as this will have no benefit to the specialty retailers. In terms of car parking bays, the supermarket should have a minimum of 1 bay per 7m2, around 170 car parking bays for customers. The architect will also need understand the loading requirements of supermarkets and ensure this site has sufficient capacity for ease and safety of delivery. Should the supermarket have coverage on the high street, we will need to ensure the supermarket operator has an element of glass frontage to maintain a level of presentation for the high street. The extent of glazing will be based on discussions with the operator as they will be reluctant due to not using this area as racking. Examples of where has been successfully achieved are at IGA Good Grocer on Cambridge Street, Wembley and IGA at Canning Bridge, Applecross.









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LIQUOR STORE

Estimated Area	140m²
Estimated Frontage	13.00m
Trading Hours	Monday to Friday - 9am to 8pm Saturday - 9am to 8pm Sunday - 11am to 6pm
Lease Term	5 - 10 years, however likely to align with Supermarket if taken by same operator
Budgeted Gross Rent	$56,000 ($400/m²)
Percentage Rent	2% above an unnatural breakeven of $5,000,000 excluding GST
Estimated MAT	$800,000
Rent Reviews	Fixed 3%
Incentive	$70,000 plus Landlord Works
Landlord Works	Provide warm shell including shopfront
Budgeted Occupancy Cost	7.0%
Leasing Strategy	The procurement of an individual liquor store operator will only occur should the Supermarket or Tavern do not wish to undertake the sale of packaged liquor as part of their overall offering at Provence Estate. In first instance the liquor store will not be put to market and be held aside to offer to prospective supermarket operators. Operation of the liquor store by the supermarket may be one of the key metrics a perspective supermarket operator requires to ensure opening of the supermarket at Provence Estate is sustainable. Should the supermarket not require the liquor store then this may be offered to the prospective tavern operator if they wish to include sale of packaged liquor as part of their tavern license at Provence Estate. Again, as with the supermarket operator, offering the packaged liquor component for the tavern, may be the defining factor to secure the preferred tavern operator at Provence Estate. Should neither the Supermarket nor Tavern require the ability to sell packaged liquor, we will then go to market to secure an independent liquor store operator. The local operator will need to demonstrate their ability to compete or show their point of difference with large format liquor stores such as Dan Murphy's. This may be competitive pricing on mainstream alcoholic products or ability to supply specialist alcohol products, i.e. craft beer or small batch spirits.
Design Strategy	The location of liquor stores in retail assets is generally at the doorstep of the supermarket which has historically been driven by the supermarket operator also operating the liquor store. Due to the likelihood the liquor store will be operated by the supermarket, we recommend the liquor store is positioned next to the entry to the supermarket. Suitable loading access direct into the liquor store will also be factored into the design of this site.











PHARMACY / NEWS / LOTTO / AUS POST

Estimated Area	150m² (170m² with News / Lotto / Aus Post)
Estimated Frontage	12m
Trading Hours	Monday to Friday - 9am to 6pm Saturday - 9am to 5pm Sunday - 9am to 5pm
Lease Term	8 - 10 years
Budgeted Gross Rent	$75,000 ($500/m²) on 150m²
Percentage Rent	2% above $2,000,000 excluding GST for only News sales and Lotto and Aus Post commission. Percentage Rent will not be payable for pharmacy related sales.
Estimated MAT	$800,000 including pharmacy and extra $200,000 for news sales and Lotto and Aus Post commission.
Rent Reviews	Fixed 3%
Incentive	$100,000
Landlord Works	Bare shell with ducted air conditioning and connection to water, waste and power including shopfront
Budgeted Occupancy Cost	9.4% on Pharmacy ONLY
Leasing Strategy	We recommend a pharmacy consultant be engaged to provide a report outlining the ACPA metrics required to secure a pharmacy license for this development. Securing the pharmacy will be key to attracting a medical centre to this development as pharmacies tend to fund part of the fitout for the doctors to entice them opening at the development. The procurement strategy of a pharmacy operator will consist of issuing an Expression of Interest (EOI) to Southwest and Metro based pharmacists. The prospective pharmacy operators will be encouraged to identify and outline their own procurement strategy for the medical centre as this will be one of the key metrics to assess when reviewing EOI applications. The other key metrics to identify when short listing pharmacy operators will be on being a community focused pharmacy and potentially a compounding pharmacy. Generally, a separate Newsagency with Lotto and Australia Post would be considered for a shopping centre development, however given the uncertain future around the Newsagency industry we do not a recommend a separate Newsagency tenancy is factored into this tenancy mix. We will encourage the pharmacy operator to provide a hybrid pharmacy / newsagency offering and obtain the Lotterywest and Australia Post licenses. While there is an uncertain future for Newsagencies, the Lotterywest and Australia Post licenses will hold value in the market in drawing customers and providing an amenity to the local catchment. Lease Equity have an established relationship with Lotterywest and have worked closely with ensuring our shopping centre developments appear on the Lotterywest network plans so potential licensees can apply for a license. Once the supermarket is secured. Procuring the pharmacy and

Design Strategy	The pharmacy generates a stronger customer traffic from the medical centre as opposed to the supermarket and for that reason we have located the pharmacy next to the medical centre on the opposite side of the high street from the supermarket in our draft scheme. The Pharmacy will still pay one of the highest rate per sqm in the development without being in a prime location in relation to the supermarket entrance, i.e. next to the supermarket entrance. The pharmacy should still be prominently placed on the high street for exposure however does not need that direct customer traffic of the supermarket as much as the other specialty retailers we've listed for this retail mix at Provence Estate.









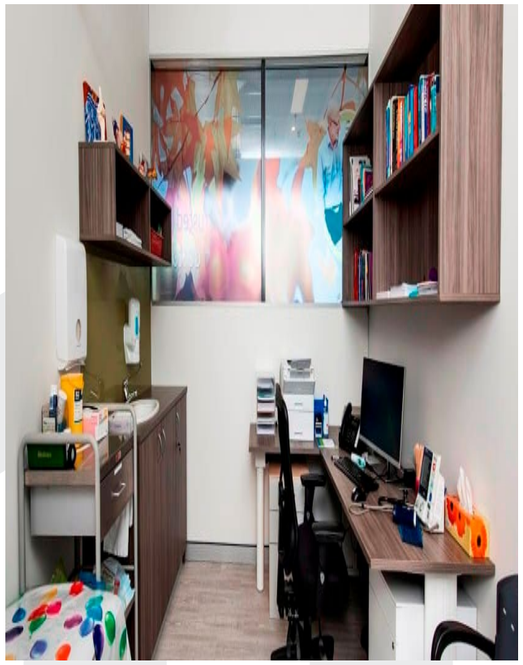
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MEDICAL CENTRE

Estimated Area	215m²
Estimated Frontage	15m
Trading Hours	Monday to Friday - 8am to 6pm Saturday - 9am to 1pm Sunday - Closed
Lease Term	10 years + 5 years
Budgeted Gross Rent	$59,125 ($275/m²)
Rent Reviews	Fixed 3%
Incentive & Landlord Works	$344,000. Incentive of $1,600/m² to provide full fitout / turnkey for Medical Centre including shopfront
Leasing Strategy	The ability of securing a medical centre operator will be influenced by whether Provence Estate falls under an area of need for overseas doctors. At the time of compiling this report, Busselton is considered an area of need under the Health Workforce Locator on the Department of Health and Aged Care website. On the basis Busselton remains as an area of need at the time of the leasing campaign, medical centre operators will be more enticed to consider this location due to the ease of them securing overseas doctors to practice at this centre. As mentioned in the Pharmacy Leasing Strategy, the right pharmacy operator will assist in procuring a medical centre through their networks and likely contribute towards the medical centre's fitout to secure the medical centre. Its in the pharmacy's best interest to have the medical centre secured as they will receive majority of the scripts from patients at the medical centre. We have budgeted a turnkey solution at $1,600/m2 in incentive to secure a medical centre. The strategy will be for the pharmacy to contribute towards these costs to secure the medical centre, however work on the assumption the full incentive will be payable by the Landlord.
Design Strategy	The medical centre is a drawcard in itself and as with the pharmacy does not need to be in a prime position in relation to the supermarket entrance. Therefore the medical centre should be located near the pharmacy on the opposite side of the high street from the supermarket. Considerations such as ambulance / emergency vehicle bays will need to be factored into the design for the medical centre in the precinct.











FOOD AND BEVERAGE (CAFE / BAKERY & T/A FOOD)

Estimated Area	70m² - 100m² with 30m² - 40m² alfresco per tenancy
Estimated Frontage	5.5m - 7.5m
Trading Hours	Cafe / Bakery: Breakfast and Lunch trade 6 to 7 days a week Takeaway Food and Beverage: Dinner on weeknights and Lunch and Dinner on weekends, trading 6 days a week.
Lease Term	5 - 8 years
Budgeted Gross Rent	$350/m² - $375/m²
Percentage Rent	5% above a natural breakeven on the gross rent.
Estimated MAT	$350,000 - $450,000
Rent Reviews	Fixed 3%
Incentive	$40,000 - $50,000
Landlord Works	Ceilings and lighting, ducted air conditioning and connection to water, waste, grease trap, power, gas and, staff and customer toilet facilities including shopfront
Leasing Strategy	Given the population size of Provence Estate and close proximity to Busselton main town centre, we do not foresee this precinct attracting national / franchise food and beverage brands such as Subway, Dominos, etc. For that reason, we foresee this catchment attracting local / independently branded food and beverage operators, most likely living in the Provence / Busselton catchment. These operators will be driven by affordable rent and flexible fitout requirements. We have only included 3 food and beverage operators as part of the tenancy mix as we believe one café and two takeaway food operators will be sustainable for Provence Estate. The takeaway food operators may consist of Turkish Kebab / Mediterranean, Pizza, Fish & Chips and/or Asian cuisines. Café and food and beverage tenants will be canvassed following the procurement of the pharmacy and medical centre to provide the key drivers for the retail catchment
Design Strategy	The ideal situation will to have the café and takeaway food to provide activation to both the high street and town square / greenspace and encourage the architect to workshop different schemes to achieve this outcome. The license seating / alfresco areas for these food and beverage operators will encourage activation and provide the tenants with opportunity to have additional customer without having to indirectly pay for it in rent or additional fitout costs by having a larger tenancy.











HAIR SALON / BARBER / NAIL AND BEAUTY SALON / MASSAGE

Estimated Area	60m²
Estimated Frontage	6m
Trading Hours	Monday to Saturday - 9am to 5pm Sunday - Closed
Lease Term	5 - 7 years
Budgeted Gross Rent	$21,000 ($350/m²)
Percentage Rent	5% above natural breakeven on the gross rent.
Estimated MAT	$200,000
Rent Reviews	Fixed 3%
Incentive	$30,000
Landlord Works	Ceilings and lighting, ducted air conditioning and connection to water, waste , power and staff and customer toilet facilities including shopfront
Budgeted Occupancy Cost	10.5%
Leasing Strategy	We have only included 2 service retail of being a mix of Hair Salon, Barber, Nail and Beauty Salon and/or Massage as being the sustainable for this tenancy mix. As with the food and beverage operators, we foresee this catchment attracting local / independently operators, most likely living in the Provence / Busselton catchment. These operators will also be driven by affordable rent and flexible fitout requirements. Service retail tenants will be canvassed alongside the food and beverage following the procurement of the pharmacy and medical centre to provide the key drivers for the retail catchment.
Design Strategy	We believe the service retail tenants are best suited and benefit the most of being in direct access / close proximity to the supermarket entrance to draw customers to their businesses. Each service retail tenancy does not require more than 60m2 to help keep their rental and fitout costs down to feasible levels to attract quality independent operators. The ability to cater to the proximity to the supermarket entry and size requirements of the sites will assist in attracting quality operators that will create further repeat visitation and dwell time at this retail and community hub.











TAVERN

Estimated Area	1,000m²
Estimated Frontage	34m
Trading Hours	Monday and Tuesday - Closed Wednesday to Sunday - 11am - 9pm
Lease Term	10 years + 5 years
Budgeted Gross Rent	$250,000 ($250/m²)
Percentage Rent	5% above an unnatural breakeven of $4,000,000
Rent Reviews	Fixed 3%
Incentive	$1,200,000
Landlord Works	Bare shell with ducted air conditioning and connection to water, waste, power, grease trap and gas including shopfront
Budgeted Occupancy Cost	8.3%
Leasing Strategy	The suburban Tavern concept has evolved in the West Australian Landscape of being an adult and alcohol focused offering to being a "family tavern" with a stronger focus on the family friendly environment. This includes a stronger focus on quality and affordable pub food, group booking / large table settings and fairly significant playground facility. Our view of the success of a tavern within Provence Estate will need to ensure it caters and appeals to the family environment. Modelling the concept as a family tavern should allow the operator attract beyond the Busselton catchment and potentially pick up tourists and family groups visiting the South West. South West and Perth based tavern and restaurant operators will be canvassed for this site with target tenants that meet this pitch including Treendale Farm Hotel, Shelter Brewing Co., Brewhouse Margaret River, Beerfarm and Colonial Brewing Co. The procurement of a tavern operator will occur once the supermarket operator has been secured. Given the limited population in Provence Estate, the Tavern is to be treated as an aspiration for Provence Estate that may not be achieved. We have set the commercial terms and incentive levels to potentially attract prospective operators with the intention to secure additional rent through a percentage upside on performance. The potential use for this site may need to pivot to a large format restaurant offering of around 500m2 – 600m2 should there be limited interest for a 1,000m2 plus tavern for this site. Tavern operators may be drawn to this development on the basis they can sell packaged liquor. While the overall strategy for Provence Estate is to first offer the liquor store to the Supermarket operator, should the Supermarket not require it, then this liquor store may be offered to the tavern operator to secure them at Provence Estate. A liquor license consultant should be engaged to provide advice at the prospect of being able to secure licenses for both a liquor store and tavern selling packaged liquor.
Design Strategy	The Tavern needs to be designed to back on / spill out on the greenspace / town square of Provence Estate. Placing the tavern with the greenspace can provide greater connectivity between holding events in the park such as outdoor cinemas and the Tavern acting as the food and beverage offering for the events. Though the Tavern will connect to the greenspace, which may have its own playground facilities, the intention will be for the Tavern operator to build their own playground facility for customers children to play in. This will add to the convenience and customer experience of customers being able to monitor their children within the tavern boundaries as opposed to leaving the tavern grounds for their children to play on a public playground.







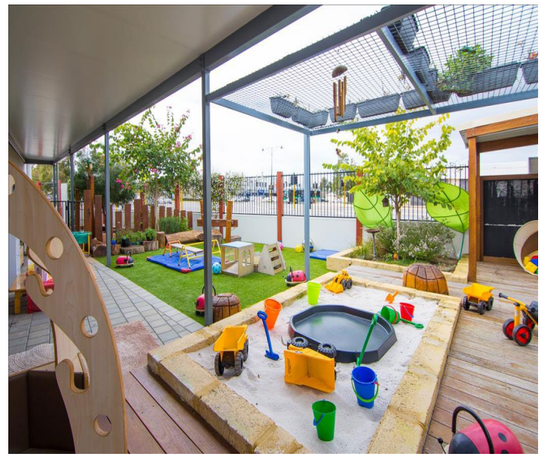




CHILDCARE CENTRE

Estimated Area	430m² (Internal), 440m² (External)
Estimated Frontage	21m
Trading Hours	Monday to Friday - 6:30am - 6:30pm Saturday and Sunday - Closed
Lease Term	10 years + 10 years + 10 years
Budgeted Gross Rent	$2,700 per child at 65 places = $175,500
Rent Reviews	Fixed 3%
Incentive	$860,000 plus Landlord Works
Landlord Works	Ceilings and lighting, ducted air conditioning and connection to water, waste and power including shopfront
Leasing Strategy	We have anticipated a childcare centre with a minimum placement of 65 children. The procurement strategy will be to undertake an Expression of Interest (EOI) campaign to Perth metro and southwest based childcare operators. Operators will be driven by the developer providing effectively a 'turnkey' solution and a rent free period in Year 1. We have estimated the turnkey incentive at $2,000/m2 based on the internal area. The level of incentive provided will factor into the rent payable by the operator. The minimum placement of 65 children will be required to attract a number of the larger childcare groups to consider this site at Provence Estate.
Design Strategy	An architect specialising in Childcare centre designs is recommended to be engaged that can provide the most efficient use of indoor and outdoor space to provide the highest yield of children placements. Another factor the architect will need to consider is the configuration of the drop off / pick up for the children. The ease of parents walking their children into the childcare centre has become a major factor Childcare operators look for when assessing new Childcare Centre sites. As outlined in our design guidelines the Childcare location can be set back in a secondary location that doesn't face the high street. As the rent is based on the number of childcare placements, the operators will not pay a higher rate to be located on the high street. Ideally the childcare centre should be located on the same side of the road as the supermarket to encourage parents to undertake their shopping either before or after they pick the children up from the childcare without them requiring to cross the road during peak hour.









4.0 CONTACT DETAILS

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ANNEXURE
FEE SUBMISSION

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YOLK PROPERTY GROUP

Provence Estate, Busselton

As at 01/07/2022

PLAN REF: Retail Precinct MASTER - 1-1000 (Op 2)

LEASE EQUITY

	LEQ Proposed			URBIS	Budgeted Base Rent		Variable Outgoings		Budgeted Gross Rent			LEQ Budgeted			URBIS COVID-19 Unaffected		
Shop	Target Tenant	Frontage M	Area /m2	Area /m2	/m2	PA	/m2	PA	/m2	PA	Leasing Incentive $AUD	MAT $AUD	MAT /m2	Occ. Cost Ratio	MAT $AUD	MAT /m2	Occ. Cost Ratio
Retail Precinct																	
SUPERMARKET	IGA	15.00	1,200.00	3,601.00	$ 200	$ 240,000	$ 50	$ 60,000	$ 250	$ 300,000	$ 1,000,000	$ 4,500,000	$ 3,750	6.7%	$ 47,512,000	$ 13,196	NA
2	Bakery / Café	7.50	100.00	79.00	$ 250	$ 25,000	$ 100	$ 10,000	$ 350	$ 35,000	$ 50,000	$ 450,000	$ 4,500	7.8%	$ 687,000	$ 8,668	12.8%
3	Takeaway F&B	5.50	70.00	66.00	$ 275	$ 19,250	$ 100	$ 7,000	$ 375	$ 26,250	$ 40,000	$ 350,000	$ 5,000	7.5%	$ 520,000	$ 7,848	15.3%
4	Takeaway F&B	5.50	70.00	66.00	$ 275	$ 19,250	$ 100	$ 7,000	$ 375	$ 26,250	$ 40,000	$ 350,000	$ 5,000	7.5%	$ 520,000	$ 7,848	15.3%
5	Medical Centre	15.00	215.00	190.00	$ 175	$ 37,625	$ 100	$ 21,500	$ 275	$ 59,125	$ 344,000	NA	NA	NA	NA	NA	NA
6	Pharmacy / News / Lotto / Aus Post	12.00	150.00	248.00	$ 400	$ 60,000	$ 100	$ 15,000	$ 500	$ 75,000	$ 100,000	$ 800,000	$ 5,333	9.4%	$ 2,239,000	$ 9,032	10.8%
7	Hair / Barber	6.00	60.00	63.00	$ 250	$ 15,000	$ 100	$ 6,000	$ 350	$ 21,000	$ 30,000	$ 200,000	$ 3,333	10.5%	$ 306,000	$ 4,874	22.1%
8	Nails / Beauty	6.00	60.00	64.00	$ 250	$ 15,000	$ 100	$ 6,000	$ 350	$ 21,000	$ 30,000	$ 200,000	$ 3,333	10.5%	$ 175,000	$ 2,753	36.6%
9	Liquor	13.00	140.00	159.00	$ 300	$ 42,000	$ 100	$ 14,000	$ 400	$ 56,000	$ 70,000	$ 800,000	$ 5,714	7.0%	$ 3,224,000	$ 20,268	4.2%
TAVERN / BAR (L)	Tavern / Bar	34.00	1,000.00	750.00	$ 150	$ 150,000	$ 100	$ 100,000	$ 250	$ 250,000	$ 1,200,000	$ 3,000,000	$ 3,000	8.3%	$ 3,553,000	$ 4,738	NA
CHILDCARE	Childcare Centre	21.00	430.00	853.00	$ 300	$ 132,500	$ 100	$ 43,000	$ 408	$ 175,500	$ 860,000	NA	NA	NA	NA	NA	NA
TOTAL/AVERAGE - Provence Estate, Busselton		118.00	3,180.00	5,870.00	$ 218	$ 693,000	$ 81	$ 258,000	$ 299	$ 951,000	$ 3,370,000	$ 10,650,000	$ 3,349	8.4%	$ 58,736,000	$ 62	16.7%
		Total	Total	Total	Average	Total	Average	Total	Average	Total	Total	Total	Total	Average	Total	Total	Average

Explanatory Notes

1) All figures are GST Exclusive

2) Areas are estimates only

3) (L) Refers to tenant requiring a licence

4) Gross Rent consists of Net Rent + VO's

5) Rental feasibility to be read in conjunction with strategy report

6) Assumed lease term, rental reviews outlined in strategy report

Assumptions

1) Outgoings are assumed at at $100/sqm. A full outgoings budget should be prepared. (Any increase in outgoings will result in proportionate reduction in rent)

2) All tenants are on Net leases except Supermarket (Semi-Gross)

3) MAT's are based upon Lease Equity assumed turnovers for this specific tenant

4) Tavern license to be approved and not to sell packaged liquor

5) There will be wayfinding signage around and near proximity to the building

6) Minimum tenant services / Landlord works outlined in strategy report

7) Medical, Childcare Centres to provide full turn key fitout as part of leasing incentive

8) Childcare Centre to have minium 65 children capacity - size of childcare centre to be based on having minimum 65 child capacity

9) The supermarket box will be built to operators specification for base works (IGA Design Guide Brief provided)

10) Liquor store to be operated by Supermarket operator

11) Landlord works provided in addition to incentives. Shopfronts to be provided by Landlord in addition to incentives.

12) All alfresco / licensed seating areas to be provided at no additional rent

13) Sufficient staff toilet facilities to be provided by Developer / Landlord for all tenants at development

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III
ANNEXURE
GAP ANALYSIS

DRAFT

Provence Estate, Busselton - High Street Gap Analysis

As at 27/06/2022	BALDIVIS SQUARE, BALDIVIS	BRIGHTON VILLAGE, BUTLER	VASSE VILLAGE CENTRE, VASSE	LAKESIDE PLAZA, BYFORD	HARVEST LAKES VILLAGE, ATWELL	WELLARD SQUARE, WELLARD
Size	**GLAR: 3,500m2**	**GLAR: 3,985m2**	**GLAR: 4,700m2**	**GLAR: 4,710m2**	**GLAR: 5,845m2**	**GLAR: 5,980m2**
	TENANT	**TENANT**	**TENANT**	**TENANT**	**TENANT**	**TENANT**
Supermarkets						
National Full Range Chain						
Coles		Coles	Coles			
Woolworths					Woolworths	Woolworths
Other Supermarkets						
IGA	IGA			IGA		
Aldi						
Bunbury Farmers Market			Bunbury Farmers Market (2023)			
Total Food Specialties						
Bakery/Cakes/Pastries						
Bakery	Yen's Bakery		Bakery			Bake My Day Bakery
Brumby's					Brumby's	
Liquor						
Cellarbrations	Cellarbrations					
Liquorland			Liquorland			
The Bottle-O				The Bottle-O		
BWS					BWS	BWS
Total Food Catering						
Takeaway Food						
Chain/Franchise Pad Site						
McDonalds			McDonalds			
Chain/Franchise						
Pizza Hut					Pizza Hut	
Subway						Subway
Burger/Diner food				HotChik		
Dessert/Snack/Patisserie	Take 5 Iceream Parlour					
Gelare					Gelare	
Middle Eastern						
Kebabs		DeDe Kebab & Pizza House	Mr Kebab			Kebab House
Chinese/Malaysian			Newton Chinese		Dancin Wok	My Noodle Rules
Thai						Aroy Thai
Indian				Tartan Spice		
Japanese/Sushi			The Origin153			
Fish and Chips	Fish and Chips	Chippy's Fish Café	Beach 2 Basket	The Glades Fish & Chips	Atwell Fish & Chips	
Pizza		OnFire Pizzeria				Pizza Parlour
Cafes						
Cafes			Magpie Coffee Café		Degani	Bliss MoMo's
Restaurants/Bars						
Bar / Tavern		The Cornerstone Ale House				The Well Tavern
Western						
Brother of Mine	Brother of Mine					
Italian						
Catalano & Co	Catalano & Co					
Pizzeria				Pizzeria		

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Provence Estate, Busselton - High Street Gap Analysis

As at 27/06/2022	BALDIVIS SQUARE, BALDIVIS	BRIGHTON VILLAGE, BUTLER	VASSE VILLAGE CENTRE, VASSE	LAKESIDE PLAZA, BYFORD	HARVEST LAKES VILLAGE, ATWELL	WELLARD SQUARE, WELLARD
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	TENANT	**TENANT**	**TENANT**	**TENANT**	**TENANT**	**TENANT**
Chinese/Malaysian						
Golden Dragon Tea House				Golden Dragon Tea House		
Harvest Lakes BBQ Chinese					Harvest Lakes BBQ Chinese	
Indian						
Swadesh Indian Restaurant	Swadesh Indian Restaurant					
Mobile Phones						
Accessories & Repairs			Mobile Genie			
General Retail						
Giftware						
Gifware		Dig, Design Inspired Gifts	Gypsea Collective			
Fabrics			Cotton Rose			
Florist/Pets/Toys/Msc						
Florist			Blush & Bloom			
			One Rustic Bloom Flowers & Gifts			
Misc						
Smoke Shop		Cloud 9 Smoke Shop				Smokemart & Giftbox
		Up In Smoke				
Pharmacy & Cosmetics						
Chemist						
Pharmacy	Pharmacy		Pharmacy		Pharmacy	Pharmacy
Discount Drug Store				Discount Drug Store		
Terry White Chemmart					Terry White Chemmart	
Cosmetics / Skin Care / Perfume		Cinnamon Skincare				
Retail Services						
Hairdressing / Beauty						
Volona & Associates					Volona & Associates	
Independent Hair Salon	Scissor Stone	Five for Hair	Cinco Hair Boutique			
		California Queens	Hair @ Vasse			
Barber	The Den, Hairazing Barber	The Barbershop			Barbers are Us	Barber Shop
		Rock Razor Sicssors				
Nails	Graceful Nails	Precision Nail Care	Nifty Nails & Eyelash	Babe'n Nails	Happy Nails	Missy Nails & Beauty
Spa/Skin			Renew Skin & Beauty			
Massage					Li's Chinese Massage	
Optometrist						
Optometrist/Eyewear						
Optometrist					Optometrist	
Total Leisure						
Newsagents & Stationary						
Newsagency						
Newsagency		Newsagency				
News & Lotto			News & Lotto			
Gifts & News					Gifts & News	Gift & News
Other Reporting Categories						

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Provence Estate, Busselton - High Street Gap Analysis

As at 27/06/2022	BALDIVIS SQUARE, BALDIVIS	BRIGHTON VILLAGE, BUTLER	VASSE VILLAGE CENTRE, VASSE	LAKESIDE PLAZA, BYFORD	HARVEST LAKES VILLAGE, ATWELL	WELLARD SQUARE, WELLARD
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	TENANT	**TENANT**	**TENANT**	**TENANT**	**TENANT**	**TENANT**
Other Reporting (incl Pad Sites)						
Recruitment/ Real Estate Services						
Real Estate Services		Professionals Real Estate	Hanson Property Group		Harcourts Regal Gateway	
Healthcare Services						
Pathology	Clinipath Pathology			Western Diagnostic Pathology		Clinipath Pathology
Psychologist			Psychologist			
Physiotherapist			Physiotherapist		Physiotherapist	
Medical Services						
Medical Centre	Medical Centre		Duchess Medical Centre	Jupiter Health	Medical Centre	Family Practice
Dental	QVC Dental		Dental			Dental
Vet		Vet		Best Friends' Family		
Childcare						
Bimbi Early Learning Centre	Bimbi Early Learning Centre					
3 Little Kids Early Learning Centre		3 Little Kids Early Learning Centre				
Little People's Place			Little People's Place			
Jumping Jacks Play Centre				Jumping Jacks Play Centre		
Buggles Childcare					Buggles Childcare	
Busy Bees						Busy Bees
Allied Health						
Psychologist			Psychology			
Physiotherapist			Physiotherapist	Back in Motion		
Podiatrist			Podiatrist		Podiatrist	
Chiropractor						Chiropractor
Gym / Fitness						
Yoga / Pilates	Best Body					
Gym		XO Fit				
Petrol						
Shell Coles Express			Shell Coles Express			
Other						
Complete Approvals				Complete Approvals		
Non-Reporting						
Government Office	Reece Whitby MLA					
Accountant			Capital Q Business Advisors and Chartered Accountants			
Banks						
Bankwest		Bankwest				

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IV
ANNEXURE
IGA DESIGN BRIEF

DRAFT

RETAIL
DEVELOPMENT



NATIONAL SUPERMARKET DESIGN BRIEF 2020

DRAFT

Project:
Issue to:
Date:

Release Date: 01/05/2020
Revision: 004

CONTENTS

1 GENERAL INSTRUCTIONS

LANDLORD'S ARCHITECTS/CONSULTANTS

2 BUILDING DESIGN

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3 SERVICES DESIGN

3.3.1.1 General……..44
3.3.1.2 Luminaires……44
3.3.1.3 Emergency Lights and Exit Signs……..45

……

DRAFT

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"As Built" Documents

4 MECHANICAL DESIGN BRIEF

DRAFT

5 SCHEDULE OF FINISHES GUIDE

FLOORING cont'd…

1.1 INTRODUCTION

/Developer as a guide to the Tenant's requirements relating to
's W

Tenant's fitout can commence, defined as Handover in 1.2.11.

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Lease as the 'Fitout Plan'

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1.2 TERMS OF REFERENCE

's consultants to prepare working drawings for construction
(this document is referred to in the Agreement for Lease as the 'Fitout Plan')

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- the Landlord's Works are complete so that the Centre is reasonably capable of
-
-

issued for the Landlord's Works.

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- the Landlord's Works are completed, except for those Landlord's Works which cannot
tion, of the Tenant's Works;
- the Tenant's Works can proceed without interruption or interference from the Landlord;
-
-
-

enable the delivery of Tenant's refrigeration equipment and

1.3 AUTHORITIES AND PERMITS

1.4 LANDLORD'S ARCHITECTS/CONSULTANTS

document the Landlord Works and ensure the Tenant's requirements are accurately

Tenant's requirements are met and shall inc

1.5 DOCUMENTS

DRAFT

Landlord's consultant team.

's contractor to provide proper installation and operation of

’s receipt of the Building Approval and other necessary approvals

proceed with building work prior to the issuing of the Tenant’s approval

ernal layout of the store is critical to the store’s

nd the Tenant’s premises.

’s responsibility to en

’s neglect or omission of any items outlined

the Landlord’s obligations as detail

DRAFT

1.6 VARIATIONS

’s s

builder’s
’

1.7 BUILDING VARIABLES

Tenant's drawings do not indicate topographical conditions, sub surface conditions

1.8 EXISTING BUILDINGS - SURVEY

DRAFT

Nominate on plan the floor RL's in the following locations

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-

e final survey to the Tenant on “AutoCAD ” DWG

1.9 AS BUILT WORKING DRAWINGS & SERVICE MAINTENANCE MANUALS

of “ ” Drawings

format on 3 USB’s each with all drawings

“As B ”

1.10 REGULATIONS AND PERMITS

’s responsibility to ensure that all

fails to include Tenant’s

’s Consultants as required. Should any authority

’s cost

1.11 CERTIFICATION

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1.12 WARRANTIES AND GUARANTEES

’s consultants will ins

‘Services’ on site with Tenant

1.13 DEFECTS LIABILITY PERIOD

’s

’s

’s Contracto

is to receive a certificate from the Landlord’s Consultants that all defects and omissions to

1.14 SECURITY

1.15 INSURANCES

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1.16 SAFETY

1.17 OPERATING AND MAINTENANCE MANUALS

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1.18 BUILDING PROGRAMME

ordinate with the Tenant's sub s via the Tenant's

1.19 COMPLETION SCHEDULE

The programming of the stages of the project is very closely allied with the Tenant's store

DRAFT

No of weeks prior to Handover	Stage Completed

1.20 HANDOVER

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-
-

1.21 TENANT ACCESS

Tenant and /or Tenant's

's responsibilities or liabilities.

and it's contractors will require access to carry out certain

,

DRAFT

1.22 OPENING WEEK

1.23 MATERIALS

1.24 BROKEN GLASS

ss forming part of the Tenant's Works) except glass which is broken by the Tenant's nominated subcontractors. This glass broken by the Tenant or the Tenant's nominated subcontractors will be replaced by the Landlord's contractor at the Tenant's cost, subject to the Tenant's prior acceptance of the Landlord's cost for the work.

1.25 SITE CLEANLINESS (Prior to Handover)

manufacturer's instructions

-
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-

with a "scrubber" to clean finish throughout. Then apply two coats of polish.

-

's cleaning specification.

Tenant or it's Representative

DRAFT

1.26 LANDLORD WORKS

2 BUILDING DESIGN

2.1 INTRODUCTION

2.2 ENVIRONMENTAL MANAGEMENT PLAN

State's Environmental Management System Guidelines and is valid at the time of

2.3 SECURE BUILDING PERIMETER

2.4 BUILDING DESIGN CRITERIA

DRAFT

2.5 CONSTRUCTION PARAMETERS

’s Control Plan

sufficiently insulated from moisture arising from the Tenant’s refrigeration installation. The

ordinated with the Tennant’s store design to avoid any conflict

DRAFT

’s responsibility to ensure these works are carried out in

’s

▪

1200 x 600 nom. exposed grid suspended ceiling system (‘Rondo’ or equivalent)

1200 x 600 nom. exposed grid suspended ceiling system (‘Rondo’ or equivalent)

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Location	Live Load

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reticulation and GIT's

"Laminex" Multipurpose

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2.6 SITE WORKS

2.7 CAR PARK

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- “ ”
  n close proximity to the “store” to ensure that
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  level as the “store”.
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- ings and safety rails as required to minimise “runaway” trolleys.
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2.8 HARDSTAND, MANOEUVRING & RECEIVING AREAS

’s responsibility to design the centre in such a way as to provide adequate

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-
-

-

A code compliant ‘Lift Table”

2.9 VERTICAL TRANSPORT AND GOODS HANDLING

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-
-
- to discharge in close proximity to and within sight of the Tenant’s
-
-
-

DRAFT

building configuration and the location of the major anchor Tenant. The “store” entry must

, the size and type is to meet the requirements of the “store” and relevant

serviced with a single “Tieman” 710 dock leveller or equal.

2.10 METAL WORK

Tenant’s

level of the plant room to the underside of the deck’s support structure (

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HDG = Hot Dipped Galvanised

the following as nominated on the Tenant's fitout

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level as determined by the tenants'

Tenant's

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-
-

The Tenant will provide the following stainless steel items as nominated on the Tenant's

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-

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2.11 GLAZING

depending on the orientation. The Landlord's

Where a "store" entry is exposed to extreme weather conditions, air locks or similar provided. The Landlord's architect must ensure that

2.12 CARPENTER & JOINER

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2.13 DOORS

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external “d” handle.

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2.14 SIGNAGE BY LANDLORD

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2.15 REFRIGERATION

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the Tenant's

Store Size	Max. Refrigeration Load	Sub-Mains Size

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2.16 PLANT ROOM

2.17 TENANT FITOUT

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Tenant's equipment to heat by Tenant's Refrigeration

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2.18 FINISHES

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manufacturer’s

manufacturer’s

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3 SERVICES DESIGN

3.1 INTRODUCTION

3.2 ELECTRICAL

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- circuits protected by RCD's
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- data outlets as nominated on Tenant's fitout documentation
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- Services manuals including "As Built" drawings,
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Consumer’s

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and RSD’s and auto

the manufacturer's requirements.

Supply and install dedicated UPS to data cabinet dedicated to the data cabinet

DRAFT

to Tenant's

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-

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DRAFT

Light switches and SO's to food preparation areas shall be waterproof and compliant
t codes. All wall mounted SO's will be

or labelled 'clean'

connections to the locations indicated on Landlord's Electrical drawings. E

All circuit schedules and outlets are to be clearly labelled prior to hand-over. Outlets are to be provided with engraved labels.

GPO's shall be "Classic Style Outlets", flush mounted wherever practicable or otherwise

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Description	Requirement
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be fitted with RCD's

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3.3 LIGHTING

Area	Type of Fitting	Maintained Lux Level	Preferred Luminaire Manufacturer

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Tenant’s

the Tenant’s refrigeration contractor

"Track" or similar channel.

Tenant's fit

(⅓)

DRAFT

Emergency and exit light fittings must be installed such that the LED's

WARNING
INTERRUPTING SUPPLY WILL DISCHARGE
EMERGENCY LIGHTING BATTERIES

,

It is recommended that the emergency and exit lighting be of “Clevertronic” and that the fittings are complete with ‘Clevertest’ facility. The contractor shall supply the Clevertest app

’s

’s electrical contractor shall check the entire installation prior to the

DO NOT TURN OFF.

DRAFT

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Install a 20 pair voice graded “Tie Cab e” between MDF and Comms Cabinet for

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- Manager’s Office
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- / Storeman’s

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3.4 HYDRAULICS

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Tenant’s approval must be obtained. Acceptance of the Landlord’s documentation will

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e documentation is to be provided (in an AutoCAD “dwg” and

The Landlord's installing contractor

The below floor sewer drainage system is to gravitate to the Local Sewage Authority's

Unless otherwise approved all in ground Sewer Drainage pipe material shall be 'DWV'

Refrigerated cabinets' con

surface water and must be installed to comply with the Local Stormwater Authority's

relieving configurations which represent no threat to the Tenant's

DRAFT

The below floor drainage system is to gravitate to the Stormwater Authority's system.

shopping trolleys nor cause inconvenience to the Tenant's customers. The gravity

DRAFT

shall be "Thermotec 4 Zero" low temperature pipe insulation or approved equal with

acturer's

manufacturer's requirements. Where possible fixtures and tapware shall be Australian

's contractor.

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or similar to “Thermotec WZ” with zinc anneal metal sheathing protection.

‘hot’ or ‘cold’.

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ITEM	DUTY

“4 ero” and be 25mm thick.

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ITEM	TEMPERATURE

ITEM	STORAGE / PEAK

Water boiler within staff room shall be Zip Hydroboil” model HB003F

Serviced Prep Areas

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Staff Areas

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shall provide & connect cold water (inc. vacuum breaker's & check valves

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Prep Areas

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Staff Amenities/ Restroom

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Staff Room Sink

-

Cleaners Sink

-

Wash Down Hoses

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Amenities

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Staff Room

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Fresh Produce, Meat, Deli and Chicken Preparation Rooms

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3.5 FIRE PROTECTION

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- Portable hand extinguishers at the Landlord’s main electrical and mechanical switchboards and the Tenant’s main electrical switchbo
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DRAFT

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- Light wall steel pipe (“Fire Plus”) and CPVC pipe and fittings shall not be used
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- Will be provided to monitor pressure at town's main inlet, Fire Authority booster
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- Pressure will display in 'kPa' at 50kPa intervals.
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manufacturers' requirements.

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The capacity of the pump sets shall comply with the “Systems Demand” section of the

LOCATION	HEAD TYPE / FINISH

DRAFT

panel unless a stand alone panel is required as part of the “store” Fitout.

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The year of installation, installer’s and maintenance contractor’s contact details.

“As Built” Documents

manufacturers’

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3.6 MECHANICAL SERVICES

ection 4 ‘Mechanical Design Brief’ contained in this docu

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All plant, equipment and systems installed shall comply with section 4 of this document.

4 MECHANICAL DESIGN BRIEF

4.1 GENERAL REQUIREMENTS

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- The preparation of ‘As Built’ drawings covering all installed plant, equipment and
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petent trade's

accordance with manufacturer's recommendations and requirements.

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The contractor shall provide 'As Installed' documentation at the completion of the works. 'As Installed' documentation shall include duct and electrical layouts, equipment

two CD's provided to the owner and engineer. Additionally, site co

All systems / units shall be covered by a Contractor's / Manufacturer's warranty,

the Tenant's

DRAFT

4.2 SYSTEM DESIGN

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Condition	Requirement

Heat Load Source	Retail Floor	Lunch Room	Offices

Area	Level

Unit	Retail Floor	Lunch Room	Offices

Cabinet Type	Load

Item	Application	Rate
	Cleaner's Room	
	'cold aisle'.	

Parameter	Selection Point

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Weather station shall be provided to provide outdoor conditions.

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(if open fronted cabinets)

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The design consultant shall confirm all hood sizes and height above the FFL with Tenant prior to construction.

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Area	**Rate**
Staff Member's Toilets	
	noise levels shall be the Landlord's

4.3 EQUIPMENT

’s

’s electricity supply and shall not supplement the of the building’s common areas.

The large AHU’s shall be fitted wi

DRAFT

Alternative: Built up Type Plant:

Alternative: Packaged Type Plant:

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Alternative Design:

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Tenant's

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  -
    ‘Cush Clamps’ at no more than 2.4 metre spacing.
  -
  - strut ‘Cush Clamps’ or other as
  -
    ‘Cush Clamps’ or other as approved.
-
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-
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-
- ‘see all’ or ‘see thru’ solder connection liquid line sight glasses or other
- ‘catch all’ filter driers shall be used noting that any liquid line size over ¾” in size shall use demountable multi
-
-

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4.4 ELECTRICAL

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- All wiring associated with VSD's shall be run in shielded cable.
- **Joints or joining of cables shall not be permitted**
- be in strict accordance with the cable manufacturer's recommendations
- correspond with the identification detailed on the "AS Built" drawings.

4.5 TESTING, COMMISSIONING, MAINTENANCE & SERVICE

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4.4.4 Control Methodology

Plant	Qty	Stages	Control Device	Device Location	Hours of Operation	Dependency	Set point ºC / RH	Comments
Main Trading Floor Plant								

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5 SCHEDULE OF FINISHES GUIDE

5.1 FLOORING

This section provides a list of typical finishes supplied by the Landlord for all areas, and establishes a benchmark for the project. The Tenant may not select some or all of these finishes. Refer to the site specific Tenant supplied drawings for the required finishes for individual projects.

SECTION / ITEM	DESCRIPTION / SUPPLIER	COLOUR / COMMENTS
VINYL TILE – 300 x 300mm – 3mm THICK		
	–	
	–	
	–	
	–	
	–	
	–	
	–	
	–	
SLIP RESISTANT – VINYL SHEETING – 2mm THICK		
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	–	
	–	
	–	
RESIN BASED FLOOR SCREED		
	–	

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5.1 FLOORING *cont'd…*

	–	
	–	
SEALED CONCRETE		
	–	

DRAFT

5.2 SKIRTING AND COVING

SECTION / ITEM	DESCRIPTION / SUPPLIER	COLOUR / COMMENTS
VINYL SHEETING – 2mm THICK		
	– –	
VINYL SKIRTING – FEATHER EDGE 100mm		
	– –	
75mm SEALED CONCRETE COVING – ARROW HEAD		

FLOORING NOTES:

-
-
-
-
-
- ctor to confirm direction of vinyl tile grain prior to laying- refer to tenant Floor Finishes Plan.

5.3 WALLS + BULKHEADS

SECTION / ITEM	DESCRIPTION / SUPPLIER	COLOUR / COMMENTS
PAINT		
		's architect to specify
	– –	
	– –	
TILES		
		–
TILING NOTE: **Silicon to all tiled internal corners** **Epoxy grout to all tiles in preparation areas and staff dining room splash backs**		
OTHER		
	– –	

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5.4 CEILINGS

SECTION / ITEM	DESCRIPTION / SUPPLIER	COLOUR / COMMENTS
PAINT		
	–	
	–	
COOLROOM PANEL		
	–	
	–	
OTHER		

5.5 JOINERY (LANDLORD WORKS)

SECTION / ITEM	DESCRIPTION / SUPPLIER	COLOUR / COMMENTS
All specified joinery finishes	**or equivalent**	**or as selected**

5.6 OTHER (LANDLORD WORKS)

SECTION / ITEM	DESCRIPTION / SUPPLIER	COLOUR / COMMENTS
	– –	
	–	
	–	

END OF DOCUMENT

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ANNEXURE A

RETAIL
DEVELOPMENT

REVISIONS		
No:	**DESCRIPTION**	**ISSUE DATE**

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RETAIL
DEVELOPMENT

ANNEXURE B

PROJECT SPECIFIC DEPARTURES LIST

TYPE NAME OF PROJECT

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PROJECT DEPARTURES		
No:	**SECTION** *Eg. Item 5.1 Liquor not applicable to this project*	**PAGE** *80*

DRAFT

PROVENCE ESTATE, BUSSELTON

LOCATION IQ

CONTENTS

1 LOCATION & PROPOSED DEVELOPMENT 3

2 TRADE AREA ANALYSIS 12

3 COMPETITIVE ENVIRONMENT 30

4 COMPARABLE DEVELOPMENTS 34

5 FLOORSPACE POTENTIAL ASSESSMENT 40

6 TOTAL CENTRE POTENTIAL 72

INTRODUCTION

six (6) sections

- **Section 1**
- **Section 2**
- **Section 3**
- **Section 4**
- **Section 5**
- **Section 6**

1 LOCATION & PROPOSED DEVELOPMENT

1.1. Regional & Local Context

Busselton sits at the top end of the famous wine region of Margaret River – it's only 23 minutes' drive to Dunsborough, or 42 minutes' drive to Margaret River township, with cellar doors, restaurants and vineyards dotted along the way. Busselton is a place that's on the move with artisanal food, produce and craft destination."

Destination Busselton

–

Busselton’s

- **Busselton Foreshore Redevelopment (in progress):**

- **Busselton Performing Arts and Convention Centre (in progress):**

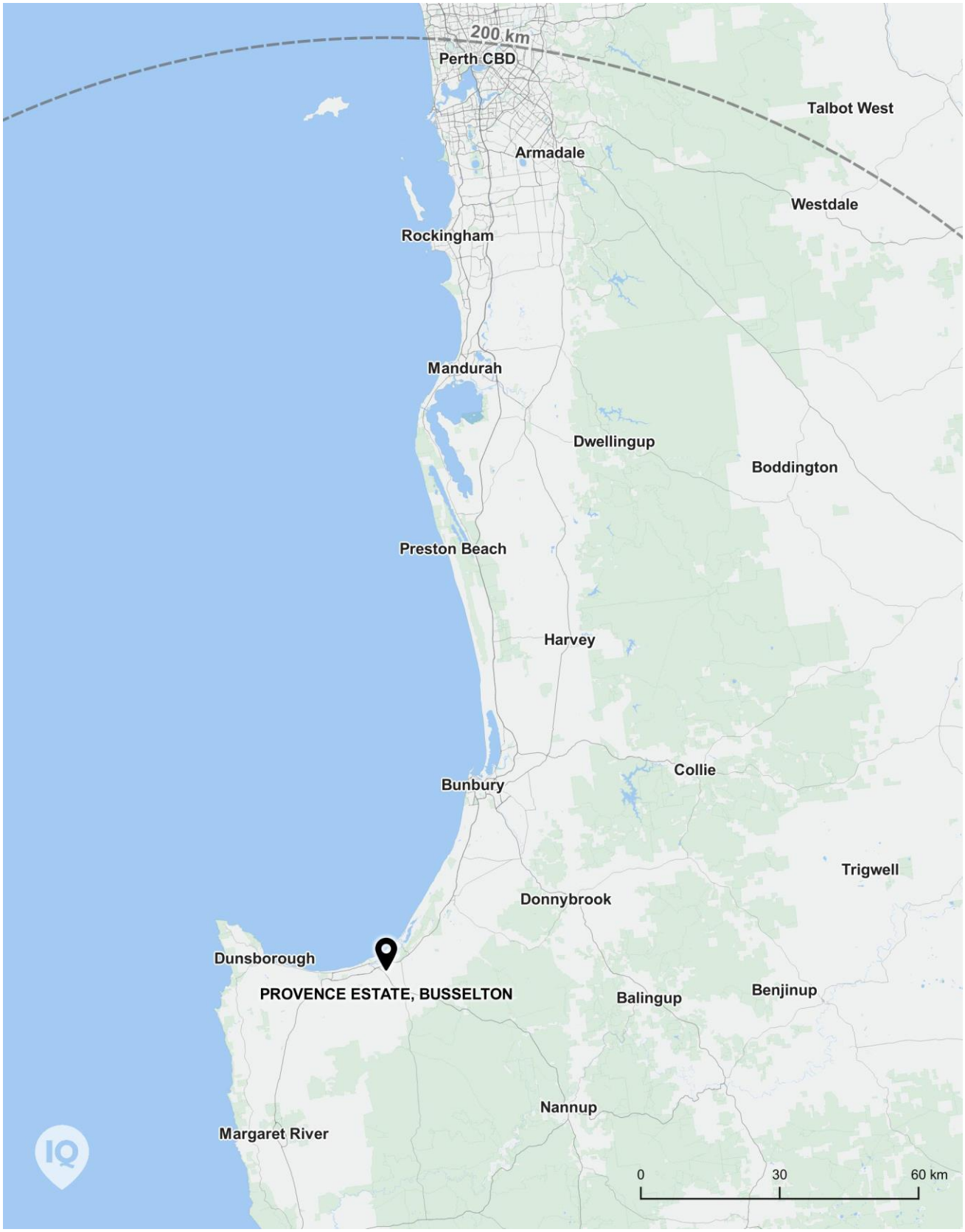
- **Busselton Margaret River Airport Upgrades (in progress):**

new

- **Road Network Upgrades (in progress):**

–

MAP 1.1. REGIONAL CONTEXT



MAP 1.2. LOCAL CONTEXT



FIGURE 1.1. BUSSELTON OUTER BYPASS (BOB) – PRELIMINARY ALIGNMENT

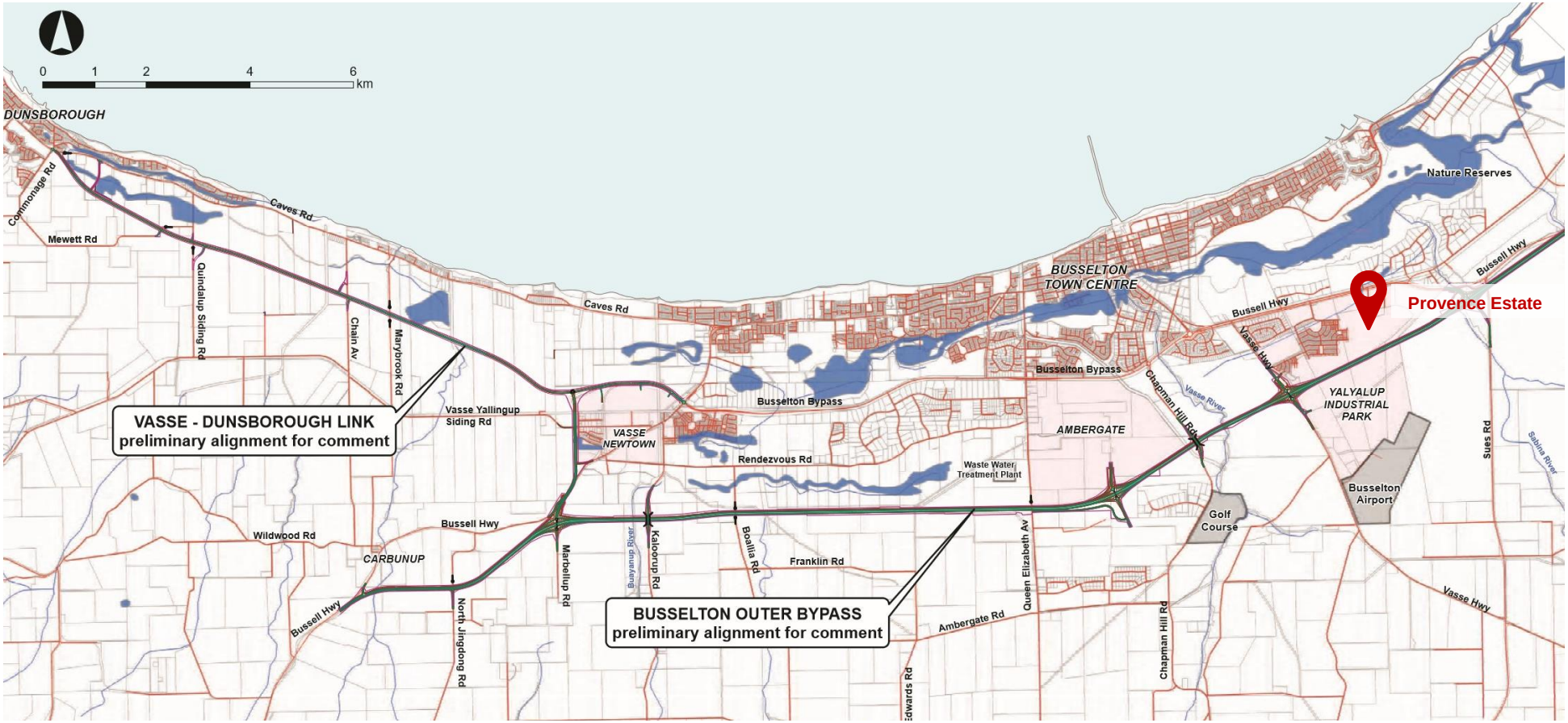
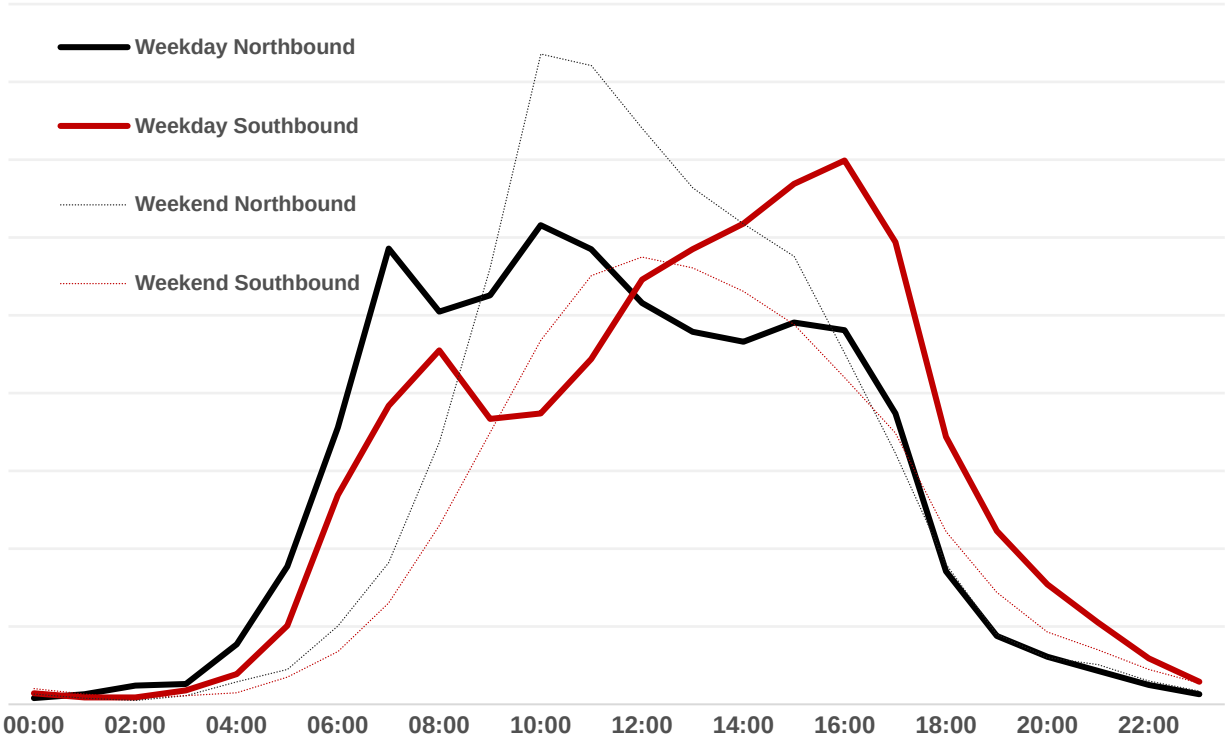


CHART 1.1. HOURLY TRAFFIC VOLUMES (BUSSELL HIGHWAY NORTH OF VASSE HIGHWAY)



Source: Main Roads WA (2022)

1.2. Proposed Development

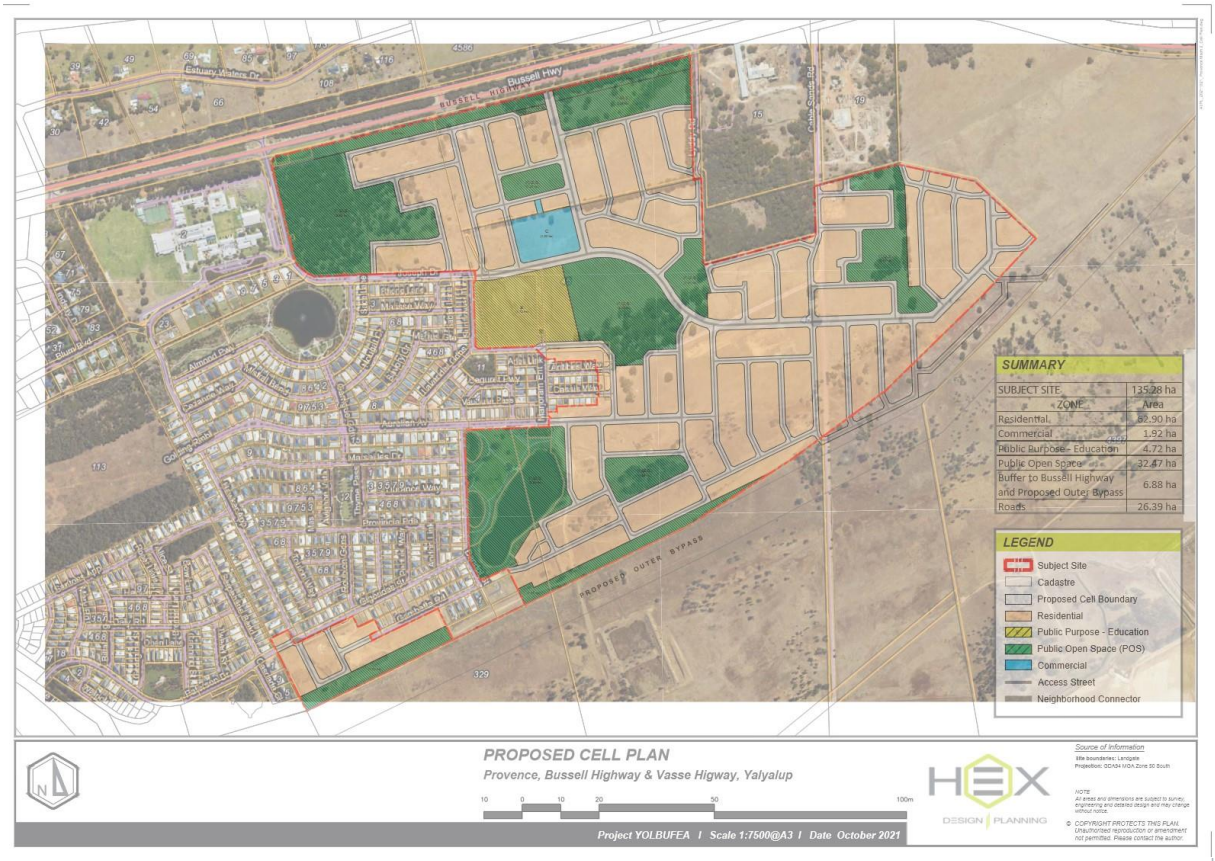
- **Previous Stages (Satterley):**
- **Current/Future Stages (Yolk):**
- **Retirement Living:**
- **Future Stages (other):**

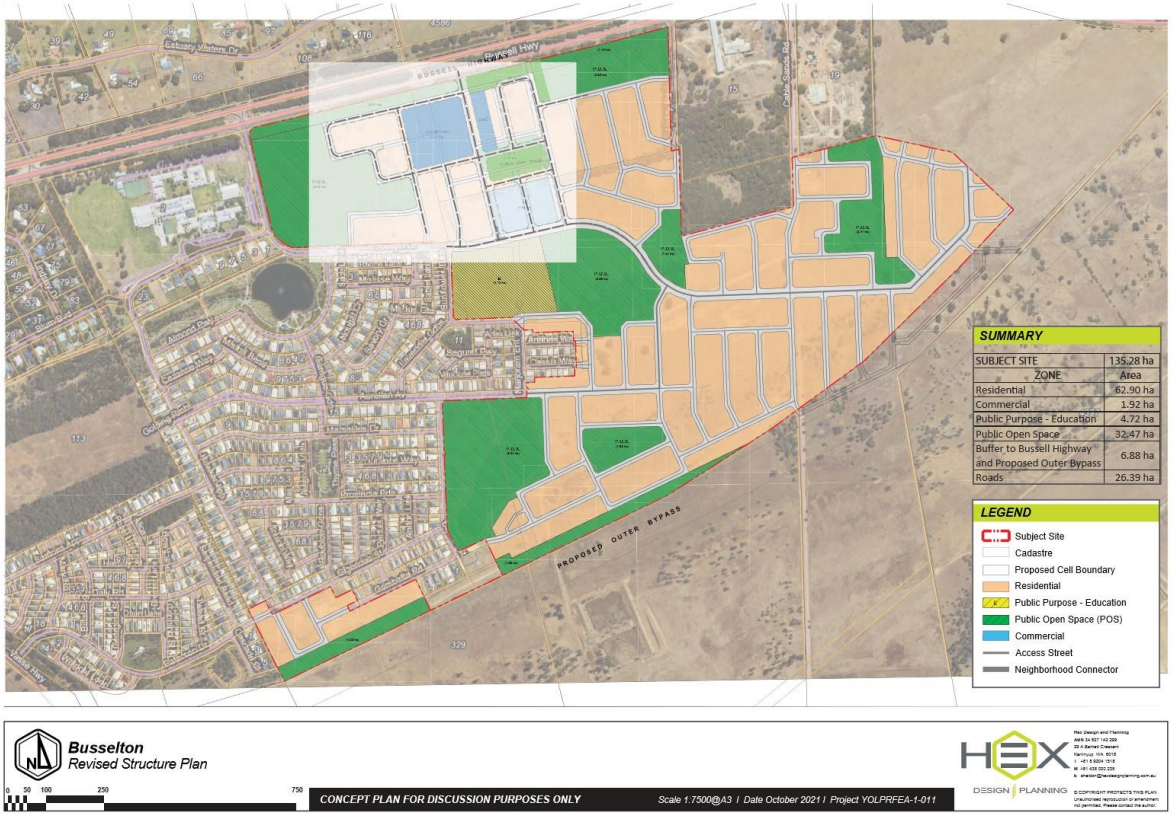
Centre would be provided in traditional ‘town centre’ format across both sides of a ‘main street’ –

located on either side of (and with frontages to) the ‘main street’.

‘main street’ (but not Bussell Highway), as

FIGURE 1.2. PROVENCE ESTATE MASTERPLAN & PROPOSED AMENDMENT





2 TRADE AREA ANALYSIS

2.1. Trade Area Definition

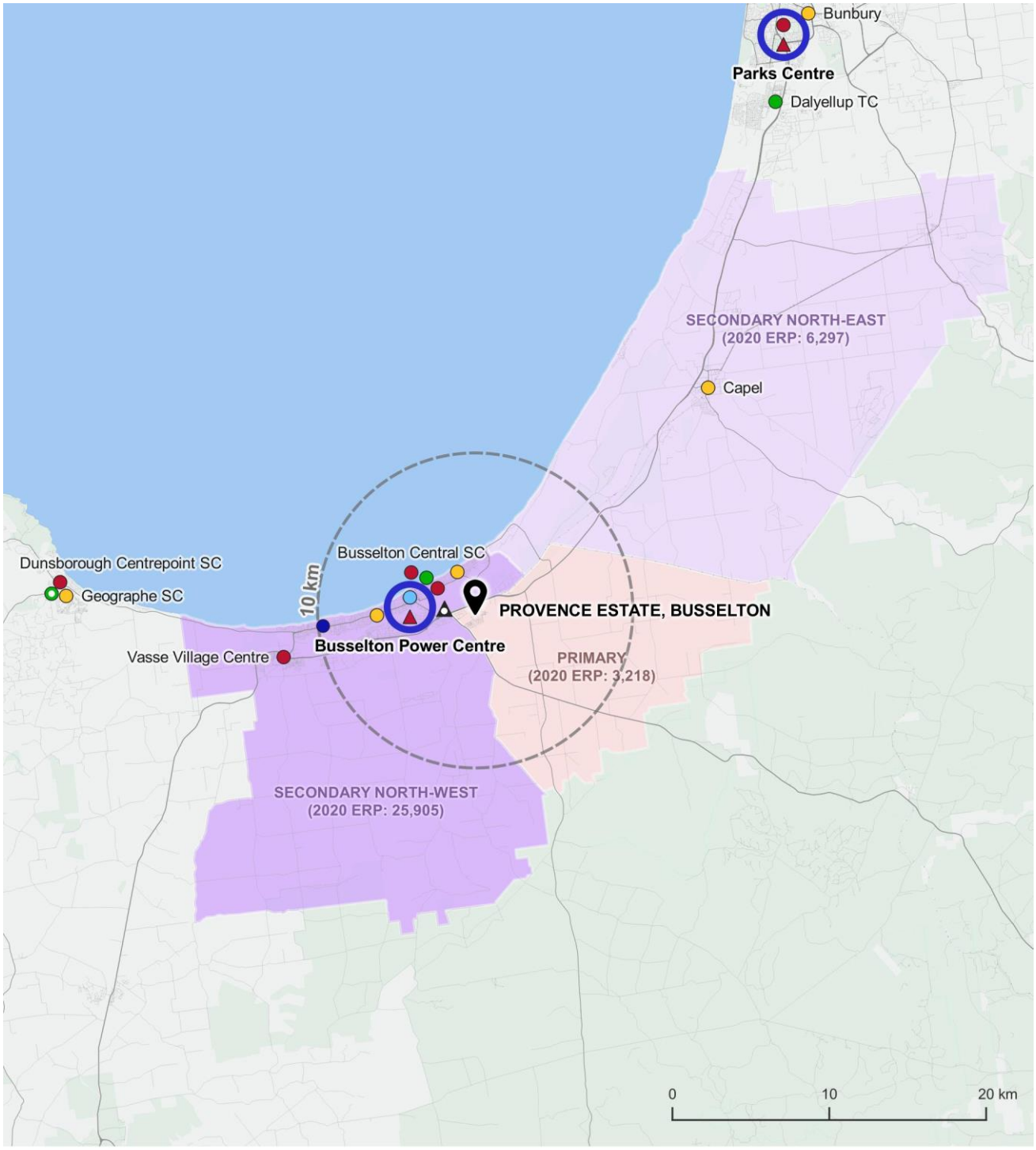
-
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- **primary sector**

- **secondary north-east sector**

- **secondary north-west sector**

MAP 2.1. PROVENCE MAIN TRADE AREA & COMPETITION



** White dot indicates proposed store*

2.2. Trade Area Population

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“The forecasts represent the best estimate of future population size if trends in fertility, mortality and migration continue. The WA Tomorrow trend forecasts are distinct from government strategies, frameworks and scenarios which are generally longer term in their outlook and seek to guide future growth to deliver desired patterns of urban form. For the user who requires only one forecast, Band C should be used”

Primary Sector

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Secondary North-west Sector

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TABLE 2.1. MAIN TRADE AREA POPULATION, 2011 – 2041

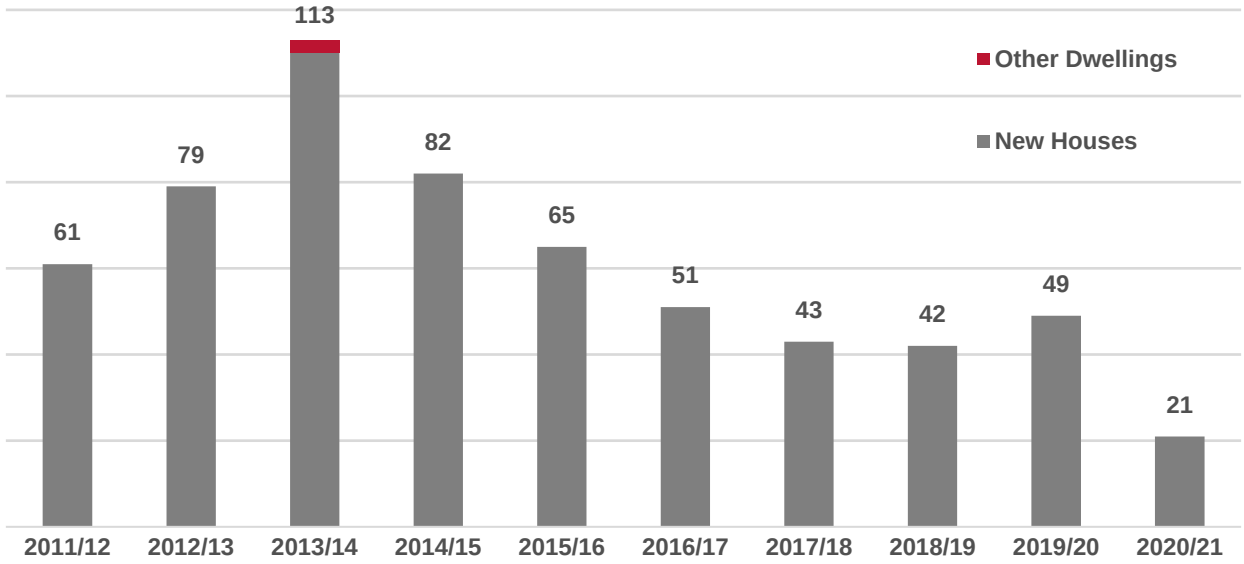
Population	Actual 2011	Actual 2016	Forecast 2021	Forecast 2026	Forecast 2031	Forecast 2036	Forecast 2041
Secondary Sectors							
• North-east							
• North-west							
Main Trade Area	**28,650**	**33,820**	**36,920**	**40,920**	**45,170**	**48,296**	**50,170**

Average Annual Change (No.)	Actual 2011-16	Forecast 2016-21	Forecast 2021-26	Forecast 2026-31	Forecast 2031-36	Forecast 2036-41
Secondary Sectors						
• North-east						
• North-west						
Main Trade Area	**1,034**	**620**	**800**	**850**	**625**	**375**

Average Annual Change (%)	Actual 2011-16	Forecast 2016-21	Forecast 2021-26	Forecast 2026-31	Forecast 2031-36	Forecast 2036-41
Secondary Sectors						
• North-east						
• North-west						
Main Trade Area	**3.4%**	**1.8%**	**2.1%**	**2.0%**	**1.3%**	**0.8%**
Non Metro WA	*0.8%*	*-0.4%*	*0.6%*	*0.7%*	*0.7%*	*0.7%*
Australian Average	*1.7%*	*1.4%*	*1.3%*	*1.3%*	*1.2%*	*1.1%*

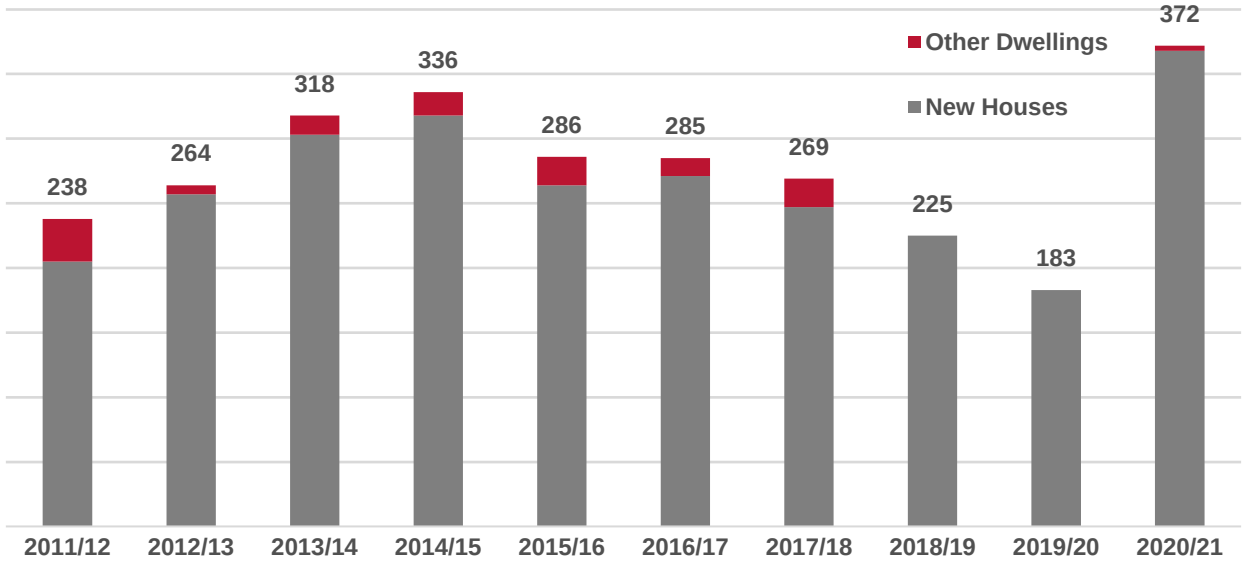
All figures as at June and based on 2016 SA1 boundary definition.
Sources : ABS; WA Tomorrow

CHART 2.1. PRIMARY SECTOR NEW DWELLING APPROVALS, 2011/12 – 2020/21



Source: ABS

CHART 2.2. SECONDARY SECTORS NEW DWELLING APPROVALS, 2011/12 – 2020/21



Source: ABS

MAP 2.2. RESIDENTIAL ESTATES

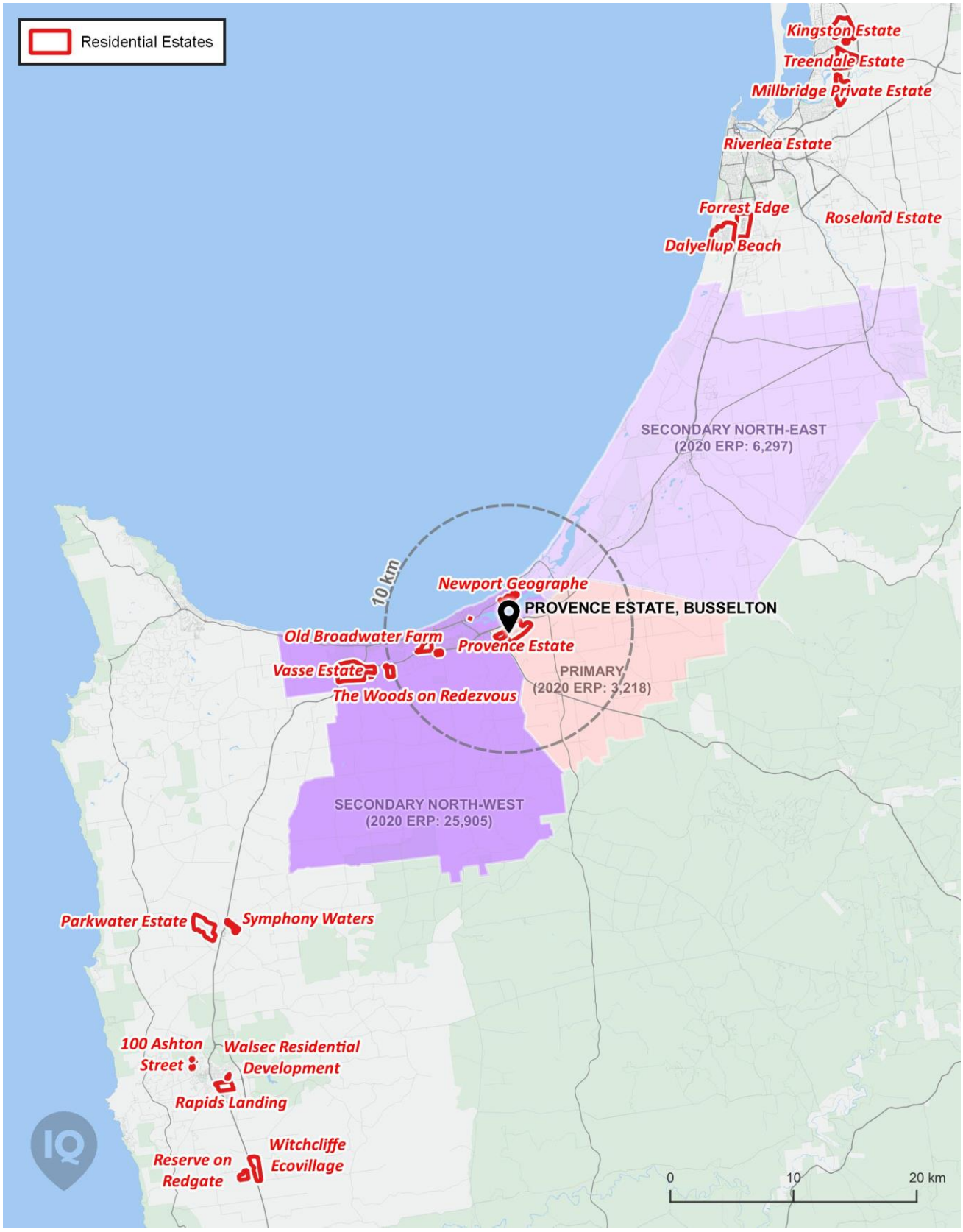


TABLE 2.2. MAIN TRADE AREA RESIDENTIAL ESTATES

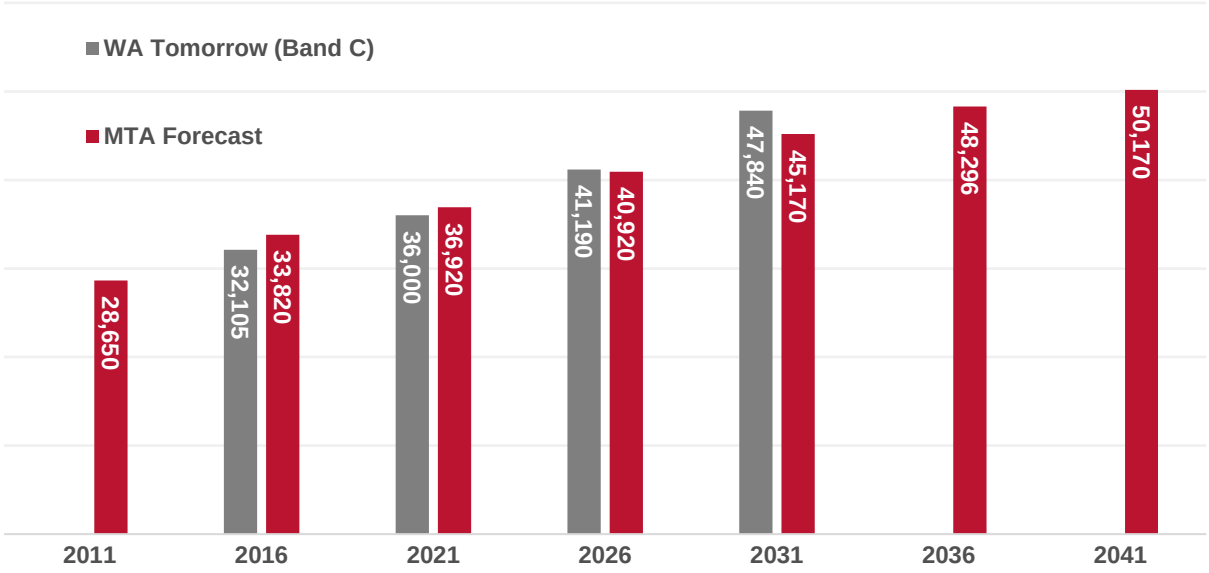
Estate/Development	Trade Area Sector	Total Yield	First Homes	Completion	To FY2021	Remaining	Financial Year																	
Dwellings							*Dwellings per year*																	
Primary Sector																								
Provence Estate	**Primary**	**2,140**	**Pre-2009**	**2033**	**725**	**1,415**	**20**	**60**	**60**	**60**	**110**	**110**	**110**	**110**	**110**	**60**	**100**	**100**	**100**	**100**	**40**	**40**	**40**	**40**	**40**	**40**
- Previous Stages (Satterley)		*725*	*Pre-2009*	*2021*	*725*	*0*																			
- Current/Future Stages (Yolk)		*790*	*2022*	*2033*	*0*	*790*	*20*	*60*	*60*	*60*	*60*	*60*	*60*	*60*	*60*	*60*	*60*	*60*	*60*	*60*						
- Provence Retirement Living		*225*	*2026*	*2030*	*0*	*225*	*-*	*-*	*-*	*-*	*50*	*50*	*50*	*50*	*50*	*-*	*-*	*-*								
- Future Stages (Other)		*400*	*2022*	*2033*	*0*	*400*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*40*	*40*	*40*	*40*	*40*	*40*	*40*	*40*	*40*	*40*
Total Primary							**20**	**60**	**85**	**85**	**135**	**135**	**135**	**135**	**110**	**60**	**100**	**120**	**120**	**120**	**60**	**60**	**60**	**60**	**60**	**60**
Secondary North-west Sector																										
Total Secondary North-West							**149**	**162**	**181**	**172**	**160**	**160**	**160**	**160**	**160**	**160**	**125**	**75**	**75**	**75**	**75**	**75**	**53**	**50**	**50**	**50**
Residents							*Persons per year*																	
Primary Sector																								
Provence Estate							**56**	**168**	**168**	**168**	**258**	**258**	**258**	**258**	**258**	**168**	**280**	**280**	**280**	**280**	**112**	**112**	**112**	**112**	**112**	**112**
- Previous Stages (Satterley)							*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
- Current/Future Stages (Yolk)							*56*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*168*	*-*	*-*	*-*	*-*	*-*	*-*
- Provence Retirement Living							*-*	*-*	*-*	*-*	*90*	*90*	*90*	*90*	*90*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*
- Future Stages (Other)							*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*-*	*112*	*112*	*112*	*112*	*112*	*112*	*112*	*112*	*112*	*112*
Total Primary							**56**	**168**	**238**	**238**	**328**	**328**	**328**	**328**	**258**	**168**	**280**	**336**	**336**	**336**	**168**	**168**	**168**	**168**	**168**	**168**
Secondary North-west Sector																										
Total Secondary North-West							**417**	**454**	**507**	**482**	**448**	**448**	**448**	**448**	**448**	**448**	**350**	**210**	**210**	**210**	**210**	**210**	**148**	**140**	**140**	**140**

**Assuming 2.8 persons per dwelling*

*** Long term assumed land infill development*

**** Long term development assumed within Bovell &Ambergate*

CHART 2.3. MTA POPULATION FORECAST VS. WA TOMORROW (BAND C)



Source: Location IQ, WA Tomorrow

2.3. Socio-economic Profile

-
-
-

TABLE 2.3. TRADE AREA SOCIO-ECONOMIC PROFILE, 2016 CENSUS

Characteristic	Primary Sector	Secondary Sectors		Main TA	Non Metro WA Average	Aust Average
		North-east	North-west			
Income Levels						
Age Distribution (% of Pop'n)						
Housing Status (% of H'holds)						
Birthplace (% of Pop'n)						
•						
•						
•						
Family Type (% of Pop'n)						

Sources: ABS Census of Population and Housing 2016

TABLE 2.4. MAIN TRADE AREA SOCIO-ECONOMIC PROFILE COMPARISON

Characteristic	Provence Estate MTA			Non Metro WA		
	2011	2016	Change (%)	2011	2016	Change (%)
Income Levels						
Age						
Birthplace (% of Pop'n)						
Household Size & Structure						
Housing Status (% of H'holds)						
Labour Force (%of Pop'n)						

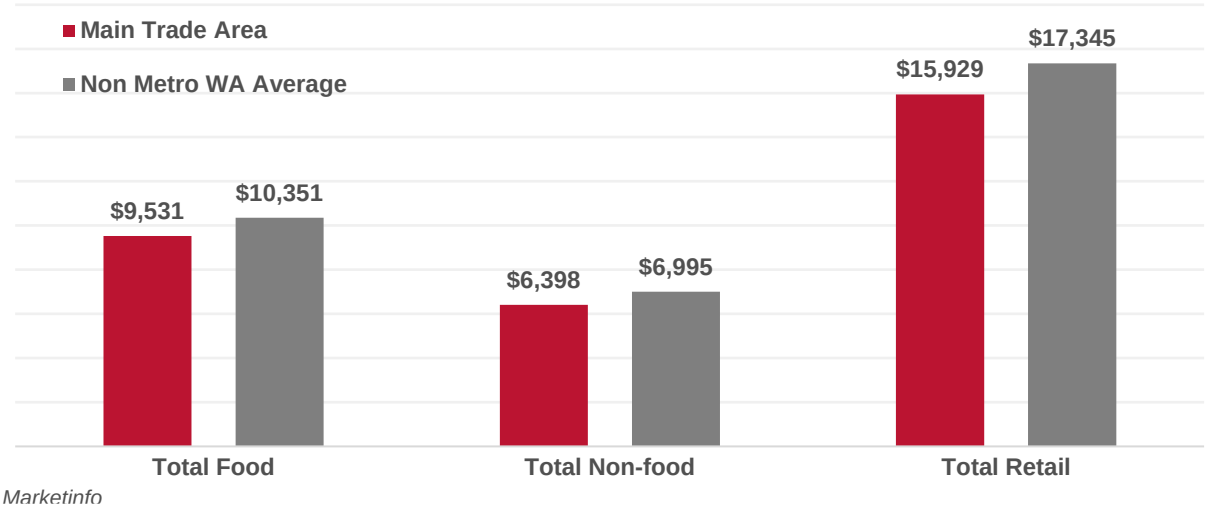
Source: ABS Census of Population and Housing 2011 & 2016

2.4. Main Trade Area Retail Expenditure Capacity

–

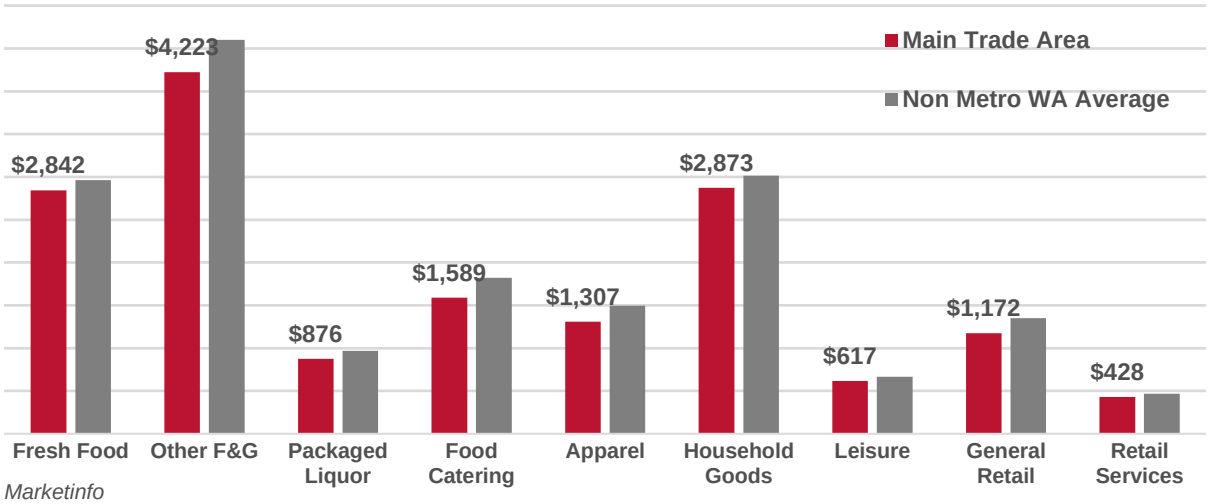
- **Food category inflation** –
- **Non-food category inflation** –
- **Real growth**
- **Main trade area population growth**

CHART 2.4. MAIN TRADE AREA PER CAPITA RETAIL SPENDING, 2020/21



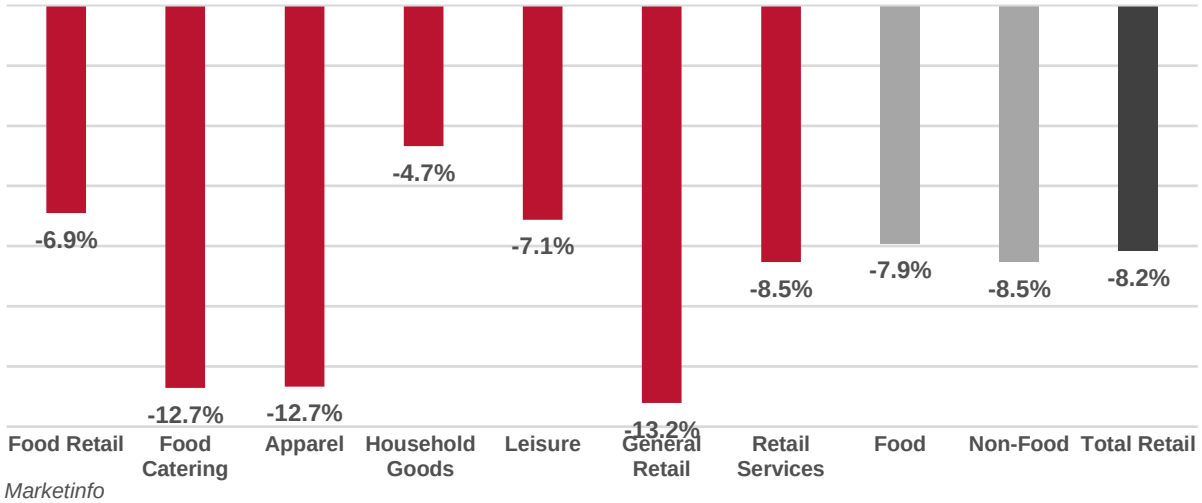
Source: Marketinfo

CHART 2.5. MAIN TRADE AREA PER CAPITA SPENDING, 2020/21



Source: Marketinfo

CHART 2.6. VARIATION FROM NON-METRO WA BENCHMARK (%)



Source: Marketinfo

TABLE 2.5. MAIN TRADE AREA RETAIL EXPENDITURE, 2021 – 2041

Y/E June	Primary Sector	Secondary Sectors		Main Trade Area
		North-east	North-west	
Expenditure Growth				
Average Annual Growth Rate				

**Inflated dollars & including GST*
Source : MarketInfo

TABLE 2.6. MTA RETAIL EXPENDITURE BY KEY COMMODITY GROUP, 2021 – 2041

Y/E June	Food & Liquor	Food Catering	Apparel	H'hold Goods	Leisure	General Retail	Retail Services
Expenditure Growth							
Average Annual Growth Rate							

**Inflated dollars & including GST*
Source : MarketInfo

2.5. Tourists & Visitors

given the region's position as a top tourism destination:

> *"Busselton has a foreshore that will stop you in your tracks and have you entertained for hours. You'll be dazzled by the ivory sand and the translucent turquoise ocean lapping at its edges. Then, a 1.8 kilometre-long, heritage-listed jetty will draw your eyes out to sea where, from May to December, tens of thousands of whales pass by on their annual migration. And that's only the beginning.*
>
> *Busselton sits at the top end of the famous wine region of Margaret River – it's only 23 minutes' drive to Dunsborough, or 42 minutes' drive to Margaret River township, with cellar doors, restaurants and vineyards dotted along the way.*
>
> *Busselton is a place that's on the move with artisanal food, produce and craft destination, Origins Market that opened late 2021. A new performing arts centre and a bustling dining and entertainment precinct are due to arrive in coming years. Visit before the secret is out."*
>
> *Destination Busselton*

TABLE 2.7. BUSSELTON LGA OVERNIGHT TOURISM (2017 – 2019)

Metric	Intrastate	Interstate	International	Total
Margaret River - Augusta LGA				
Visitation				
• Change 2013-15 to 2017-19 (%)				
• Change 2013-15 to 2017-19 (%)				
Expenditure	*Domestic*			
Purpose of Travel				

Source: Tourism WA - September 2020

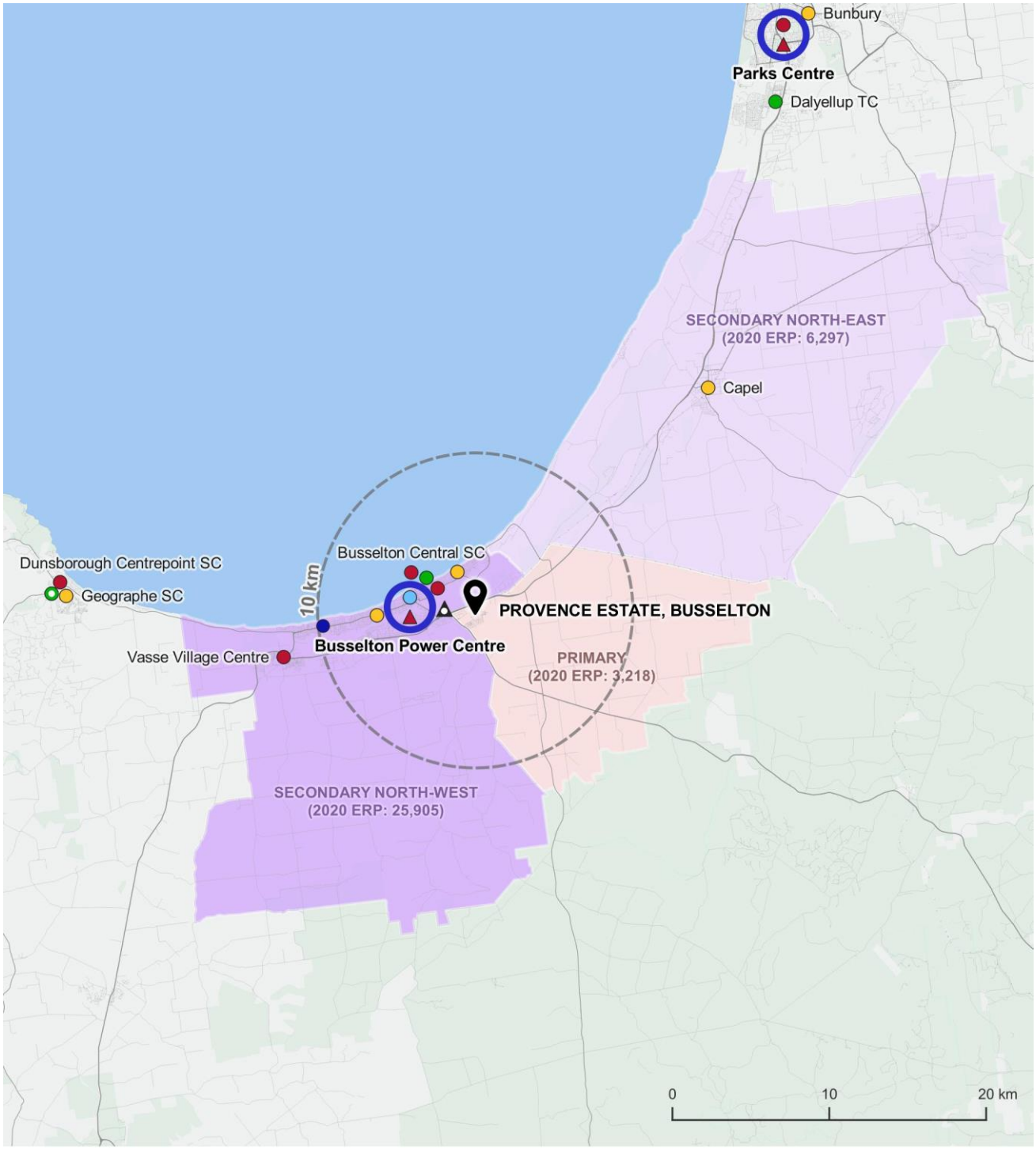
3 COMPETITIVE ENVIRONMENT

TABLE 3.1. COMPETITIVE CENTRES

Centre	Shopfront GLA	Anchor Tenants	Dist. From Site
Within Main Trade Area			
Busselton			
• Independent			
• Primewest Busselton Home Depot			
• Busselton Central SC			
• Busselton Boulevard			
• Fig Tree Lane			
• Busselton SC			
• Busselton Power Centre			
• Busselton Homemaker Centre			
• Busselton IGA			
• Geographe IGA			
Vasse			
• Vasse Village Centre			
Capel			
• IGA			
Beyond Main Trade Area			
Dunsborough			
• Geographe SC			
• Dunsborough Centrepoint SC			

Source: Australian Shopping Centre Council Database

MAP 3.1. MAIN TRADE AREA AND COMPETITION



** White dot indicates proposed store*

3.1. Within the Main Trade Area

-
-
-
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-

3.2. Beyond the Main Trade Area

3.3. Proposed Retail Developments

-

-

-

4 COMPARABLE DEVELOPMENTS

4.1. Shopping Centre Developments Sample

Small (less than 5,000 sq.m GLA)

-
-
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-
  –
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  – –

Medium (5,000 – 6,500 sq.m GLA)

-
-
-
-
-

TABLE 4.1. COMPARABLE DEVELOPMENTS (LESS THAN 5,000 SQ.M GLA)

Metric	Average	Rossmoyne SC	Beeliar Village SC	Rouse Hill VC	Frewville SC	Lukin Centre	The Local Village	Baldivis Square	Sovereign Place TC	Merriwa Plaza	Harrington Waters SC	The Parks SC	Zuccoli Village SC	Eastwood Village SC	Beaumaris City SC	Empire Village	Worrigee Shopping Village	Ropes Crossing Village	Brighton Village	Vasse Village Centre	Lakeside Plaza	Seacrest SC	Winthrop Shopping Village
Location																							
Resident Population (3km radius)																							
Supermarket																							
Retail Specialty Shops																							
Total	9.1	8	12	10	7	7	9	11	9	11	9	15	3	12	9	9	4	9	7	7	6	7	20
Other Non-retail																							
• Banks																							
• Travel Agent																							
• Post Office																							
• Other																							
• GP																							
• Other																							

Estimated
Source: Location IQ Databases

TABLE 4.2. COMPARABLE DEVELOPMENTS (5,000 – 6,500 SQ.M GLA)

Metric	Average	Mandurah Greenfields	Brighton Central	Prestons Place	Carramar Village	Willowdale SC	Kinross Central SC	Caversham Village	Harvest Lakes Village	Greenfield Shopping Village	Greystanes SC	Singleton Village	Spring Farm SC	Tramsheds	Ashby Hub	Wellard Square
Location																
Resident Population (3km radius)																
Supermarket																
Retail Specialty Shops																
Total	12.1	13	16	8	12	8	11	11	13	18	22	6	8	15	9	11
Other Non-retail																

*Estimated
Source: Location IQ Databases

4.2. Key Success Factors & Considerations

- **High-Profile Site:**

- **Access:**

- **Anchor Tenants:**

–

- **Shopping Centre Floorspace:** –
- **Strong Initial Supermarket Sales:**

- **Car Parking:**

- **Limited mini-major tenants:**

- **Strong Population Growth:**

- **Convenience focused specialty mix:** –

–

- **Non-retail:** –

- **Customer amenities:**

- **Design:**

–

5 FLOORSPACE POTENTIAL ASSESSMENT

5.1. Retail Floorspace Provision & Demand

- –
- –
- –
- –
- –

–

retail floorspace

- **Short-medium term (2026 - 2031):**
- **Long term (2036 - 2041):** –

“Grocery and dry goods stores of at least 500 sq.m, with smaller stores classified as foodstores.”

- **Western Australia:**
- **Non-metropolitan Western Australia:**
- **Australia:**

supermarket floorspace

- **Short-medium term (2026 - 2031):**

- **Long term (2036 - 2041):**

TABLE 5.1. RETAIL FLOORSPACE DEMAND, 2021 - 2041

	Demand Benchmark	Existing Provision	Population				
			2021	2026	2031	2036	2041
Population							
Main Trade Area			**30,530**	**34,030**	**37,780**	**40,531**	**42,155**
Retail Floorspace Demand							
	2.3 sq.m per p.						
	2.3 sq.m per p.						
Main Trade Area			**70,219**	**78,269**	**86,894**	**93,222**	**96,956**
Supermarket Floorspace Demand							
	501 sq.m per 1k p.						
	501 sq.m per 1k p.						
Main Trade Area			**15,296**	**17,049**	**18,928**	**20,306**	**21,119**
Retention & Demand (Provence Estate Village Centre)							
Retail floorspace			**2,119**	**2,664**	**3,526**	**4,390**	**4,893**
•	*22.5%*						
•	*2.5%*						
• *Beyond*	*+5%*		*101*	*133*	*176*	*219*	*245*
Supermarket Floorspace			**1,495**	**1,973**	**2,611**	**3,251**	**3,623**
•	*80%*						
•	*2.5%*						
• *Beyond*	*+5%*		*75*	*99*	*131*	*163*	*181*

5.2. Supermarket Potential

–

–

–

- *(IGA or similar independent operator)*
- *Supa IGA, Spudshed, Farmer Jacks, non full-line Woolworths, Coles or similar)*
- *(Coles or Woolworths)*

Full-line Supermarket (3,200 sq.m)

-
-
-

Small - Medium Supermarket (500 sq.m - 2,000 sq.m)

-
-
  -
-
  - Farmer Jack's is a Western Australian supermarket operator that has a focus on fresh

    currently 11 Farmer Jack's supermarkets listed on the brand's website, all of which are

–

–

–

–

– Similar to Spudshed, Bunbury Farmer's Market

–

–

Romeo's (IGA), Ritchies (IGA), Supamart (Karellas Group IGA), Good Grocer (IGA), various Foodland IGA's in Adelaide and more

–

–

–

- **Short-medium term (2026 - 2031):** –

–

- **Long term (2036 - 2041):**

Woolworths' appetite.

–

TABLE 5.2. PROVENCE ESTATE VILLAGE CENTRE PROJECTED SUPERMARKET SALES

Y/E June	Projected Supermarket Sales ($M)		
	Small Supermarket (1,000 sq.m)	Supermarket (2,000 sq.m)	Full-line Supermarket (3,200 sq.m)
	Supportable		
			Supportable

5.3. Mini-major Potential

-
-
-

Fresh Produce Operator

-

Pharmacy/Chemist

-
-
-

Discount Variety

-
-

s (Dan Murphy's and First Choice)

. This represents the ultimate yield of the main trade area, and Dan Murphy's

5.4. Retail Specialty Floorspace Potential

- **Short-medium term (2026 - 2031):**

  –

- **Long term (2036 - 2041):**

Food Retail (50 – 350 sq.m)

- –
-

Food Catering (200 – 650 sq.m)

-
-
-
-
-
-
-

- –

Leisure (0 – 100 sq.m)

-
-

General Retail (100 – 300 sq.m)

-
- –
-

Retail Services (50 – 300 sq.m)

-
-
- –
-

–

These ‘hero’ operators that can serve as mini

- **Short-medium term (2026 - 2031):**
  –
  –
  – –
  – –
  – –
- **Long term (2036 - 2041):**
  – –
  – –
  – –
  – –

TABLE 5.3. RETAIL TENANTS MATRIX

Category	Tenant Examples	Supportability Low | Moderate | High	GLA per Tenant (sq.m)	Short-medium Term		Long Term	
Supermarket				**1**	**2,000**	**1**	**3,200**
		Moderate					
		Moderate - High					
Food Retail				**2**	**150**	**3**	**325**
•		Moderate					
•		Moderate					
		Low					
•		Low					
•		Low					
		Moderate					
		Low - Moderate					
		Low - Moderate					
		Moderate - High					
		Low					
Food Catering				**3**	**300**	**7**	**650**
•		Moderate					
•		Low - Moderate					
•		Moderate - High					
•		Moderate - High					
•		Moderate					
•		Low - Moderate					
Apparel				**0**	**0**	**0**	**0**
		Low					
		Low					
		Low					
		Low					
		Low					
		Low					
Household Goods				**0**	**0**	**0**	**0**
		Low					
		Low					
General Retail				**1**	**100**	**2**	**250**
•		Moderate					
•		Low					
		Low					
		Low - Moderate					
		Low - Moderate					
		Low					
		Low					
		Moderate					
Leisure				**0**	**0**	**1**	**100**
		Moderate					
		Low - Moderate					
		Low					
Retail Services				**2**	**100**	**5**	**275**
		Moderate - High					
		Moderate					
		Low - Moderate					
		Moderate					
		Low - Moderate					
		Low - Moderate					
Total Retail				**9**	**2,650**	**19**	**4,800**
•							
•							

5.5. Non-retail Floorspace Potential

-
-
-
- **Bank:**
- **Travel Agent:**
- **Real Estate Agent:**
- **Lottery kiosk:**
- **Post Office:**

- **Community Facilities:**

- **Childcare:**
- **Medical Facilities:**

- **Gyms:**
- **Commercial/Office:**

- **Tavern:**
- **Education:**

5.5.1. Medical Centre

‘Medical centre’ is a term used for a collection of medical services provided at the same site, typically

an vary substantial, ranging from a single GP’s office/suite, up to a 10+

- **Short-medium term (2026 - 2031):**

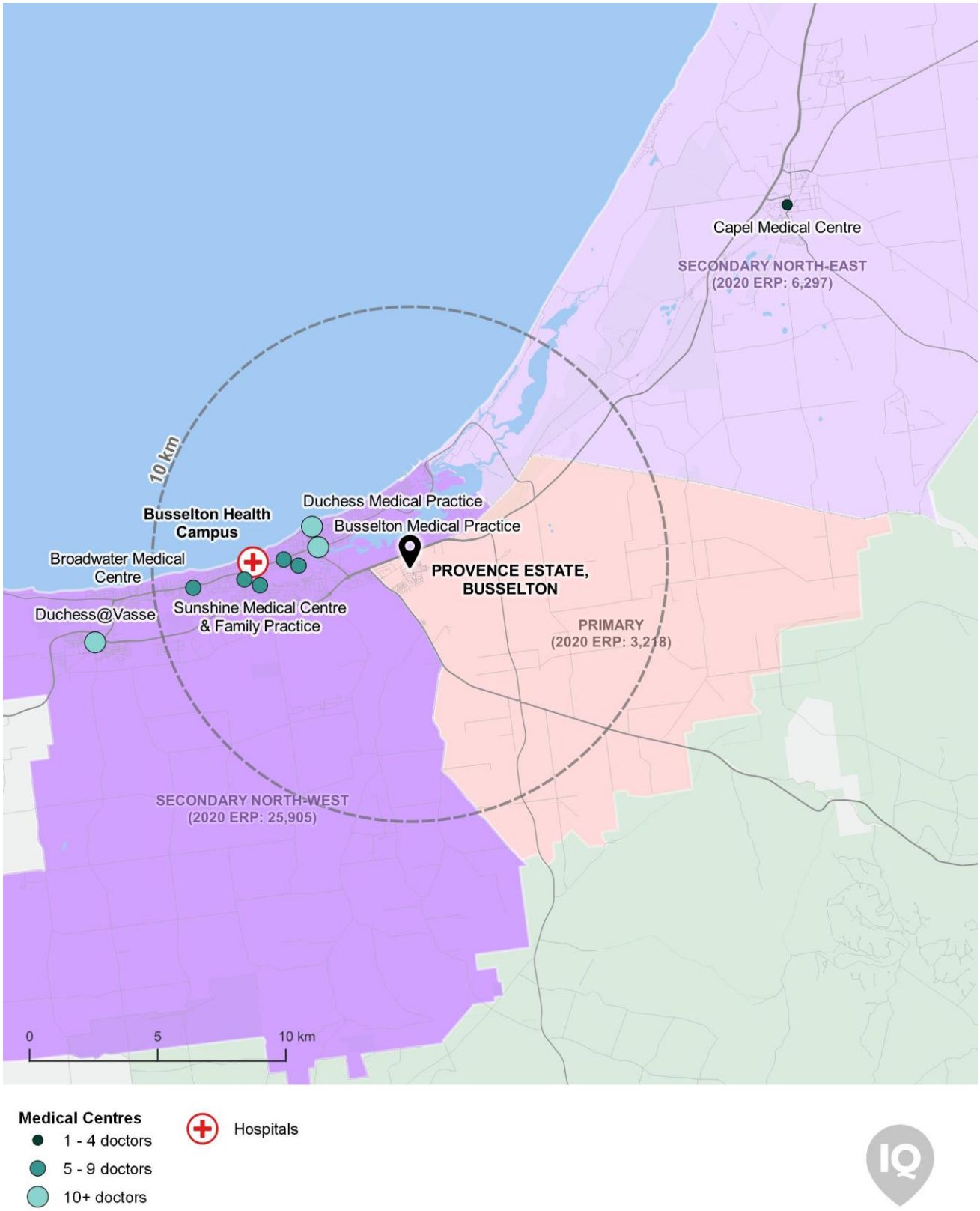
- **Long term (2036 - 2041):**

TABLE 5.4. PRIMARY SECTOR INDICATIVE DEMAND FOR HEALTH PROFESSIONALS

	Health Professionals per 10,000 persons*	2021	2026	2031	2036	2041
Primary Sector Population		**3,510**	**4,633**	**6,133**	**7,634**	**8,509**
Total	**240**	**84**	**111**	**147**	**183**	**204**

Source: AIHW
**Assuming National Average of Health Professionals in 2019*

MAP 5.1. MEDICAL CENTRES



5.5.2. Gym

- –

-

Memberships generally accounts for around half of a gym's total revenue stream. Based on a 2015

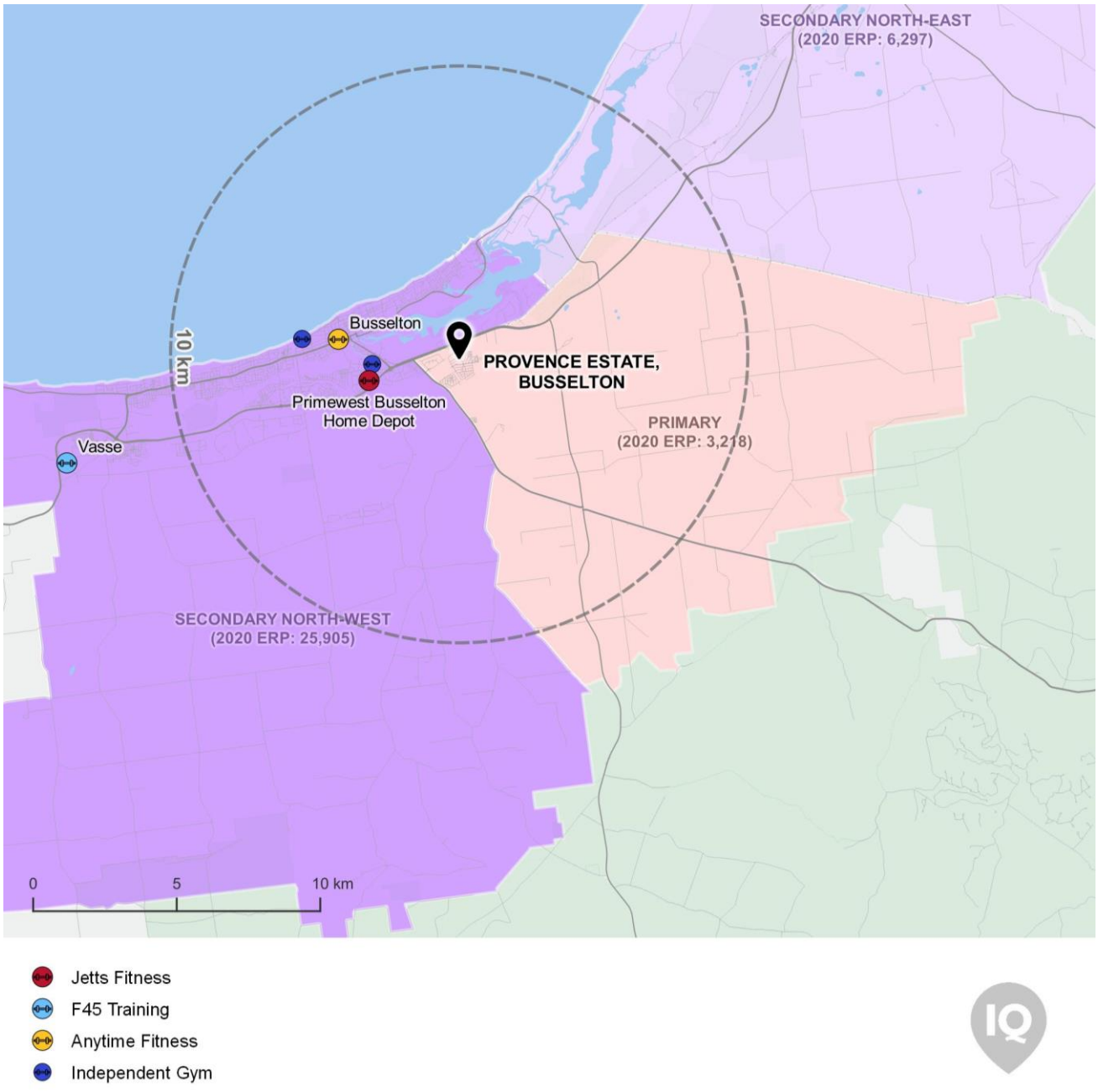
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According to the IBISWorld publication titled: "Gyms and Fitness Centres in Australia", there are

–

- **Health:**
- **Wellness:**

MAP 5.2. GYMS



5.5.3. Childcare Centre

-

-

– **primary sector**

demand, by way of proximity to residents' homes and possibly workplaces. For the purposes of this

place of work or sibling's schools) and more.

- **Short-medium term (2026 - 2031):**
- **Long term (2036 - 2041):**

–

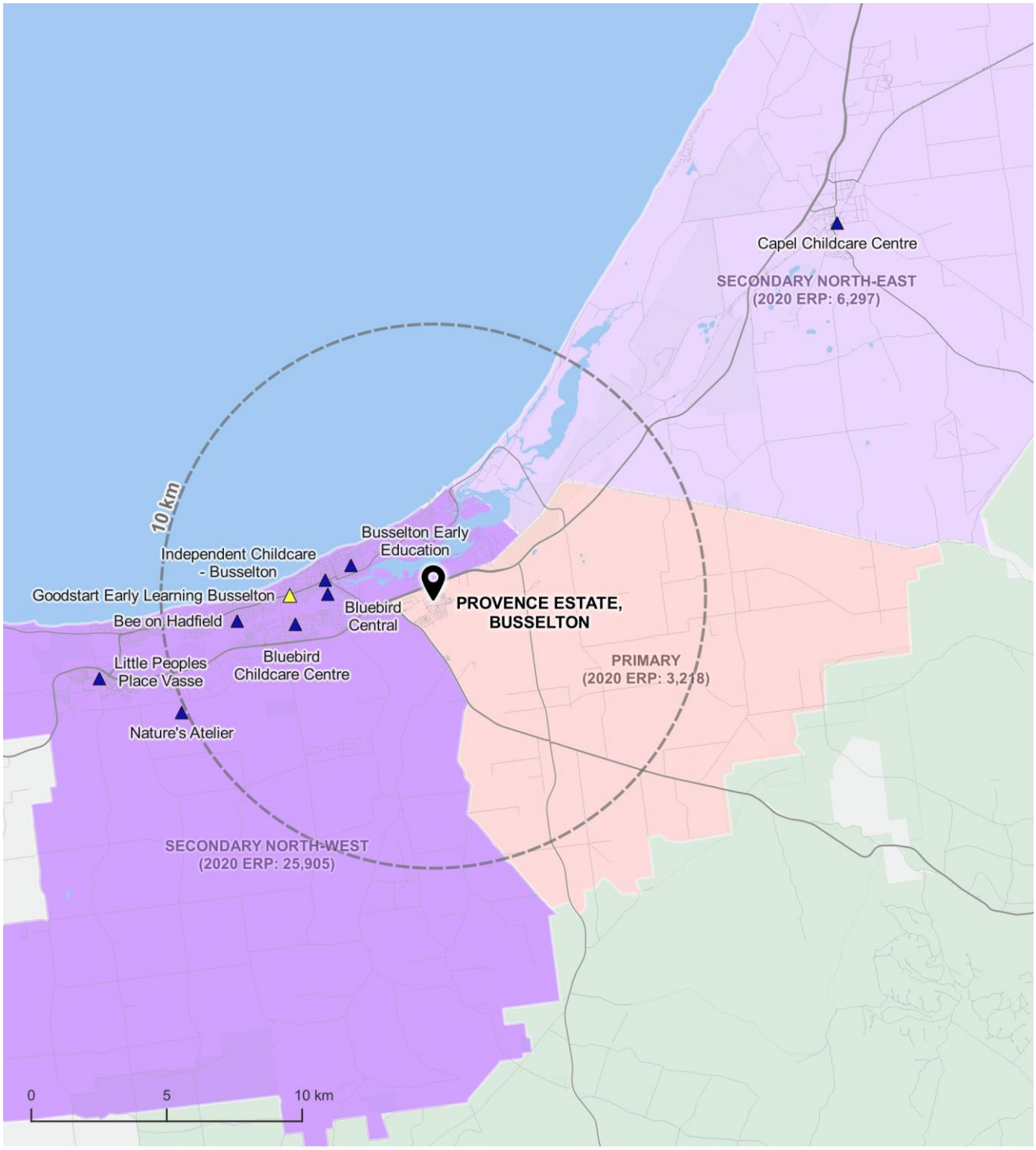
TABLE 5.5. CHILDCARE SUPPLY & DEMAND (PRIMARY SECTOR)

	Projected Childcare Demand				
	2021	2026	2031	2036	2041
Population					
Demand for Childcare Places					
Supply of Child Care Places (All)					
	–	–	–	–	–
Indicative Demand (Places)					
•					
•					
Indicative Demand (Facilities @ 65 places)	**0.8**	**1.2**	**1.7**	**2.2**	**2.5**

**Source: ABS: Childhood Education & Care, 2017*

**Source: Department of Education and Training, Early Childhood and Childcare in Summary*

MAP 5.3. EXISTING CHILDCARE CENTRES



5.5.4. Bar/Tavern/Roastery

FIGURE 5.1. TAVERNS (COMPARABLE DEVELOPMENTS)

The Cornerstone Ale House (Brighton Village)





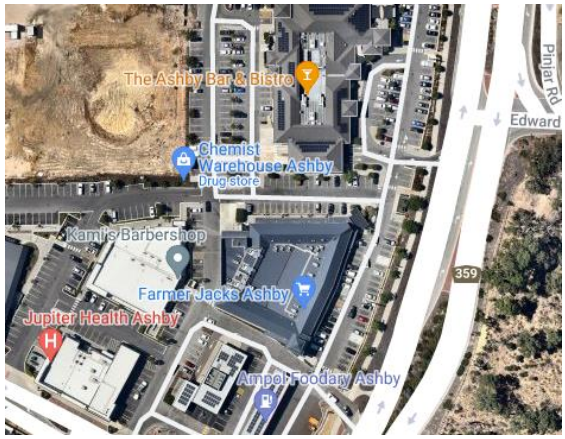
The Duke (Carramar Village)





The Ashby Bar & Bistro





The Well Tavern (Wellard Square)





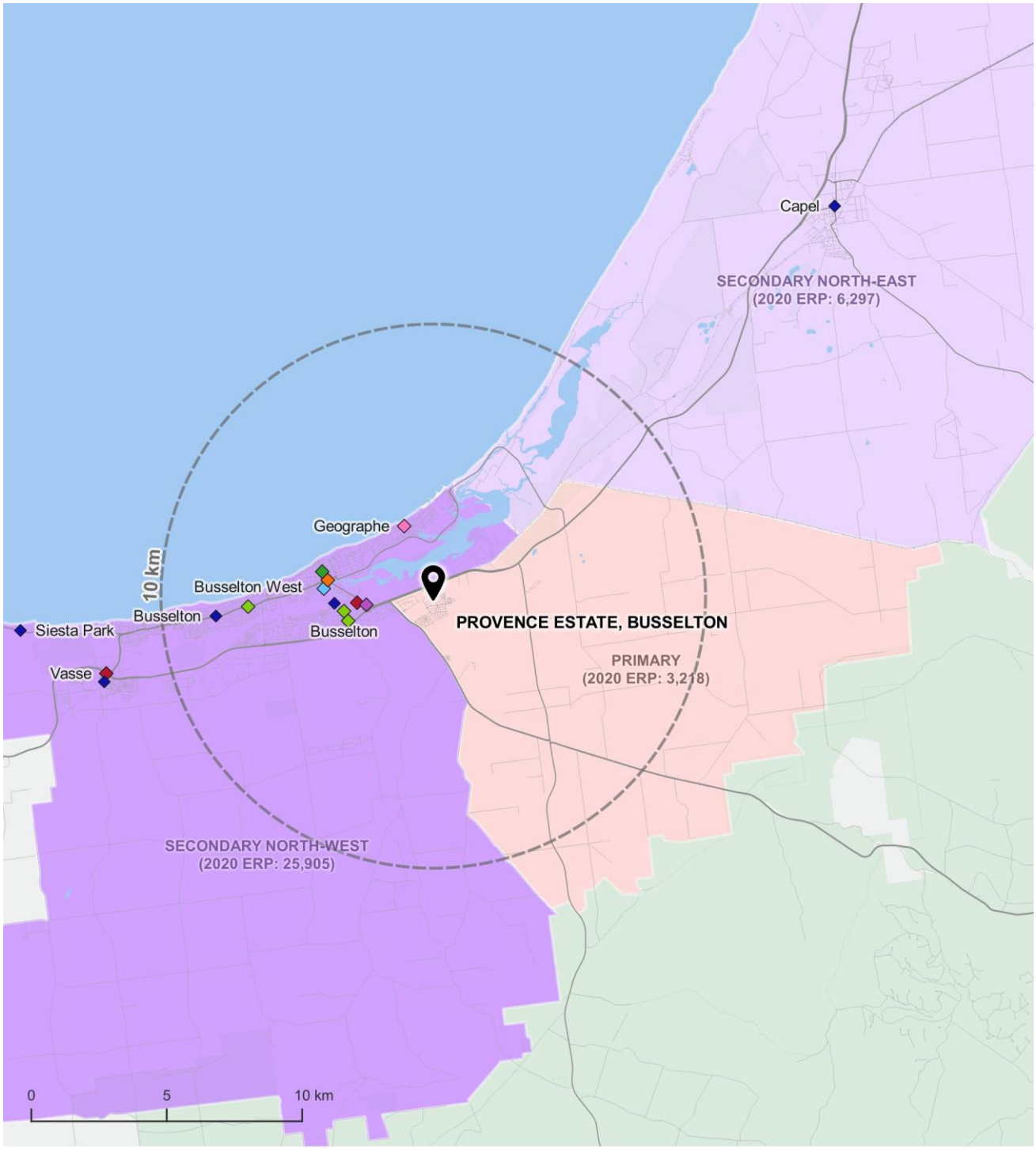
5.5.5. Service Station & Fast Food Pad Sites

body representing Australia's oil industry,

> *"The most significant trend in the retail fuel sector over the last decade has been the reduction in the number of retail service station sites, and the move to higher volume outlets located in busy areas and on highways where there is greater traffic volume, thus achieving economies of scale. The number of sites has reduced from around 20,000 sites in 1970 to around 6,300 sites now.*
>
> *The average customer base per service station is around 2,000 people in regional areas (and well below in many towns) whereas metro/city sites have a customer base of around 4,000 to 5,000"*

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-
-

MAP 5.4. SERVICE STATIONS



5.5.6. Commercial Office

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-
-
-

TABLE 5.6. NON-RETAIL TENANTS MATRIX

Category	Tenant Examples	Supportability Low | Moderate | High	GLA per Tenant (sq.m)	Short-medium Term		Long Term	
Non-retail Shopfronts				**1**	**100**	**3**	**275**
•		Low - Moderate					
•		Low - Moderate					
•		Low - Moderate					
•		Low - Moderate					
•		Moderate					
Medical				**3**	**500**	**5**	**800**
•		Moderate - High					
•		Moderate					
Health & Wellness				**1**	**225**	**2**	**450**
		Moderate					
		Low - Moderate					
		Moderate					
Childcare Centre				**1**	**1000**	**2**	**1500**
		Moderate - High					
Bar/Tavern				**1**	**150**	**2**	**1150**
•		Moderate					
•		Low - Moderate					
•		Low - Moderate					
Commercial Office				**2**	**100**	**4**	**200**
•		Moderate					
•		Low - Moderate					
•		Low					
Total Non-retail				**9**	**2,075**	**18**	**4,375**

6 TOTAL CENTRE POTENTIAL

6.1. Composition

Short-medium term (2026 - 2031) *4,000 – 5,000 sq.m retail and non-retail GLA (1.5 – 2.5 ha site)*

- **Supermarket (500 – 2,500 sq.m):**

- **Retail Specialty Floorspace (500 - 800 sq.m):**

  –

  – –

  – –

  – –

- **Non-retail Floorspace** –

  –

  –

  – – –

  – – –

  – –

  –

  –

  – –

Medium-long term (2036 - 2041) *8,250 – 9,500 sq.m retail and non-retail GLA (3 – 4 ha site)*

- **Supermarket (3,200 sq.m):**

  this time would purely be driven by Woolworths' appetite. Woolworths would also be unlikely to

- **Retail Specialty Floorspace (~1,500 sq.m):**

  – –

  – –

  – –

  – –

- **Non-retail Floorspace** –

6.2. Forecast Sales & Gross Rents

6.2.1. Forecast Sales

Short-medium Term (2026 – 2031)

-
  -
  -

Medium-long Term (2026 – 2031)

-
  -
  -

–

6.2.2. Forecast Gross Rents

-
-
-
-
-

–

TABLE 6.1. PROVENCE VILLAGE CENTRE, COMPOSITION, AND FORECAST SALES & GROSS RENTS (2026 & 2036)

Tenant/ Category	Short-medium Term (2026) GLA	Average Sales*	Gross Rents	Occ Cost	Medium-long Term (2036) GLA	Average Sales	Gross Rents	Occ Cost
Majors								
Retail Specialties								
Total Retail	2,650	22,145	8,357	1,617	610	7.3%	4,800	63,713	13,273	3,679	766	5.8%
Total	4,725			2,643	559		9,175			6,489	707	

**Inflated dollars and including GST*

6.3. Design & Comparable Developments

6.3.1. Design Considerations

Centre would be provided in traditional ‘town centre’ format across both sides of a ‘main street’ –

-
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-
-
-
-
-
-

- **generate significant customer flows past specialty shops**
- **location and amenity of car parking**
- **Weather protection**
- **Activating food catering floorspace**
- **Major tenant performance**
- **significant density**
- **activation across extended hours**

–

ing a ‘main street’ may hinder the ability of customers to move freely around the Village Centre –

–

In retail, the concept of a ‘third place’ refers to destinations such as cafes, bars and restau

establishing the development as a viable ‘third place’ for local residents and possibly visitors.

- **Food Retail:**

- **Food catering:**

- **Bar/Tavern/Roastery:**

- **Non-retail Shopfronts and Retail Services:**

- **Non-retail Shopfronts and Retail Services:**

- **Health & Wellness:**

–

- **Childcare:**

6.3.2. Comparable Built-form Developments

–

Baldivis Square *Example of short-medium term development (2026 – 2031)*

- Prime Group's $30 million Baldivis Square shopping centre
  –

- *'The centre has committed to creating an inner-city atmosphere with a strong emphasis on local community engagement. For example, Baldivis IGA owner Pat Rock said it was supporting local producers where possible, including Baldivis Fresh Eggs and local Peel District wines and WA craft beers.'*

- 'Brother of Mine', which is a destinational coffee roaster

- –

- –

-

- level, open air ‘high street’ town centre format, with shopfronts facing onto Lyon Road. The
-
-
- The Lucky Charm Newsagency, Pizza Hut, Brumby’s and Gelare.
-
- –
- –
-
-

TABLE 6.2. BALDIVIS SQUARE & HARVEST LAKES INDICATIVE COMPOSITION

Tenant/ Category	Baldivis Square Tenants	Baldivis Square GLA	Harvest Lakes Tenants	Harvest Lakes GLA
Majors				
Retail Specialties				
	–	—	–	—
Total Retail	**14**	**2,150**	**17**	**5,775**
	–	–	–	–
Total	**22**	**4,175**	**23**	**7,526**
Total Land Size (ha.)		**2.0**		**2.7**
Car Bays (all uses)		**220**		**375**

Estimates only

MAP 6.1. BALDIVIS SQUARE LOCAL CONTEXT & LAYOUT



MAP 6.2. HARVEST LAKES LOCAL CONTEXT & LAYOUT



Appendix C

Retirement Living Analysis

Appendix D

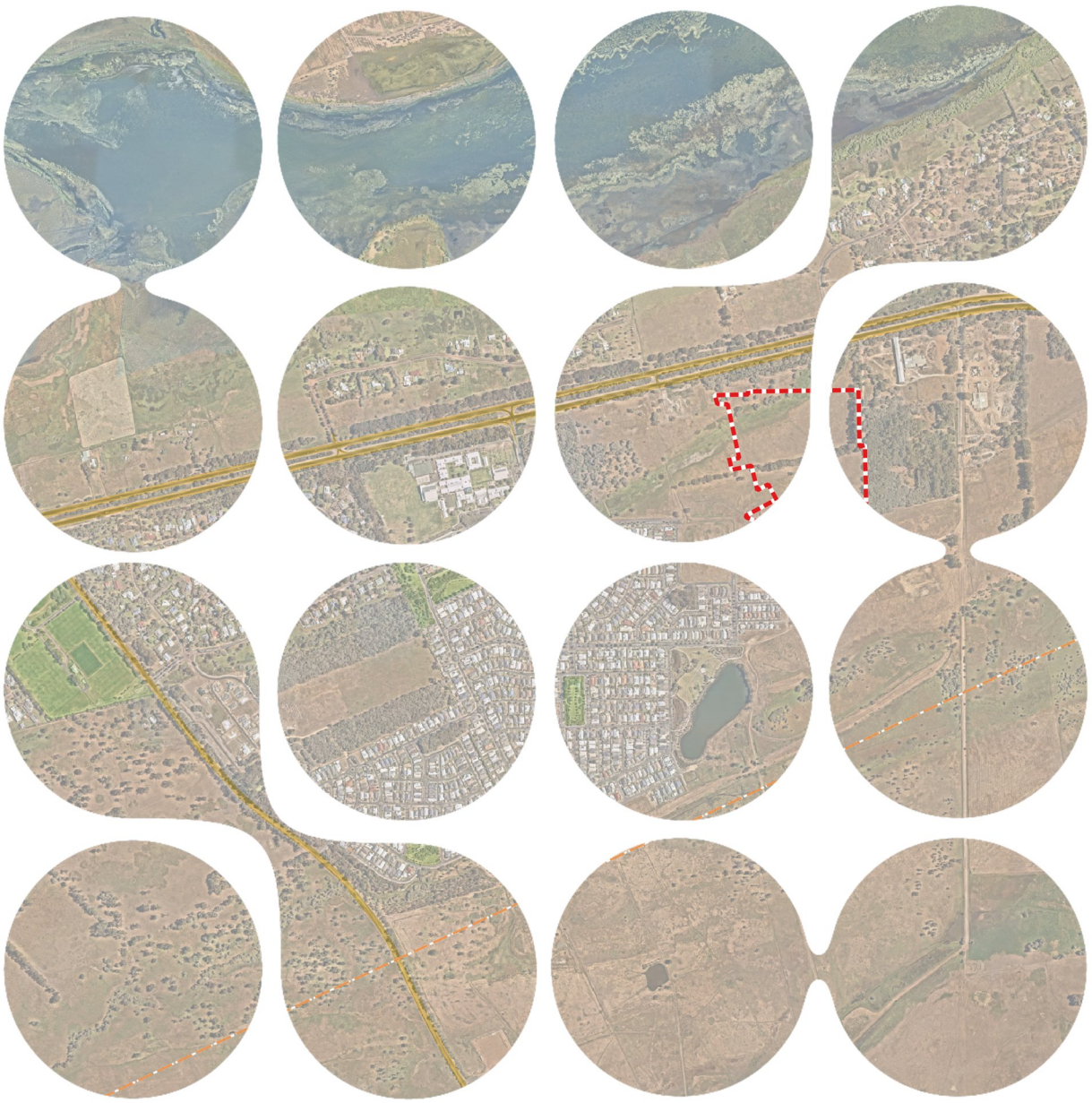
Transport Impact Assessment

deep end services

Yalyalup Land Lease Retirement Community

Busselton region retirement living need analysis

Prepared for Yolk Property Group
16 December 2022



Deep End Services
Deep End Services is an economic research and property consulting firm based in Melbourne. It provides a range of services to local and international retailers, property owners and developers including due diligence and market scoping studies, store benchmarking and network planning, site analysis and sales forecasting, market assessments for a variety of land uses, and highest and best use studies.

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This report should be read in its entirety, as reference to part only may be misleading.

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1

Introduction

1.1 Background

This report presents an assessment of the retirement living market in the Busselton region and an examination of future need for additional retirement units, and has been prepared as input to a submission by Yolk Property Group for a residential park retirement community within their Embark Estate at Yalyalup.

The proposal is for a retirement community of 300 units to be established on undeveloped land forming an expansion to the original Provence Estate area at Yalyalup, just to the south of the Bussell Highway and immediately adjacent to a future neighbourhood centre which will contain a supermarket and a range of other shops and services.

The proposed retirement community would be operated on a land lease model under the provisions of the Residential Parks (Long Stay Tenants) Act 2006 in which residents would purchase a relocatable dwelling and occupy the land on a long-term lease arrangement. The community would be marketed for older people (over 45s) although most residents are anticipated to be between 65 and 75 years of age.

Further details of the proposed development are provided in Chapter 2.

1.2 Retirement living

This report analyses existing and future demand and supply conditions within the *retirement living* sector, which is defined to comprise independent living units (dwellings) made available through rent or purchase, and typically provided either as a traditional retirement village or a residential park under a land lease agreement.

A summary of these two models is provided below:

Traditional retirement village

A traditional retirement village is operated under the Retirement Villages Act 1992 and comprises a community of seniors living in individual premises that share common facilities and amenities.

Independent living units (or ILUs) are made available to people over 55 years and their partners or spouse.

Contractual arrangements can include a lease/license model or purchase of freehold as strata title (or as 'purple title' – ie purchase of a share of the village as co-owner). Stamp duties are payable on the title purchase.

Residents are required to make an ingoing contribution payment covering purchase cost of the ILU and title. A recurrent monthly service fee is charged to cover operating costs and common services and amenities, and residents are also liable for rates and land taxes.

Departure ('exit') fees are liable, usually called a 'deferred management fee' and capped at an agreed proportion of the purchase cost (usually 25-40%).

Lifestyle village / residential park

A lifestyle village or residential park operates under the Residential Parks (Long Stay Tenants) Act 2006 and consists of sites on which relocatable homes are placed. Residents usually purchase the home (although in some cases they can be rented) and lease/rent the land on which the home is placed, on a long-term basis. No stamp duty is payable.

Although there can be overlaps with caravan parks that provide long stay rental, modern lifestyle villages are usually targeted at over 45s as a retirement living option. Most residents are older than 65, however, and once residents require care they usually move into other assisted living formats.

Like retirement villages, residential parks incorporate a range of amenities and common facilities.

Residents do not pay an incoming contribution but purchase their home, which can be a caravan park or mobile home but in modern lifestyle villages usually involves a high-quality prefabricated dwelling that is built to be relocatable.

Weekly rents or site fees are charged to cover ongoing maintenance of grounds and common facilities. Importantly, residents can qualify for rental assistance, contributing to this model's affordability for older people with less resources.

When residents move out of the lifestyle village they are responsible for the sale of the dwelling and retain any capital gain. A sales commission is charged by the operator.

Typically, buying into and living in such a setting is significantly less expensive than in a traditional retirement village, and residents have an opportunity to retain equity when moving out of such facilities by retaining capital growth in the asset. This can be very attractive for people deterred by high outgoing DMF charges.

Other retirement living options

Other housing options are available to people as they age, but these are not assessed in the subsequent analysis for the Busselton project:

- Rental villages are usually owned by one or more investors and then offered for rent under a tenancy agreement. Ongoing rental payments are usually calculated as a percentage of the age pension and the value of rental assistance. This can be an attractive housing option for older residents who have insufficient funds to purchase a retirement village unit or a house within a residential park.
- Permanent caravan sites are one of the few affordable options for older, less affluent people. As noted above, there is some overlap with residential parks, particularly in so-called 'mixed-use parks' where there is a combination of long stay tenants and sites/cabins for tourists. The quality of accommodation and amenity is usually relatively low.
- A large share of older people chooses to age-in-place in their family home until they are frail and require supported accommodation in an aged care facility.
- Aged care is an option for people that have assisted care requirements and are assessed to qualify for a funded aged care 'bed'. There are many forms of aged care, ranging from shelters, hostels and older-style nursing homes, to modern for-profit aged care homes that have a variety of common facilities and amenities and can look similar to a retirement village.

1.3 Data sources

Analysis in this report draws mainly on official data released by the Australian Bureau of Statistics, with a key source being the ABS Census of Population and Housing (2021).

Study region definition

ABS Census data is used to determine a study region by examining the previous location of residence five years ago for older people now living in Busselton.

Propensity to live in a retirement community

The ABS Census data is also used to understand the propensity for residing within a retirement living community. In this regard, the Census records the location of residence in 2021 according to the following dwelling location categories:

- Caravan parks, camping grounds and residential parks
- Marina
- Manufactured home estate
- Retirement village (self-contained)
- Other (including standard private homes)
- Not applicable (eg people living in non-private dwellings).

The ABS categorisation makes it difficult to accurately assess the propensity to live within a retirement community, as there is insufficient information to distinguish between older people living in a residential park and those captured while on holiday as a tourist in a caravan park. Similarly, while data is recorded for those living in manufactured home estates, it is not clear which of these are operated as retirement communities.

Due to these limitations the propensities used in this report only relate to people classified as living within a 'retirement village (self-contained)', and therefore understate the true propensity to live within all types of retirement community. The analysis of need for retirement units presented in this report should therefore be interpreted as a conservative forecast given these limitations.

Population by age

The ABS has released data on population by age structure at the Statistical Area 2 (SA2) geography level, and this is used to understand changes in age structure from 2001 to 2021. For the purposes of subsequent analysis, the following age cohorts are used:

- 0-54 years
  - Younger age groups not likely to live in any retirement accommodation other than some instances of younger spouses or family dependents still at home, and some younger occupants in residential parks.
- 55-64 years
  - People gain access to their superannuation balances once they reach the 'preservation' age from the age of 55 as they approach retirement.
  - The Retirement Villages Act defines a retirement village as a community for residents who are over the age of 55 or have retired from full time employment, or their spouse or partner.
- 65-74 years
  - People can claim an age pension over the age of 65.
  - Superannuation can also be accessed from the age of 65 even if people have not retired.
  - Aged care provision ratios are calculated per people aged 70 years and over
- 75-84 years
  - People tend to move out of a family home, particularly if single, and choose retirement options such as retirement community or aged care if they have ongoing health needs.
- 85+ years
  - A larger share of people in this age cohort require care and move out of all forms of retirement communities into aged care.

The key age cohorts that account for most residents living in retirement communities are those aged 65-74 and 75-84 years.

Population projections

Population projections in this report are based on the Western Australia Tomorrow 2018 edition (WAT) – Band 'C' population forecasts, which are available at the SA2 geographic level. Consideration is also given to small area forecasts prepared by .id consulting (SAFi), although these were last reviewed in 2017 and are somewhat out of date.

The WAT population projections have been rebased to 2021 and are adjusted for the period 2022 to 2024 to reflect anticipated immediate post-Covid trends, as indicated by projections prepared by the Australian Government Centre for Population which informs Federal budgetary considerations.

Age-based projections are based on a combination of:

- Historic trends in the proportion of the population within different age groups
- Age-based forecasts contained in the WAT – Band 'C', and projected changes in the proportion of the population within each age group
- Age-based forecasts by .id consulting (SAFi), and projected changes in the proportion of the population within each age group.

1.4 This report

The remainder of report is structured as follows:

- Chapter 2 describes the proposal and its context
- Chapter 3 examines demand for retirement living
- Chapter 4 examines existing and future supply of retirement ILUs
- Chapter 5 considers need for additional retirement living in the study region based on the above.

2

Proposed development

2.1 Location context

The subject site is vacant land within the wider structure plan area for the original Provence Estate at Yalyalup, located around 5km to the east of the Busselton town centre and just to the south of the Bussell Highway. Yolk Property Group are developing the land as 'Embark Estate'.

The City of Busselton itself is a fast-growing area within the wider Bunbury Region which also incorporates other popular visitor destinations in South West WA including Augusta - Margaret River Shire. The region is about 220 km south of Perth and within a 2½ hour drive, while Bunbury is 50km away to the north (refer Figure 1).

The site for the proposed retirement community consists of around 15ha of land that forms part of the remaining developable land within the wider Provence Estate area and is adjacent to a future neighbourhood centre. The Provence housing estate was commenced by Satterley in 2009, with around 725 lots now completed and provision for another 1,200 dwellings including land owned by Yolk and future development stages.

Over the last ten years housing development and population growth in Busselton – at Yalyalup and in other growth precincts such as Vasse and Dunsborough – has occurred at historic highs, with new residents attracted by the amenity, lifestyle and services available in the region.

The site is well-located with respect to critical service and infrastructure: there will be a new exit from Bussell Highway to service the community; the proposed alignment for the Outer Bussell Highway is just to the south of Provence; the Margaret River Busselton Airport is just to the south; and access to the town centre is quick and easy.

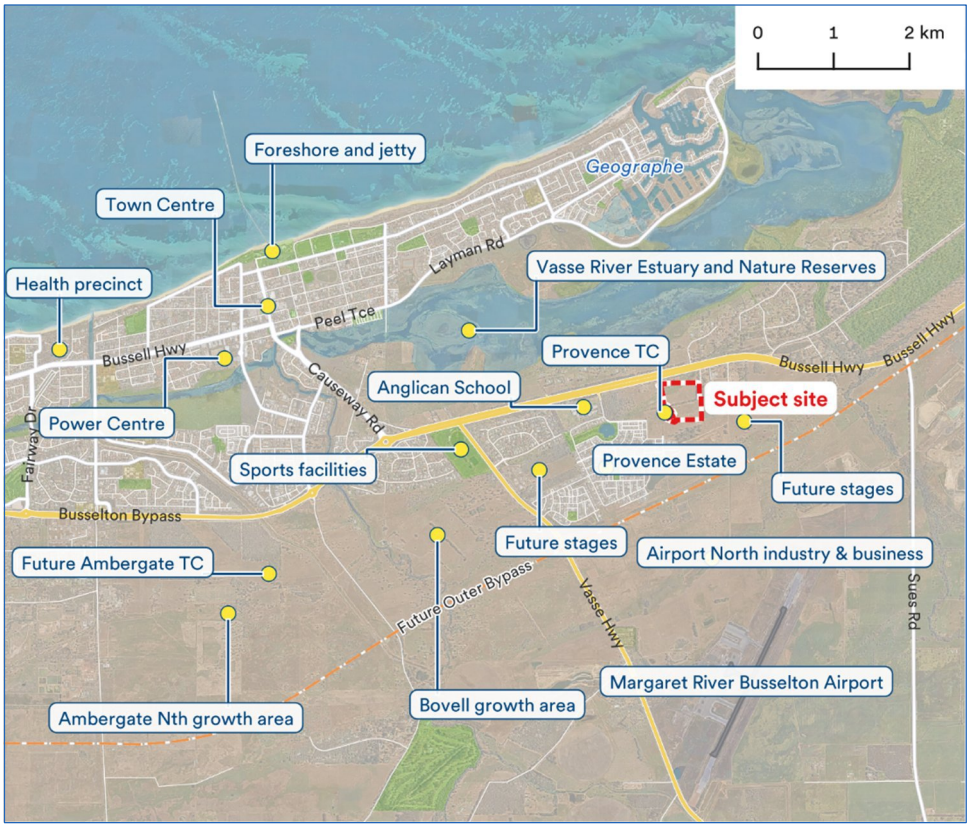
Figure 1—Region context map

Source: Deep End Services; OpenStreetMap; MapBox; QGIS



Figure 2—Local context map

Source/Notes/Desc



2.2 Development plan

The proposal is for a residential park retirement community of 300 units to be constructed on a site of around 15ha. The community would be located adjacent to the future Yalyalup neighbourhood centre that will be built on a site at the eastern end of the current alignment of Joseph Drive.

Joseph Drive is planned to continue eastwards and intersect with the northern extension of Marjoram Entrance, forming the southern boundary of the site.

A future north-south road would run along the western boundary and provide access from Bussell Highway via a new median crossover.

The retirement community is proposed to contain high quality prefabricated dwellings aimed at meeting the higher end of the residential park/lifestyle community sector.

Residents would have access to a wide range of amenities including:

- Shared lounge, library, hall (for dances and dinner events), and kitchen area able to be used by professional caterers
- Range of sports and active recreation facilities including indoor pool, spa and sauna, outdoor pool/resort area, gym, pickleball court, ten-pin bowling alleys, lawn bowl green, croquet lawn/putting green
- Other entertainment and recreation including cinema, café, arts & crafts room, BBQ pavilion, health and wellness area, bar, music room, men's shed.

Overall, the plan represents a very high quality and amenity-rich environment that would be attractive for those wishing to move to the Busselton region either pre-retirement or during their older years, or for locals wishing to remain close to friends and family as they age.

Figure 3— Retirement community concept

Source: Hex Design Planning



2.3 Land lease model

The proposed retirement community would be developed using a land lease model in which residents purchase their dwelling and make weekly rental payments to the operator to cover maintenance and provision of shared services and amenities.

As noted in Chapter 1, the land lease model is an attractive one for older residents as it is generally more affordable due to several factors:

- Typically lower purchase cost when compared to the purchase of a property and title within a retirement village (although noting in this case that Yolk intends to target the upper end of the market with high-specification dwellings)
- Savings due to no stamp duty payment on entry cost
- Weekly site fees are typically lower than the monthly service charges required in a retirement village, particularly as there is an opportunity to offset ongoing charges in cases where residents qualify for rental assistance
- Residents are not liable for rates and taxes that are attached to the land
- Access to capital gain when selling the dwelling, with this offset by a sales commission rather than the high capped DMFs of around 25-40%.

The dwelling purchase price has not yet been set but is typically aimed at providing a significant price differential compared to prevailing house prices. In the case of the proposed Yolk development at Yalyalup the dwelling price may be in the order of $450,000, which is an attractive proposition when compared to current house prices[1]:

- Busselton:
  - Median sale price of $590,000 overall, ranging from $495,000 for a 2-bedroom house to $572,000 for 3-bedrooms and $760,000 for 4-bedrooms
  - Lower medians for units, but these are typically associated with older, lower-quality stock or holiday properties
- Yalyalup:
  - Median sale price of $517,500 overall, with lowest entry cost around $450,000 to $510,000 for 2-bed and 3-bed product.

[1] REIWA, based on transactions to December 2022 (https://reiwa.com.au/suburb)

3

Retirement living demand

3.1 Introduction

Demand for independent living units (ILUs) at retirement villages and residential parks/lifestyle communities operating in the Busselton region is examined using the following approach:

1. Determine a relevant Study region by examining the migration trends of older people now living in the City of Busselton
2. For the Study region, analyse:
   a. Population trends
   b. Changes in the age breakdown over the period 2001 to 2021
3. Prepare population projections for the Study region, including by age group
4. Examine Census data with respect to dwelling location to identify the current (2021) propensity to live in a retirement community by age cohort (noting the limitations identified in Section 1.3)
5. Combine the population forecasts by age group with estimates of retirement living propensity (also by age group) to forecast how the number of people seeking to live in a retirement community will change over time
6. Convert this to forecast demand for ILUs by applying appropriate estimates of the average number of residents per dwelling for those living within retirement communities.

Note that, because of the limitations in using Census data to analyse propensity rates, the demand forecasts presented in this Chapter should be viewed as conservatively low.

3.2 Study region

Census data for 2021 has been analysed to determine the previous usual residential address for residents of the City of Busselton who had moved house during the previous five years (ie from 2016), with these results summarised in Table 1.

While people tend to move from a wide region, the largest share of older 'movers' changed address within Busselton itself (38% of the total). Other key 'sources' are the nearby SA2s within parts of the Bunbury region from Capel southwards.

Based on this data, Figure 4 defines a relevant Study region comprising a 'Core' sector consisting of Busselton, and a 'Remainder' sector covering the other SA2s. These are adopted for subsequent analysis.

Table 1—Busselton LGA migration patterns of older residents

Residents aged 55+ in 2021 who had moved since 2016

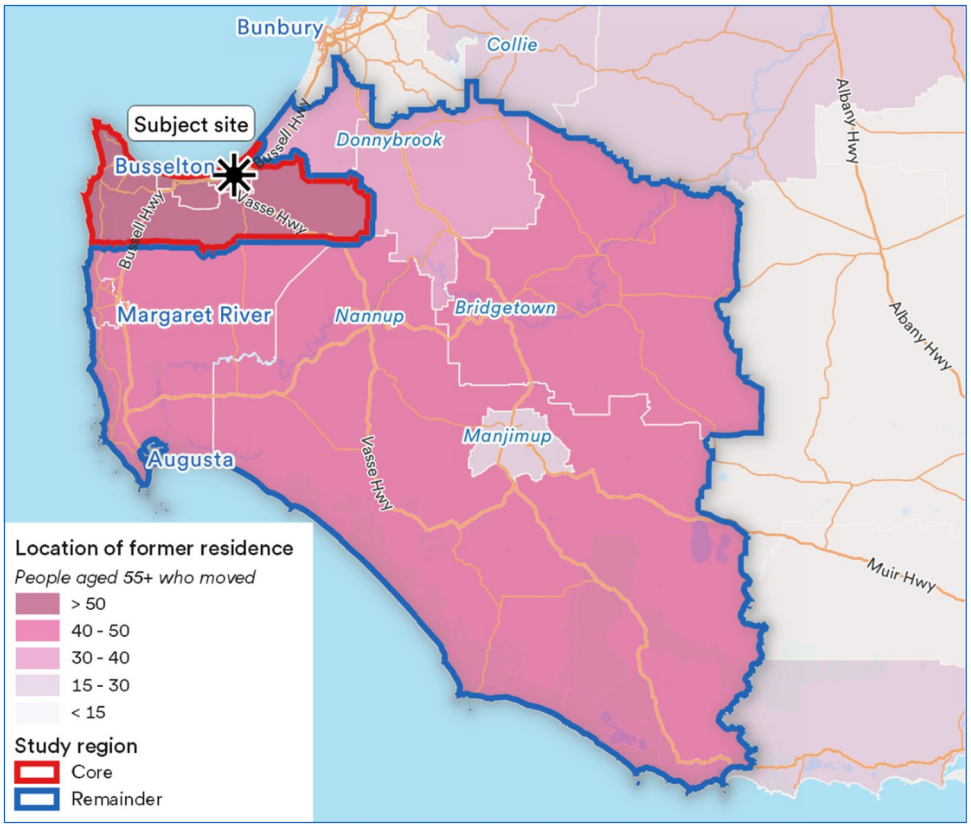
Source: ABS Census 2021

Moved (2016-21) from ...	No.	% moved within WA	% moved
Busselton - West	709	19%	16%
Busselton - East	446	12%	10%
Busselton Surrounds	491	13%	11%
Margaret River	49	1%	1%
Augusta	48	1%	1%
Other Bunbury SA4	296	8%	7%
Total Bunbury SA4	2,039	54%	47%
Perth metro	1,371	36%	32%
Other WA	388	10%	9%
Total moved within WA	3,798	100%	88%
Interstate	319		7%
Overseas	148		3%
Location not stated	33		1%
Total residents 55+ who changed address	4,298		100%

Figure 4—Busselton LGA migration patterns of older residents

Residents aged 55+ in 2021 who had moved since 2016

Source: ABS Census 2021



3.3 Population

Population trends

Trends in the residential population within the Study region have been examined with reference to official estimates prepared by the ABS for the period 2001 to 2021, which have been rebased following the results of the ABS Census 2021.

This data, presented in Table 2, shows that the Study region had an official estimated resident population of 89,297 in 2021, consisting of 41,906 people living within the Core part of the Study region (ie in Busselton) and 47,391 people living in the remainder of the Study region. The average annual growth rate of 2.0% across this period is higher than the WA average of 1.8%, with the Core study region (3.0% pa) growing significantly faster than the state average.

Table 2—Study region population 2001-21

Source: ABS population estimates by SA2 and above

Study region sector	2001	2006	2011	2016	2021
Estimated resident population					
Core study region	23,134	26,664	31,475	37,690	41,906
Remainder study region	36,570	36,991	39,357	43,124	47,391
Total Study region	**59,704**	**63,655**	**70,832**	**80,814**	**89,297**
Average growth pa					
Core study region		706	962	1,243	843
Remainder study region		84	473	753	853
Total Study region		**790**	**1,435**	**1,996**	**1,697**
Average growth (% pa)					
Core study region		2.9%	3.4%	3.7%	2.1%
Remainder study region		0.2%	1.2%	1.8%	1.9%
Total Study region		**1.3%**	**2.2%**	**2.7%**	**2.0%**

Population projections

Population projections are shown in Table 3. These are based on the WAT Band C projection set, but have been rebased to align with the most recent ABS estimates, and have been altered in the short term (to 2024) to reflect State forecasts prepared by the Australian Government Centre for Population.

The projections anticipate continued strong growth, with the Study region reaching 99,575 persons in 2026 and nearly 123,000 persons in 2036. By around 2026 the populations of the Core and Remainder sectors would be almost equal, reflecting the continued focus of growth within existing and future growth areas in Busselton.

Table 3—Study region population projections 2021-36

Source: Deep End Services; WAT – Band C (Dept Planning, Lands & Heritage); Centre for Population (Aust. Government)

	2021	2026	2031	2036
Estimated resident population				
Core study region	41,906	49,527	58,770	67,790
Remainder study region	47,391	50,048	52,642	55,169
Total Study region	**89,297**	**99,575**	**111,412**	**122,959**
Average growth pa				
Core study region		1,524	1,849	1,804
Remainder study region		531	519	505
Total Study region		**2,056**	**2,367**	**2,309**
Average growth (% pa)				
Core study region		3.4%	3.5%	2.9%
Remainder study region		1.1%	1.0%	0.9%
Total Study region		**2.2%**	**2.3%**	**2.0%**

Trends in population by age group

According to ABS estimates of population within the Study region by age group (Table 4), most of the Study region's population growth has occurred in older age groups. For example, over the period 2001 to 2021, only 35% of all growth within the Study region was for people under 55 years, and this share was even lower (26%) over the period 2016 to 2021.

Table 4—Trends in population by age 2001-21

Source: ABS, Age by Sex (SA2)

Age group	2001	2006	2011	2016	2021
POPULATION					
Core study region					
Under 55	17,676	19,708	22,484	25,740	26,823
55-64	2,151	2,907	3,884	4,782	5,489
65-74	1,868	2,153	2,851	4,209	5,573
75-84	1,090	1,441	1,688	2,097	2,983
85 and over	349	455	568	862	1,038
Total	**23,134**	**26,664**	**31,475**	**37,690**	**41,906**
Remainder study region					
Under 55	28,903	27,493	27,802	29,025	30,127
55-64	3,692	4,882	5,794	6,482	7,233
65-74	2,331	2,721	3,588	4,826	6,316
75-84	1,231	1,447	1,604	2,086	2,883
85 and over	413	448	569	705	832
Total	**36,570**	**36,991**	**39,357**	**43,124**	**47,391**
Total Study region					
Under 55	46,579	47,201	50,286	54,765	56,950
55-64	5,843	7,789	9,678	11,264	12,722
65-74	4,199	4,874	6,439	9,035	11,889
75-84	2,321	2,888	3,292	4,183	5,866
85 and over	762	903	1,137	1,567	1,870
Total	**59,704**	**63,655**	**70,832**	**80,814**	**89,297**
AVERAGE GROWTH					
Core study region					
Under 55		406	555	651	217
55-64		151	195	180	141
65-74		57	140	272	273
75-84		70	49	82	177
85 and over		21	23	59	35
Total		**706**	**962**	**1,243**	**843**
Remainder study region					
Under 55		-282	62	245	220
55-64		238	182	138	150
65-74		78	173	248	298
75-84		43	31	96	159
85 and over		7	24	27	25
Total		**84**	**473**	**753**	**853**
Total Study region					
Under 55		124	617	896	437
55-64		389	378	317	292
65-74		135	313	519	571
75-84		113	81	178	337
85 and over		28	47	86	61
Total		**790**	**1,435**	**1,996**	**1,697**

The effect on the age-share distribution of the Study region population is shown in Table 5, highlighting the decline in the share of under 55s, from 78% of the total population in 2001 to just 63.8% in 2021.

All older age cohorts have experienced growth in their population share. However, the key age groups that drive demand for retirement living – those aged 65-74 years and 75-84 years – have increased their share most significantly, together accounting for 20% of the population, up from just 11% in 2001.

Also of relevance in the data shown in Table 5 is that the share of the population in the pre-retirement age of 55-64 years has appeared to have plateaued, with this age cohort's share levelling off at around 13% in the Core region and 15% in the Remainder region.

Table 5— Population by age share 2001-21

Source: ABS, Age by Sex (SA2)

Age group	2001	2006	2011	2016	2021
Core study region					
Under 55	76.4%	73.9%	71.4%	68.3%	64.0%
55-64	9.3%	10.9%	12.3%	12.7%	13.1%
65-74	8.1%	8.1%	9.1%	11.2%	13.3%
75-84	4.7%	5.4%	5.4%	5.6%	7.1%
85 and over	1.5%	1.7%	1.8%	2.3%	2.5%
Remainder study region					
Under 55	79.0%	74.3%	70.6%	67.3%	63.6%
55-64	10.1%	13.2%	14.7%	15.0%	15.3%
65-74	6.4%	7.4%	9.1%	11.2%	13.3%
75-84	3.4%	3.9%	4.1%	4.8%	6.1%
85 and over	1.1%	1.2%	1.4%	1.6%	1.8%
Total Study region					
Under 55	78.0%	74.2%	71.0%	67.8%	63.8%
55-64	9.8%	12.2%	13.7%	13.9%	14.2%
65-74	7.0%	7.7%	9.1%	11.2%	13.3%
75-84	3.9%	4.5%	4.6%	5.2%	6.6%
85 and over	1.3%	1.4%	1.6%	1.9%	2.1%

Age share projections

Projections of the share of the population within each age cohort are displayed in Table 6, and have been prepared with reference to the trends shown in the ABS data above, and age-based projections contained in the WAT (Band C) projections by the Department of Planning, Lands & Heritage. Consideration has also been given to the SAFi age and gender projections prepared by .id consulting, which accord well with the historical data released by the ABS.

The projections adopt a continuation in the trends seen over the last 10-20 years, with a slow decline in the share of residents under 55, accompanied by increases in the proportion of the population in older age groups – particularly those older than 65 years.

Table 6—Projected population age share 2021-36

Source: Deep End Services; WA Tomorrow – Band C (Dept Planning, Lands & Heritage); SAFi small area projections (.id consulting)

Age group	2021	2026	2031	2036
Core study region				
Under 55	64.0%	61.3%	59.1%	57.5%
55-64	13.1%	13.3%	13.4%	13.4%
65-74	13.3%	14.8%	15.9%	16.7%
75-84	7.1%	8.0%	8.7%	9.3%
85 and over	2.5%	2.7%	2.9%	3.1%
Remainder study region				
Under 55	63.6%	61.2%	59.2%	57.8%
55-64	15.3%	15.5%	15.5%	15.5%
65-74	13.3%	14.7%	15.9%	16.7%
75-84	6.1%	6.7%	7.3%	7.8%
85 and over	1.8%	1.9%	2.1%	2.2%
Total Study region				
Under 55	63.8%	61.2%	59.2%	57.7%
55-64	14.2%	14.4%	14.4%	14.3%
65-74	13.3%	14.7%	15.9%	16.7%
75-84	6.6%	7.3%	8.1%	8.6%
85 and over	2.1%	2.3%	2.5%	2.7%

Population projections by age group

Population projections by age group are calculated by applying the proportional share of the population by age group (from Table 6 above) to the total projected population within each sector (from Table 3, p12).

The resulting projections (Table 7) show that of the total increase in the Study region population of +33,662 persons over the period 2021 to 2036, a projected +19,720 (or 59%) are expected to be over 55 years old.

The increase in the population within the key age groups of 65-74 years and 75-84 years is forecast to be approximately +13,350, representing 40% of all population growth within the Study region over the forecast period 2021 to 2036.

Within the Core study region, the increase in the population aged over 55 years is forecast to be +13,716 over the period, accounting for 53% of growth. The key age groups covering those between 64 years and 85 years account for +9,060 residents, or 35% of all Study region growth.

It is the growth in these key age groups that will continue to drive ongoing demand for retirement living within the Busselton Study region.

Table 7— Population projections by age 2021-36

Source: Deep End Services; WA Tomorrow – Band C (Dept Planning, Lands & Heritage); SAFi small area projections (.id consulting)

Age group	2021	2026	2031	2036	2021-36	Share
POPULATION						
Core study region						
Under 55	26,823	30,346	34,740	38,991	+12,168	47%
55-64	5,489	6,585	7,853	9,059	+3,570	14%
65-74	5,573	7,308	9,342	11,325	+5,752	22%
75-84	2,983	3,950	5,124	6,290	+3,307	13%
85 and over	1,038	1,338	1,710	2,125	+1,087	4%
Total	**41,906**	**49,527**	**58,769**	**67,790**	**+25,884**	**100%**
Remainder study region						
Under 55	30,127	30,629	31,179	31,901	+1,774	23%
55-64	7,233	7,734	8,176	8,569	+1,336	17%
65-74	6,316	7,364	8,345	9,191	+2,875	37%
75-84	2,883	3,362	3,856	4,300	+1,417	18%
85 and over	832	958	1,086	1,208	+376	5%
Total	**47,391**	**50,047**	**52,642**	**55,169**	**+7,778**	**100%**
Total Study region						
Under 55	56,950	60,975	65,919	70,892	+13,942	41%
55-64	12,722	14,319	16,029	17,628	+4,906	15%
65-74	11,889	14,672	17,687	20,516	+8,627	26%
75-84	5,866	7,312	8,980	10,590	+4,724	14%
85 and over	1,870	2,296	2,796	3,333	+1,463	4%
Total	**89,297**	**99,574**	**111,411**	**122,959**	**+33,662**	**100%**
AVERAGE GROWTH						
Core study region						
Under 55		705	879	850	811	
55-64		219	254	241	238	
65-74		347	407	397	383	
75-84		193	235	233	220	
85 and over		60	74	83	72	
Total		**1,524**	**1,848**	**1,804**	**1,726**	
Remainder study region						
Under 55		100	110	144	118	
55-64		100	88	79	89	
65-74		210	196	169	192	
75-84		96	99	89	94	
85 and over		25	26	24	25	
Total		**531**	**519**	**505**	**519**	
Total Study region						
Under 55		805	989	995	929	
55-64		319	342	320	327	
65-74		557	603	566	575	
75-84		289	334	322	315	
85 and over		85	100	107	98	
Total		**2,055**	**2,367**	**2,310**	**2,244**	

3.4 Retirement living propensity

For the purposes of this report, the share of the resident population within each age group that chooses to live within a retirement community is referred to as the 'propensity rate', and is synonymous with other similar terms such as 'penetration rate' or 'market share'.

In the absence of very detailed occupancy information at the local level, propensity rates can be derived from ABS Census data which provides information on the place of enumeration by 'dwelling location' categories comprising:

- Caravan parks, camping grounds and residential parks
- Marina
- Manufactured home estate
- Retirement village (self-contained)
- Other (including standard private homes)
- Not applicable (eg people living in non-private dwellings).

As noted in section 1.3, there are limitations on the use of this data, as retirees could be living within a caravan park or residential park, but this is indistinguishable with other people such as tourists staying in these dwelling locations.

For this reason, the only variable used to identify retirement living propensity rates is 'Retirement village (self-contained)' which therefore understates the true usage of retirement living options.

Another limitation is that the data is based on where people are enumerated at the time of the Census (in August 2021), and this may not capture people who were away from their usual place of residence within a retirement community.

Both of the above limitations act to understate true retirement living propensities.

Table 8 presents the Census data for the Study region, showing that the retirement living propensity rate increases significantly as people age, with 0.5% of people aged 55-64 living in a retirement village, increasing to 10.9% for people aged over 85 years. The overall rate for people aged 65+ years is 4.8%, ranging from 7.6% in the Core region to 2.2% in the Remainder region.

Retirement living propensity rates are higher in each age group within the Core study region due to the greater availability of supporting services for those wishing to retire close to Busselton.

Table 8— Propensity to live in retirement village by age

Source: ABS Census 2021

By age group	0-54	55-64	65-74	75-84	85+	Total
Living in retirement village						
Core study region	25	40	231	322	147	765
Remainder study region	4	17	49	109	59	238
Total Study region	**29**	**57**	**280**	**431**	**206**	**1,003**
All persons						
Core study region	25,555	5,280	5,323	2,844	1,045	40,047
Remainder study region	28,672	6,986	6,003	2,793	840	45,294
Total Study region	**54,227**	**12,266**	**11,326**	**5,637**	**1,885**	**85,341**
Propensity rate						
Core study region	0.1%	0.8%	4.3%	11.3%	14.1%	1.9%
Remainder study region	0.0%	0.2%	0.8%	3.9%	7.0%	0.5%
Total Study region	**0.1%**	**0.5%**	**2.5%**	**7.6%**	**10.9%**	**1.2%**

When compared to other parts of WA, the Core study region is already a location where retirement living is a common choice: the propensity rate of 7.6% for those aged 65+ is higher than the average in WA of 5.3%. However, other parts of the State have even higher propensity rates, including the following SA3 geographic regions:

- Mandurah: 13.5%
- Wanneroo: 10.5%
- Canning: 8.1%
- Gosnells: 7.9%

Note that the closest equivalent SA3 region is Augusta - Margaret River - Busselton, has an overall propensity rate of 6.5% and is 8th highest out of the 36 SA3s within WA.

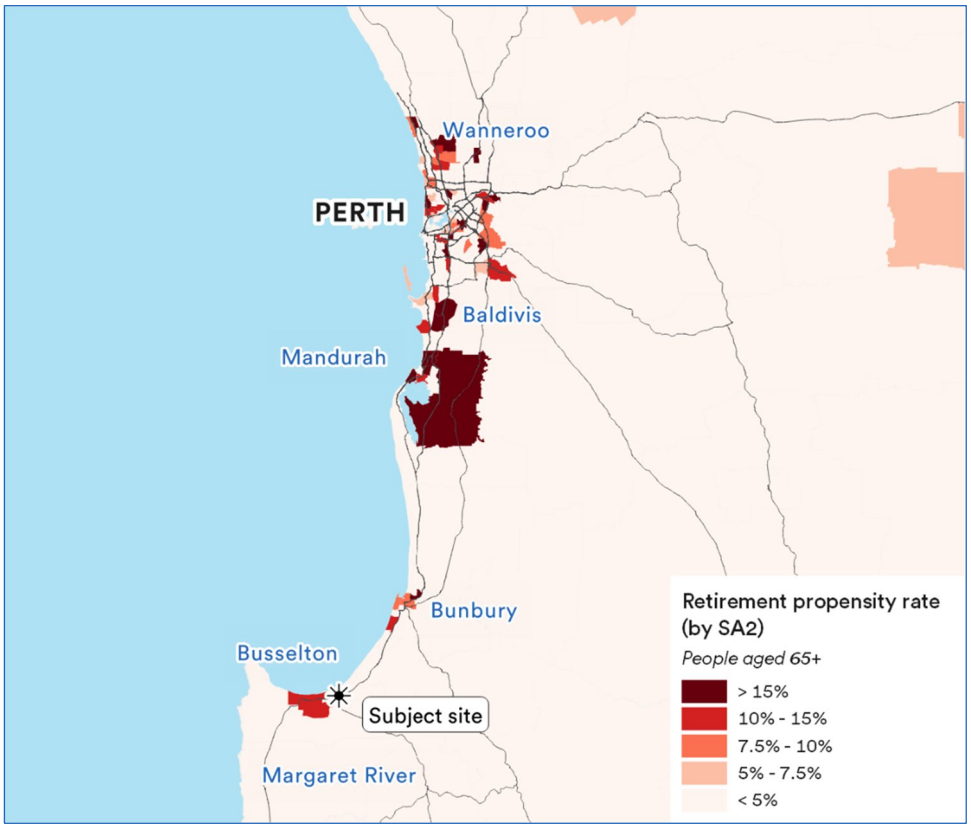
Geographic variations in the extent to which residents live in retirement villages are shown in Figure 5 over the page which illustrates propensity rates for people aged 65+ at the SA2 geography level in the southern part of WA. The map shows that very high propensity rates are evident in SA2s scattered across Perth and southwards towards the Busselton study region. Examples include:

- Greenfields in Mandurah (32%)
- Butler (31%)
- Baldivis North (30%)
- Bull Creek (23%)
- Gosnells (21%)
- Ellenbrook (20%)
- Mandurah North (19%).

Figure 5— Retirement propensity rate variations WA

By SA2 geography

Source: ABS Census 2021



Also relevant are interstate comparisons presented in Figure 6 which show that the retirement village propensity rate in Perth (5.9%) and the remainder of WA (3.5%) are relatively low when compared to places such as Brisbane (7.4%) and elsewhere in Queensland (6.3%). Queensland is a known market leader in the retirement industry, particularly in the context of land lease products which are highly popular.

Given the attractive lifestyle qualities available in WA, similar to Queensland, and the maturation of the sector, there is an opportunity for WA's propensity rates to increase substantially in coming years.

Figure 6— Australian retirement propensity rate comparisons

Persons aged 65+

Source: ABS Census 2021



3.5 Forecast retirement living demand

Demand for retirement living is projected forwards by applying age-based propensity rates to the population projections (by age) set out in section 3.4, to forecast how many people would be living in retirement communities over the forecast period. This is then converted to ILU demand by applying an appropriate average persons per unit.

Retirement propensity rates

Current (2021) age-specific propensity rates are shown in Table 8. These are adopted for 2021 and then projected forward to 2036 (refer Table 9) by incorporating future growth in the propensity rates within each age group.

Relatively small but ongoing increases in retirement living propensities have been underway for some time and are expected to continue as the sector matures and offers an improved range and quality of retirement experience.

The modelled increase in propensity rates shown in Table 9 is also underpinned by the expectation that Busselton and the wider Study region will continue to be a focus for people wishing to retire to places that are rich in natural amenity as well as having a range of activities accessible in the area. Busselton fits this profile well.

Nevertheless, given the observed higher propensity rates that exist in other locations in WA and interstate, and the limitations in using the ABS Census data, the below age-specific propensity rates should be seen as conservatively low projections of possible future retirement living demand.

Indeed, the resulting propensity rate for people aged 65+ is forecast to increase from 4.8% across the Study region in 2021 to 7.0% in 2036. Within the Core study region the propensity rate for those aged 65+ is forecast to increase from 7.6% in 2021 to 9.8% in 2036. Clearly there is a strong possibility that propensity rates will increase more rapidly, therefore driving demand for retirement living at levels greater than presented in this report.

Table 9—Projected propensity rates by age

Source: Deep End Services; ABS

Age group	2021	2026	2031	2036
Core study region				
Under 55	0.1%	0.1%	0.1%	0.1%
55-64	0.8%	0.8%	0.9%	0.9%
65-74	4.3%	4.7%	5.0%	5.4%
75-84	11.3%	12.3%	13.5%	14.7%
85 and over	14.1%	15.5%	17.1%	18.9%
Remainder study region				
Under 55	0.0%	0.0%	0.0%	0.0%
55-64	0.2%	0.3%	0.3%	0.3%
65-74	0.8%	0.9%	1.0%	1.1%
75-84	3.9%	4.4%	5.0%	5.7%
85 and over	7.0%	7.9%	9.0%	10.2%
Total Study region				
Under 55	0.1%	0.1%	0.1%	0.1%
55-64	0.5%	0.5%	0.6%	0.6%
65-74	2.5%	2.8%	3.1%	3.5%
75-84	7.6%	8.7%	9.8%	11.0%
85 and over	10.9%	12.4%	14.0%	15.8%

Projected residents in retirement living

The forecast number of people living in retirement communities is set out in Table 10, which applies the age-specific propensity rates in Table 9 to the projected population by age cohort described in Table 7.

The data in the table demonstrates that the number of people seeking to live in retirement communities is expected to increase substantially over the next 15 years, from the current estimate of 1,038 people in 2021 to 1,439 people in 2026 and reaching 2,571 people in 2036.

A large majority of this increase in people living in retirement communities is expected to occur in the Core study region, accounting for 83% of the increase in retirement living demand.

Most of the increased population projected to live in retirement communities will be from people between the ages of 65 and 75, with this cohort accounting for 74% of the increased demand over the period 2021-36 across the Study region, and 75% of the demand generated within the Core region.

Table 10— Residential population in retirement communities

Source: Deep End Services

Age group	2021	2026	2031	2036	2021-36
Core study region					
Under 55	26	31	38	44	+18
55-64	42	53	67	83	+41
65-74	242	342	470	614	+373
75-84	338	488	690	924	+586
85 and over	146	208	293	402	+256
Total	**793**	**1,121**	**1,559**	**2,068**	**+1,274**
Remainder study region					
Under 55	4	4	5	5	+1
55-64	18	21	24	28	+10
65-74	52	67	85	105	+53
75-84	113	148	193	243	+131
85 and over	58	76	98	123	+64
Total	**244**	**317**	**404**	**504**	**+260**
Total study region					
Under 55	30	36	42	49	+19
55-64	59	74	92	111	+52
65-74	293	409	556	719	+426
75-84	450	636	883	1,167	+717
85 and over	204	284	391	525	+321
Total	**1,038**	**1,439**	**1,963**	**2,571**	**+1,534**

Retirement unit demand

Table 11 presents forecast demand for ILUs in retirement communities, which has been derived by applying the following average number of persons per ILU:

Core region:

- Under 55: 1.8
- 55-64: 1.8
- 65-74: 1.4
- 75-84: 1.3
- 85+: 1.1

Remainder region:

- Under 55: 1.6
- 55-64: 1.6
- 65-74: 1.25
- 75-84: 1.1
- 85+: 1.0

The lower average persons per unit in the Remainder region is based on available data from the ABS Census 2021 which indicates fewer people per retirement village 'dwelling' in that region. Note, however, that age-based data is not available from the Census and with small numbers in some data cells there are issues with rounding to protect privacy.

As shown in Table 11, the number of ILUs required to serve demand within the Study region is projected to increase from 807 in 2021 to 1,119 in 2026, and then increasing to reach 2,005 in 2036.

This represents an increase of +1,198 units required to accommodate the projected increase in people living within retirement communities, of which growth of 965 is generated within the Core study region.

Importantly, the actual ILU supply requirement needs to be larger to allow for some vacancies as people transfer into, out of and between retirement communities, and to provide choice for those seeking retirement options.

Assuming a 90% occupancy rate, which is the current average according to data from the 2021 PwC Property Council Retirement Census, the need for ILUs is forecast to increase by +1,331 across the Study region over the period 2021 to 2036, representing an average annual increase of nearly 90 ILUs per year.

Of this, around 80% or +1,070 additional ILUs, is forecast to be required to serve the Core study region part of the market.

Table 11—Demand for retirement dwellings (ILUs)

Source: Deep End Services; ABS Census 2021

Age group	2021	2026	2031	2036	2021-36
Core study region					
Under 55	15	17	21	25	+10
55-64	23	29	37	46	+23
65-74	161	228	314	410	+248
75-84	260	375	531	711	+451
85 and over	133	189	267	366	+233
Total	**591**	**839**	**1,169**	**1,557**	**+965**
Remainder study region					
Under 55	3	3	3	3	+1
55-64	11	13	15	18	+7
65-74	41	54	68	84	+43
75-84	102	135	175	221	+119
85 and over	58	76	98	123	+64
Total	**216**	**281**	**359**	**448**	**+233**
Total study region					
Under 55	17	20	24	28	+11
55-64	34	42	53	63	+29
65-74	202	282	382	493	+291
75-84	362	510	706	932	+570
85 and over	191	265	364	489	+297
Total	**807**	**1,119**	**1,528**	**2,005**	**+1,198**
Supply requirement at 95% OR	**897**	**1,244**	**1,698**	**2,228**	**+1,331**

3.6 Summary

1. The provision of new retirement living within Busselton would generally serve a Study region consisting of a core component generally comprising the City of Busselton and a remainder component extending to Capel and Donnybrook in the north and south-east as far as Walpole.
2. The Study region has experienced strong population growth at above-average rates, particularly within the Core component. Much of this growth is in older age groups, reflecting an ageing of the population and the attraction of older people from outside the region during pre-retirement and retirement years.
3. Population growth within the Study region is projected to continue, with higher rates in the Core component leading to an equalisation of the population by around 2026. The share of the population in older age groups is projected to continue to increase.
4. The propensity to live within an retirement community can be modelled using Census data (although this may understate actual retirement choices). For the purposes of this report propensity rates are expected to increase in the future as the population ages, people are more willing to live in retirement communities, the industry quality improves and as places like Busselton attract people as places to retire to.
5. With the propensity rates applied to the forecast population, and having regard to the typical average number of people per dwelling in retirement communities as well as typical occupancy rates, the Study region is projected to require approximately an **additional 1,330 ILUs over the period 2021 to 2036**, or around 89 each year.
6. The demand generated within the Core study region represents around 80% of total demand for ILUs, at **+1,070 ILUs over the period 2021 to 2036**, or more than 70 per year.

4

Retirement living supply

4.1 Current supply

The location of existing retirement communities is presented in Figure 7, which has been prepared with reference to data held by Deep End Services, and additional information provided through research undertaken on behalf of Yolk.

Figure 7—Existing retirement communities

Source: Deep End Services; Yolk Property Group; web searches

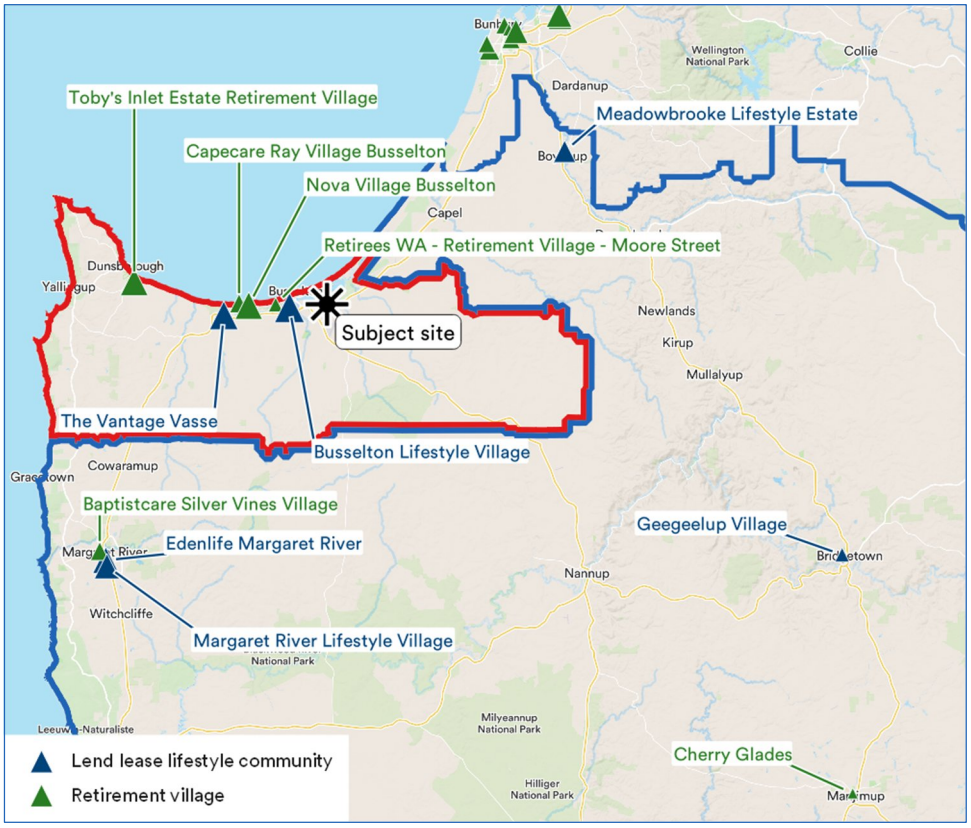


Figure 7 shows that existing retirement communities within the Study region are clustered in Busselton and Margaret River, with others at Dunsborough, Meadowbrooke, Bridgetown and Manjimup. Outside the Study region a cluster of retirement villages is evident in Bunbury.

In terms of land lease lifestyle communities, the two major ones in Busselton are the National Lifestyles Village operated at Busselton, and The Vantage at Vasse. Edenlife is a lifestyle community in Margaret River that is yet to offer homes but is expected to commence construction soon.

The existing retirement villages and lifestyle communities provide an estimated 700 ILUs according to available information, almost evenly divided between retirement villages (351 ILUs) and lifestyle communities (349 ILUs).

Within the Core study region there are 584 ILUs, comprising 290 within retirement villages and 295 within lifestyle communities.

Several of the existing villages are only part-developed, with future additional ILUs considered as a component of future supply.

Note that the estimate of existing supply of retirement units may not include some that are provided as rentals within caravan parks or in mixed use residential parks not identified in Figure 7. According to data from the ABS Census 2021 there may be as many as 100 retirement units not accounted for, potentially in smaller villages or as a component of some aged care providers.

Table 12—Existing retirement unit supply

Study region	Retirement village	Land lease lifestyle community	Total
Core region	290	294	584
Remainder region	61	55	116
Total Study region	**351**	**349**	**700**

4.2 Future supply

The future supply of retirement living units is summarised in Table 13 and incorporates future (unbuilt) stages of existing retirement communities as well as known projects such as Edenlife Margaret River that are yet to commence.

The additions to supply comprise:

- Edenlife Margaret River (159 ILUs)
- The Vantage Vasse future stages (156 ILUs)
- Toby's Inlet Estate Dunsborough future stages (151 ILUs)
- Margaret River Lifestyle Community future stages (105 ILUs)
- Meadowbrooke Lifestyle Estate future stages (78 ILUs)
- Cherry Glades indicative future capacity (41 ILUs).

In total these projects will release an additional 690 ILUs within the Study region, of which 385 (or 55%) would be within the Core study region. If all projects are delivered by 2036 the total supply of ILUs across the Study region would be 1,390 as shown in Table 13.

Of the additional ILUs, almost 500 are associated with new or expanded land lease communities.

Note that the estimates of future ILUs supply within the Study region do not incorporate proposed future projects by Yolk at Yalyalup or in Margaret River.

Table 13—Future retirement unit supply

Study region	Retirement village	Land lease lifestyle community	Total
Core region	441	528	969
Remainder region	102	319	421
Total Study region	**543**	**847**	**1,390**

4.3 Summary

1. There are an estimated 700 ILUs at identified retirement villages or land lease communities within the Study region, although it is recognised that some retirement units may not be captured in this measure – such as those within mixed use residential parks or provided as part of aged care facilities.
2. Most of the existing ILU supply is within the Core study region, and the type of units is relatively evenly distributed between traditional retirement villages and lifestyle communities using a land lease model.
3. When accounting for expansions to existing retirement communities and approved developments not yet built, the total future supply of ILUs is estimated at 1,390, representing an **increase of +690 ILUs** when compared to current supply.
4. Although the majority of future additional supply (55%, or +385 ILUs) is proposed to be delivered within the Core study region, a sizeable component of future supply is identified in and around Margaret River. This is likely to reflect an expectation on the part of the industry of increased demand for retirement living in the area due to the high amenity local environment.

5

Need analysis

The need for additional retirement living to be provided at Busselton can be examined by drawing together the demand and supply analysis that has been presented in previous Chapters.

Summary of demand analysis

The analysis of demand for ILUs presented in Chapter indicates that an additional 1,330 ILUs will be needed over the next 15 years throughout the Study region, representing an annual supply requirement of around 89 ILUs each year.

Focussing on the Core study region, the demand generated by older people living in Busselton is forecast to generate a requirement for an additional 1,070 ILUs per year, at an average of approximately 70 ILUs per year.

It is recognised that some of the demand generated in the Remainder study region could be served by retirement communities located within the Core region, and vice versa – the actual distribution will depend on factors such as relative amenity, the wish to be close to regional health services, the decisions made by developers of retirement communities, and planning decisions by local authorities.

Moreover, the analysis presents a conservative picture of potential future demand for retirement living in the Busselton region. More significant demand would emerge if retirement living propensity rates increase higher than forecast, and if Busselton becomes a nationally-recognised location for people moving into retirement living, recognising the high-quality amenity and quality of living environment available in the region.

Summary of supply analysis

The analysis of retirement unit supply presented in Chapter 4 indicates that there are currently around 700 ILUs in identified retirement communities (and possibly 100 more in other facilities that have not been identified).

Expansions in existing facilities and approved developments have capacity to increase the supply of ILUs by +690 ILUs, to bring total supply to 1,390 ILUs across the Study region. The increase in supply within the Core study region is estimated at +385 ILUs compared to current levels.

The estimates of future supply above do not make allowance for proposed new retirement communities – such as those by Yolk – that do not yet have planning approval.

Need for additional retirement living

The above assessment of demand and supply in the retirement living sector in the Study region establishes that there is a need for additional ILUs to serve forecast demand over the next 15 years.

According to the analysis, the current additional supply of +690 ILUs is sufficient to cater to demand only over the coming 7 to 8 years. **At least another 640 ILUs** will be required to cater to remaining demand for the period 2021 to 2036, with additional demand required thereafter as the region continues to be attractive for people to retire to.

The need for retirement living units would be even higher if propensity rates increase above the levels modelled in this report.

Conclusion

The analysis presented in this report provides strong support for additional provision of retirement living at Yalyalup to serve future demand for ILUs.

The proposed development would cater for projected demand over the forecast period, at a location that is well-suited for a new retirement community as it is supported by a future neighbourhood centre, is close to the Busselton town centre, is easily accessible via the Bussell Highway and potential future Outer Bussell Highway, and is convenient for retirees wishing to use the Margaret River Busselton Airport.

Engineering a better future for over 20 years!

Lots 2, 9032 and 9034 Embark Estate, Yalyalup

Proposed Structure Plan Amendment

Revised Transport Impact Assessment

PREPARED FOR:
Yolk Property Group
February 2025

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1 Introduction and Background

This second Revised Transport Impact Assessment (RTIA) report has been prepared by Transcore for Yolk Property. The subject of this report is the proposed Structure Plan (SP) amendment for lots 2, 9032 and 9034 Embark Estate in Yalyalup Busselton.

Transcore initially prepared a TIA in December 2022 for the proposed SP amendment, assuming a full development of SP amendment by 2031. Main Roads WA requested further assessments for 2041 to ensure satisfactory traffic operations on Bussell Highway. In June 2023, Transcore submitted a revised TIA for the 2041 evaluations.

Following this, Main Roads WA and the Department of Planning, Lands and Heritage (DPLH) provided feedback in September 2023, asking for updates to the traffic modelling based on agreed assumptions for the Embark Estate and future developments, detailed in Appendix A.

Transcore then prepared an updated TIA in May 2024, which included a roundabout at Access B and a full movement intersection at Joseph Drive/Bussell Highway. Main Roads WA suggested considering a signalized intersection at Access B during discussions with DPLH, which prompted DPLH to conduct independent modelling using Transcore's projections. They assessed two access options at Joseph Drive/Bussell Highway: left in/left out/right in and left in/left out.

Consequently, Transcore was tasked with updating the May 2024 TIA to reflect the latest SP amendments and intersection recommendations from DPLH and Main Roads WA for Access B.

To fulfill the requirements of this TIA and establish the trip generation of the existing developments, Transcore also organised video traffic counts for Tuesday, 6th February 2024, at the following intersections:

- Vasse Highway/ Blum Blvd;
- Vasse Highway/ Patterson Drive; and,
- Bussell Highway/ Joseph Drive

The location of the site (Structure Plan amendment area) is shown in Figure 1. The subject site is located on the southern side of Bussell Highway (north of the Busselton Airport). The Busselton City Centre is located 4.7km northwest of the subject site. The subject site is currently accessed primarily from Joseph Drive. The 'Proposed Busselton Outer Bypass' (BOB) would traverse the southern boundary of the site, with no access to this SP amendment.

A future development associated with Embark Estate (to the east of the subject site) has been included in the assessment and analysis for the preparation of this TIA to ensure adequacy of the proposed access/ egress and road standards with the balance landholdings for Embark Estate.

The subject site was subject to a structure plan amendment in 2018. The structure plan was considered by the Statutory Planning Committee of the Western Australian Planning Commission on the 12th of October 2021 and endorsed for final approval (subject to minor modifications). A copy of the approved structure plan is provided in Appendix B. Jacobs prepared a TIA for the approved SP back in March 2020. Transcore prepared a technical note (TN 01a dated 09/08/2022) as an amendment to the Jacobs TIA which outlined the framework of the implementation strategy for the SP internal and external road connections.

This second Revised TIA report will establish the traffic generation and distribution of the proposed SP amendment. The operation of the existing and future Bussell Highway intersections fronting the SP amendment area will be assessed and the proposed standard and layout of these intersections after full development of the SP amendment area will be investigated.

Further, the assessments undertaken in this TIA will include the traffic generation of the existing developments (established by traffic counts) and all the future developments in the locality including:

- Embark Estate;
- Willow Grove Estate;
- Lots 31 & 32 Bussell Hwy;
- Lot 6;
- South of Provence; and,
- Area to the East of the SP amendment.

For the preparation of this report reference was made to the following reports:

- Provence Estate Structure Plan prepared by RPS Australia Pty Ltd, July 2018;
- Short Form Planning Report prepared by Hex Design and Planning, October 2021;
- Transport Impact Assessment prepared by Jacobs for Provence Estate Structure Plan, March 2020;
- Implementation of Internal and External Road Connections; Transcore technical note, August, 2022; and,
- Market Potential Assessment prepared by IQ, February 2022.

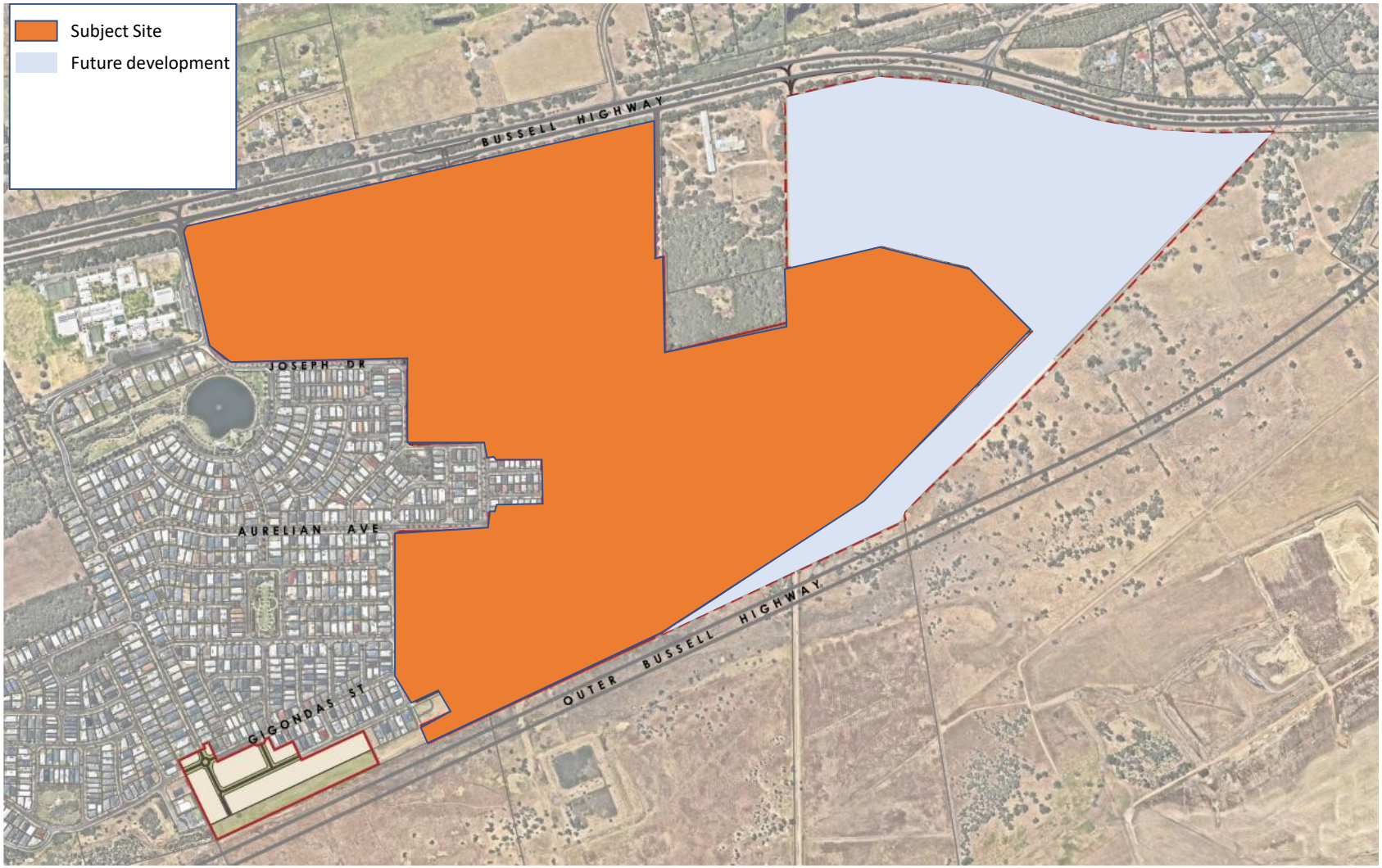


Figure 1: Location of the subject site

2 Structure Plan Amendment

The SP amendment area shown in Figure 1 falls within the approved October 2021 Provence Estate Structure Plan and will contain the following land uses:

- A total of about 875 residential dwellings;
- A retirement village with a total of about 300 units;
- A primary school; and,
- A supermarket and specialty shops within the proposed Embark Estate Village Centre with the following potential land uses shown in Table 1.

Table 1: Proposed land uses within the Embark Estate Village Centre

Land use	GFA
Medical	315
Co Working	380
Pharmacy	272
Mixed Use	300
Health and Wellbeing	300
Childcare	760
Supermarket	3628
Liquor Store	240
Retail	625
Food and Beverage	577
Café	120
Total Supermarket	**3,628**
Total Specialty shops	**3,879**
Grand total	**7,517**

Appendix A provides further details including the development site plan for the Embark Estate Village Centre.

The land to the west of the Amended LSP is developed by Satterley Property Group between circa 2005 - 2021, then known as Provence Estate. Yolk Property Group purchased the remainder of the Provence project late in 2021 and now develops the balance land under the rebranded name of Embark Estate. Willow Grove Estate is located at the southeast corner of the intersection of Vasse Highway/ Bussell Highway and has been under construction by the Blum Family since 2000. The breakdown of the existing and future residential dwellings in this locality is provided in Appendix A and summarised in Table 2. Georgiana Molloy Anglican School (GMAS) is located at the southwest corner of Joseph Drive/ Bussell Highway. The school has an enrolment of 1,200 students.

Table 2: Existing and future residential dwellings

Areas	Existing	Future	Total
Willow Grove Estate (Blum Family)	149	112	261
Via Vasse Hwy (South West)	282		282
Provence Estate	743		743
Embark Estate Residential		875	875
Embark Land Lease		300	300
Lot 31 & 32 Bussell Hwy		213	213
Lot 6		238	238
South of Provence		41	41
Area to the East of the SP amendment		450	450
Total residential	**1,174**	**2,229**	**3,403**

The timing for full development of the SP area depends on the economic conditions and development progress rate in future. Three different scenarios have been investigated by Yolk Property Group for the development progress rate following the review of annual Busselton region sales under current economic conditions. Table 3 summarises the development progress rate for the next 15 and 20 years under each scenario.

As evident for the next 15 to 20 years a maximum of about 58% and 78% of the proposed SP would be developed respectively under the optimistic scenario of 50% per annum sales (in Busselton Region). The trip generation, distribution and SIDRA analysis in this TIA were undertaken conservatively for the potential full development (100%) of the proposed SP amendment area and future development to the east of

the SP amendment area in 2044. Furthermore, the assessments do not consider the potential construction of the Busselton outer bypass by 2044. If the bypass is built, it would provide an alternative route for traffic and potentially divert a significant portion of traffic away from Bussell Highway. As a result, the traffic projections on Bussell Highway would likely be reduced compared to the estimates provided in this TIA.

Overall, these factors indicate that the assessments undertaken for this TIA are conservative and may result in a more cautious estimation of the potential traffic impacts.

Table 3: Development progress (source: Yolk Property)

15 years Scenario	SP 33% of per annum Busselton Region Sales	SP 40% of per annum Busselton Region Sales	SP 50% of per annum Busselton Region Sales
Total Annual Sales in Structure Plan	45	54	68
Total Structure Plan (SP) Yield	1751	1751	1751
15yrs total abortion of vacant lots in SP (volume of lots/homes to be used for modelling)	678	815	1019
% of SP developed	39%	47%	58%
% of SP not developed	61%	53%	42%
20 years Scenario	**SP 33% of per annum Busselton Region Sales**	**SP 40% of per annum Busselton Region Sales**	**SP 50% of per annum Busselton Region Sales**
Total Annual Sales in Structure Plan	45	54	68
Total Structure Plan (SP) Yield	1751	1751	1751
20yrs total abortion of vacant lots in SP (volume of lots/homes to be used for modelling)	904	1086	1358
% of SP developed	52%	62%	78%
% of SP not developed	48%	38%	22%

The movement network within the SP amendment area and its connectivity to the surrounding roads as shown in Figure 2 generally aligns with the approved October 2021 Provence Estate Structure Plan, with a few exceptions:

- The Embark Estate intersection on Bussell Highway (Access B) is proposed to function as a signalised intersection instead of a priority-controlled T-intersection. This decision was made based on conservative assumptions adopted for the assessments (refer Appendix A for the conservative assumptions). Previous analyses conducted by Transcore (June 2023) and Jacob (March 2020) indicated that a priority-controlled T-intersection would be sufficient at this location.

- The connection between Blum Blvd in Willow Grove Estate and Hawker Approach in Provence Estate would not be implemented. This will reduce the amount of through traffic on Blum Blvd. While Willow Grove Estate would be connected to the surrounding development via Golding Ramble, this road features numerous bends and intersections, making it a convoluted and indirect route. As a result, it is less attractive for traffic from Provence/Embark developments to utilise Blum Blvd. Additionally, the current section of Golding Ramble is designed as a Neighbourhood Connector B road without a median and with a maximum traffic volume threshold of 3,000vpd. The future sections of Golding Ramble will adhere to the same standard, indicating that it is not intended to accommodate significant through traffic.

Upon construction of the future development to the east, a roundabout intersection is assumed in the northeast part of the area where Tuart Drive connects to Bussell Highway (Access C). The standard for Access C will need to be further determined and assessed through a Transport Impact Assessment when subdivision and/or development is proposed over the area.

The proposed road network has been designed to evenly distribute traffic to the surrounding road network. The proposed Structure Plan amendment is shown in Appendix B.

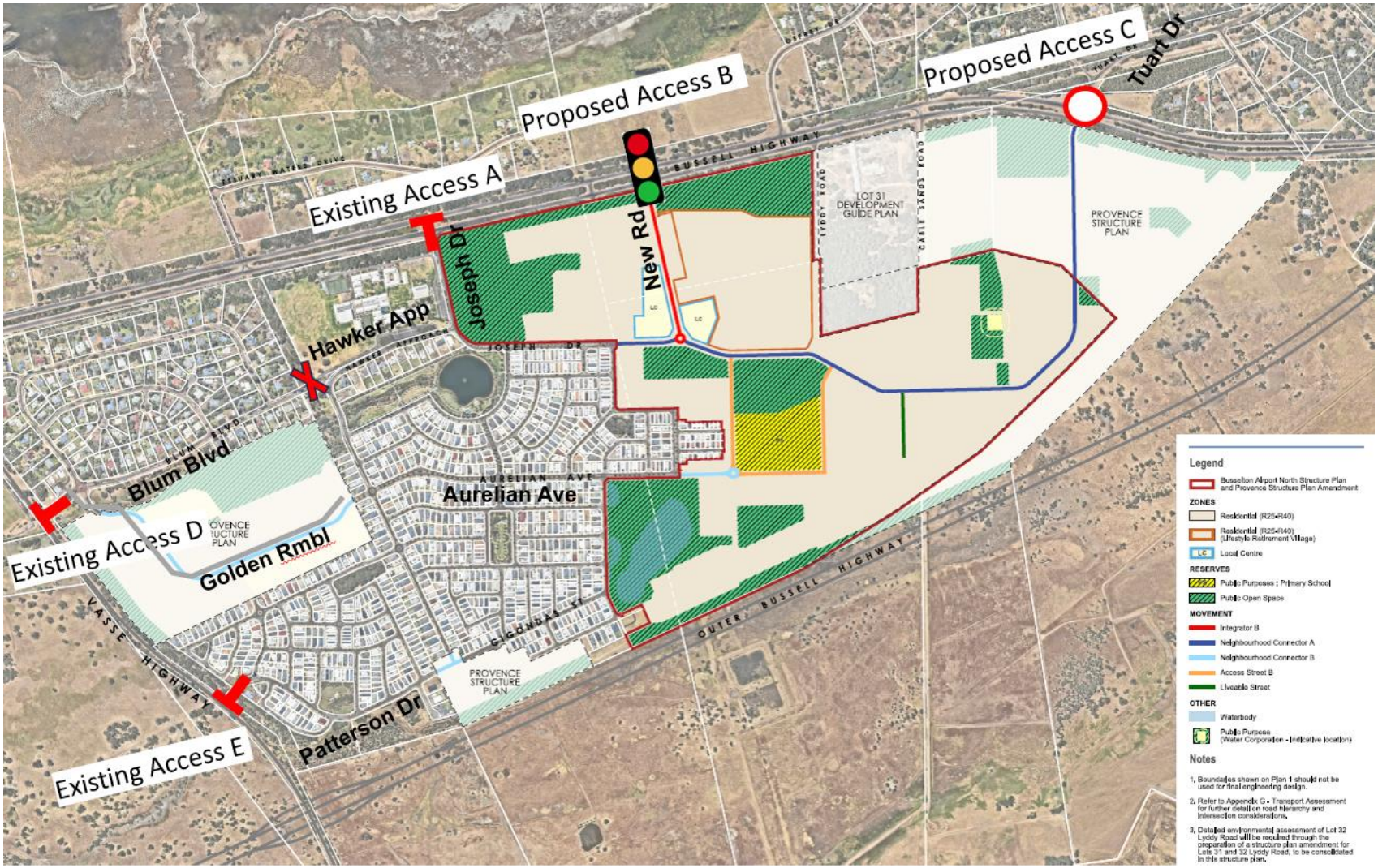


Figure 2: Existing and proposed key roads and intersections

3 Existing Situation

3.1 Existing Land Use

The subject land is currently vacant. The subject site is located to the east of the existing developed areas, as shown in Figure 1. This area has historically been developed from west to east and future development will progress towards the east.

3.2 Existing Road Network

The existing road network and its classification in accordance with the Main Roads WA functional road hierarchy is illustrated in Figure 3.

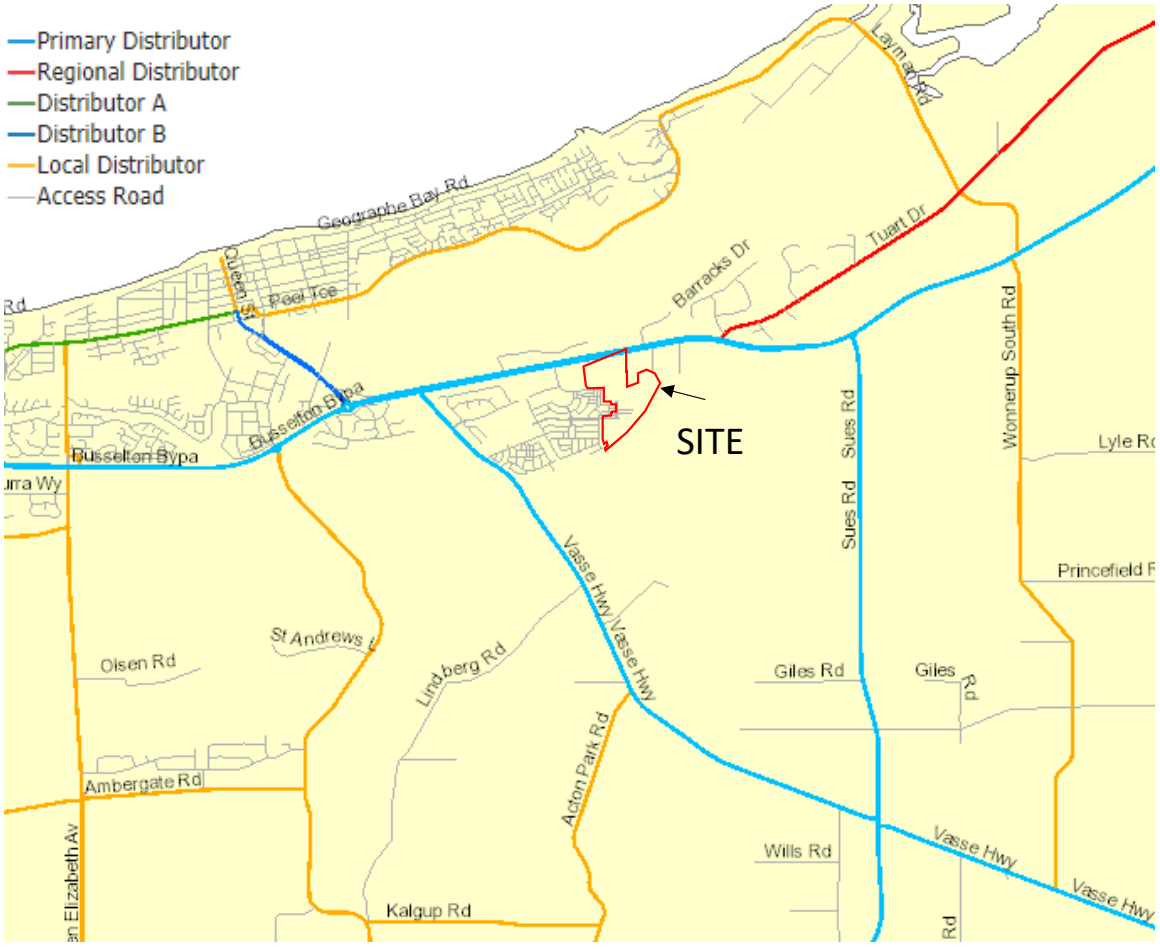


Figure 3: Existing road hierarchy

Bussell Highway forms the northern boundary of the site and is classified as a primary distributor road in this locality. It is constructed as a four-lane divided carriageway including a 28m-30m wide median. In the vicinity of the subject site, Bussell Highway has a posted speed limit of 90km/h westbound and 110km/h eastbound. The sign

posted speed reduces to 70kmh near the intersection of Vasse Highway/ Bussell Highway. Figure 4 shows Bussell Highway westbound approach in the vicinity of the subject site. Bussell Highway in this vicinity is a RAV Network 4 road classified to carry heavy vehicle combinations of up to 27.5m in length



Figure 4: Bussell Highway westbound in the vicinity of the subject site

Bussell Highway intersects with Joseph Drive at a priority-controlled T-intersection with turn lanes on Bussell Highway including an acceleration lane on Bussell Highway westbound (refer Figure 5). On the eastern and western approaches to the intersection, Bussell Highway features a central median that varies in width between 28 metres and 30 metres. This median width provides the opportunity for staged crossing, which can facilitate the right-turn movements at the intersection.



Figure 5: Intersection of Bussell Highway/ Joseph Drive (Access A)

The existing intersection of Bussell Highway and Tuart Drive is also in the form of a full movement priority control T- intersection with a central median of approximately 30m wide allowing staged crossing.



Figure 6: Intersection of Bussell Highway/ Tuart Drive (Access C location)

Vasse Highway, in this vicinity, is approximately 8m wide, single-carriageway, two-lane road with 2.5m wide unsealed shoulders (refer Figure 7). It provides regional connectivity between Busselton, Nannup and Pemberton. Vasse Highway is classified as a Primary Distributor, under care and control of Main Roads WA. In the vicinity of the site, Vasse Highway operates under an 80km/h posted speed limit increasing to 110km/h further south.

Vasse Highway in this vicinity is a RAV Network 4 road classified to carry heavy vehicle combinations of up to 27.5m in length.



Figure 7: Vasse Highway looking north

The intersection of Vasse Highway/ Blum Blvd and Vasse Highway/ Patterson Drive is currently constructed as a priority-controlled T-intersection with left turn lanes on Vasse Highway southbound and widening in the northbound direction in the form of an AUR (auxiliary right turn lane) treatment (Refer to Figure 8 and Figure 9).



Figure 8: Vasse Highway/ Blum Blvd intersection (Access D)



Figure 9: Vasse Highway/ Patterson Drive intersection (Access E)

Joseph Drive is constructed as Neighbourhood Connector A standard with a solid median, on-street parking bays and shared paths along the southern side of this road (Refer to Figure 10).



Figure 10: Joseph Drive looking west

3.3 Existing Traffic Volumes

The latest available reported traffic counts on the surrounding roads have been sourced from Main Roads WA and presented in Figure 11.

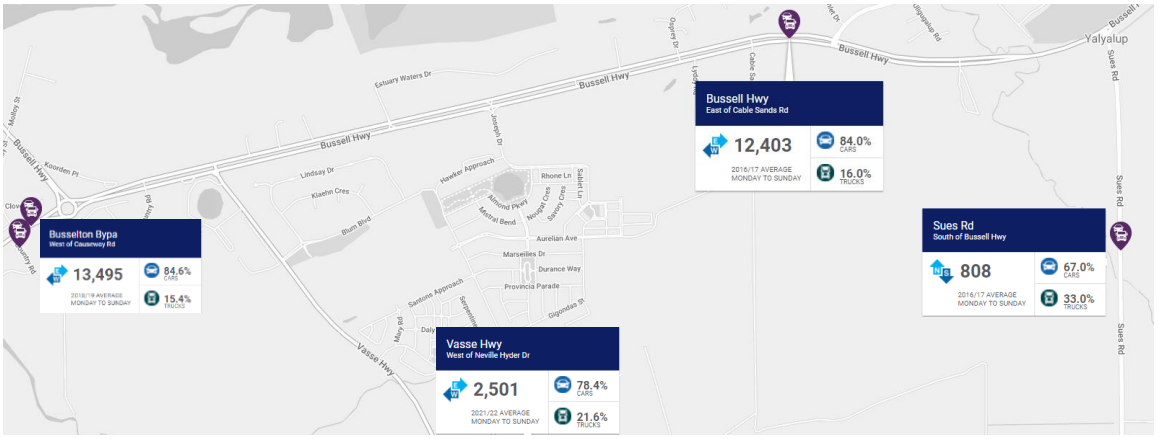


Figure 11: Existing traffic counts (Source: Main Roads WA)

Transcore organised video traffic counts for Tuesday 6th February 2024 at the following intersections:

- Vasse Highway/ Blum Blvd;
- Vasse Highway/ Patterson Drive; and,
- Bussell Highway/ Joseph Drive.

The peak hours traffic counts at the intersection are shown in Figure 12. The peak hours at the intersection of Blum Blvd/ Vasse Highway are recorded to be at 7:45-8:45 AM and 16:30 – 17:30 PM.

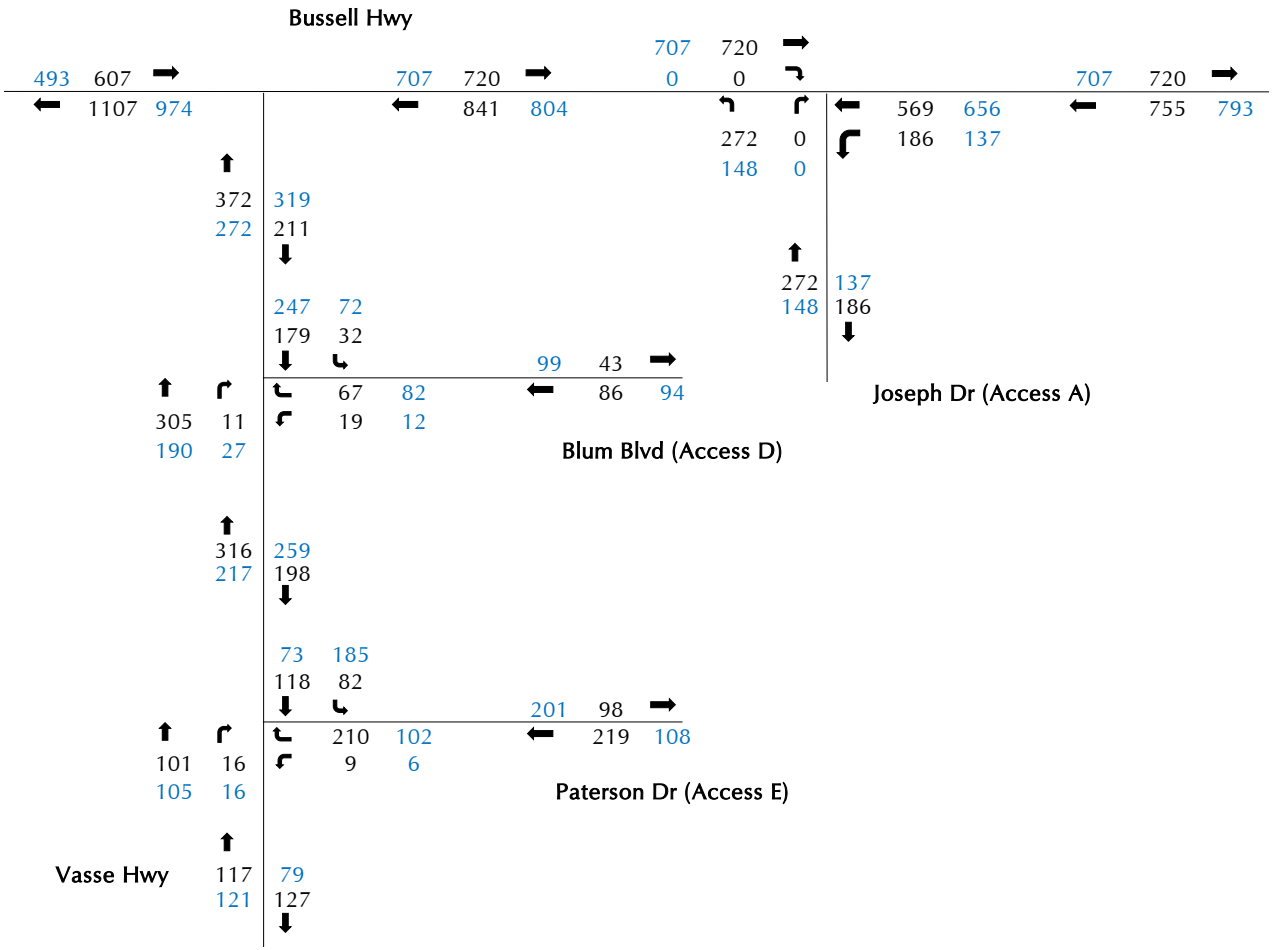


Figure 12: Existing traffic (February 2024) counts AM/PM Peak hour

3.4 Public Transport

There are no bus services on the surrounding roads in the vicinity of the subject site. Currently the demand for public transport is not sufficient to provide services in this area.

3.5 Pedestrian and Cyclist Facilities

Currently, there are no footpaths, shared paths or on-road cycle lanes on Bussell Highway in this vicinity. A shared path is in place on the southern side of Joseph Drive.

The proposed SP amendment area will be connected to the existing established residential area to the west of the subject site by a highly permeable footpath network within the SP amendment area.

3.6 Changes to the surrounding road network

The City of Busselton, in conjunction with the DPLH, are also finalising a planning study to confirm the alignment for the future BOB which will be a four-lane freeway between Sues Road and Marbellup Road. Figure 13 shows the proposed preliminary alignment of the Busselton Outer Bypass.

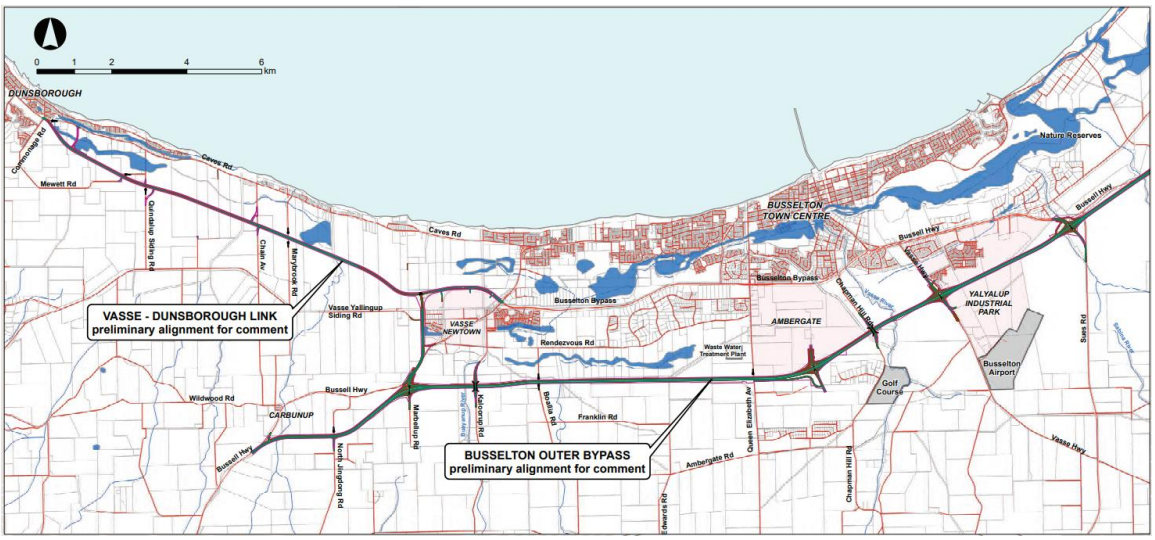


Figure 13: Busselton Outer Bypass (Preliminary alignment)

4 Proposed Internal Transport Network

4.1 Road Hierarchy

The proposed hierarchy of roads within the SP amendment area is illustrated in Figure 14 using the road hierarchy classification from the WAPC Liveable Neighbourhoods policy (2009). The proposed road reserves and standard of the internal roads are generally in line with the approved October 2021 Provence Estate Structure Plan.

As evident from Figure 14, The planning and design of the existing and proposed road network within the Embark Estate would distribute a greater amount of traffic towards Bussell Highway compared to Vasse Highway. This is evident in a few key ways:

- There are more high-capacity road connections (Neighbourhood Connector A and Integrator B) provided to directly access Bussell Highway, versus the fewer connections with lower standard (Neighbourhood Connector B) to Vasse Highway.
- The existing and proposed intersections along Bussell Highway (Access A, B, and C) are designed to a higher standard, which makes them more attractive and able to accommodate higher traffic volumes compared to the existing intersections on Vasse Highway (Access D and E).

Some key characteristics of the relevant road classifications have been summarised in Table 4. These are generally based on Liveable Neighbourhoods guidelines although the proposed widths may vary from the standard Liveable Neighbourhoods cross-section diagrams.

It should be noted that these reserve widths are indicative only and are subject to further adjustment in consultation with the DPLH and City of Busselton during detailed subdivision design. The proposed design and standards for the new roads within the Structure Plan Amendment are expected to be consistent with the existing roads in the area. This approach will ensure seamless connectivity throughout the road network.

Table 4: Key characteristics for the proposed road classifications

Road Classification	Indicative upper volume (vpd)	Indicative road reserve width (m)	Indicative road pavement width (m)
Integrator B	15,000	25m	2 x 5m (incl. cycle lanes) + median
Neighbourhood Connector A	7,000	23m	2 x 5m (incl. cycle lanes), 2m median and embayed parking
Neighbourhood Connector B	3,000	20m	7.4m and embayed parking
Access Street B	3,000	18m	9.7m (with on-street parking) or 6m (plus embayed parking)
Access Street D	1,000	15m	6m

Integrator B

The new access road on Bussell Highway, (road leading to Access B), is projected to carry approximately 11,000vpd and therefore this road would be classified as an Integrator B road.

A signalised intersection is proposed at Access B, which serves as the central access point to the Embark Estate. Compared to the priority-controlled T-intersection at Joseph Drive (Access A), the signalised intersection at Access B is expected to have additional capacity during peak hours.

This increased capacity at the signalised intersection (Access B) will result in more traffic being distributed through this access point. Consequently, the road leading to the Access B signalised intersection is anticipated to carry a higher overall traffic volume compared to Joseph Drive.

Neighbourhood Connectors

The blue road shown in Figure 14 is suggested to be classified as a Neighbourhood Connector A road. This classification is expected to accommodate traffic volumes between 3,000vpd to 7,000vpd.

The existing standard of Joseph Drive is in line with the Neighbourhood Connector A road specifications as per the Liveable Neighbourhoods guidelines. The same consistent standard is expected to be provided for the continuation of this road further east, within the proposed SP Amendment area.

The other existing east-west connections in the area are constructed within an 18m to 20m road reserve. This is consistent with the standard and classification of a Neighbourhood Connector B road, as per the LN guidelines. These roads are expected to carry traffic volumes up to 3,000vpd.

Access Streets

The basic standard of Access Street D roads within the amended SP area is a 6m wide carriageway in a 15m road reserve. The Access Street D entails 4.5m verges on both sides, with embayed parking accommodated in the verges where required, such as to provide visitor parking for lots serviced by rear laneways. This road standard is proposed where the future total traffic volumes are less than 1000vpd. It is anticipated that most of the access streets shown in the amended SP area would be of this category. It should be noted that where services are only required to one side of the road, such as those roads adjoining public open space, a reduced road reserve width of 13-metres can be provided in line with LN Guidelines.

The access street abutting the proposed primary school is recommended to be constructed to the Access Street B cross-section standard, which allows for parking on both sides of the street, either on-street or as embayed parking.

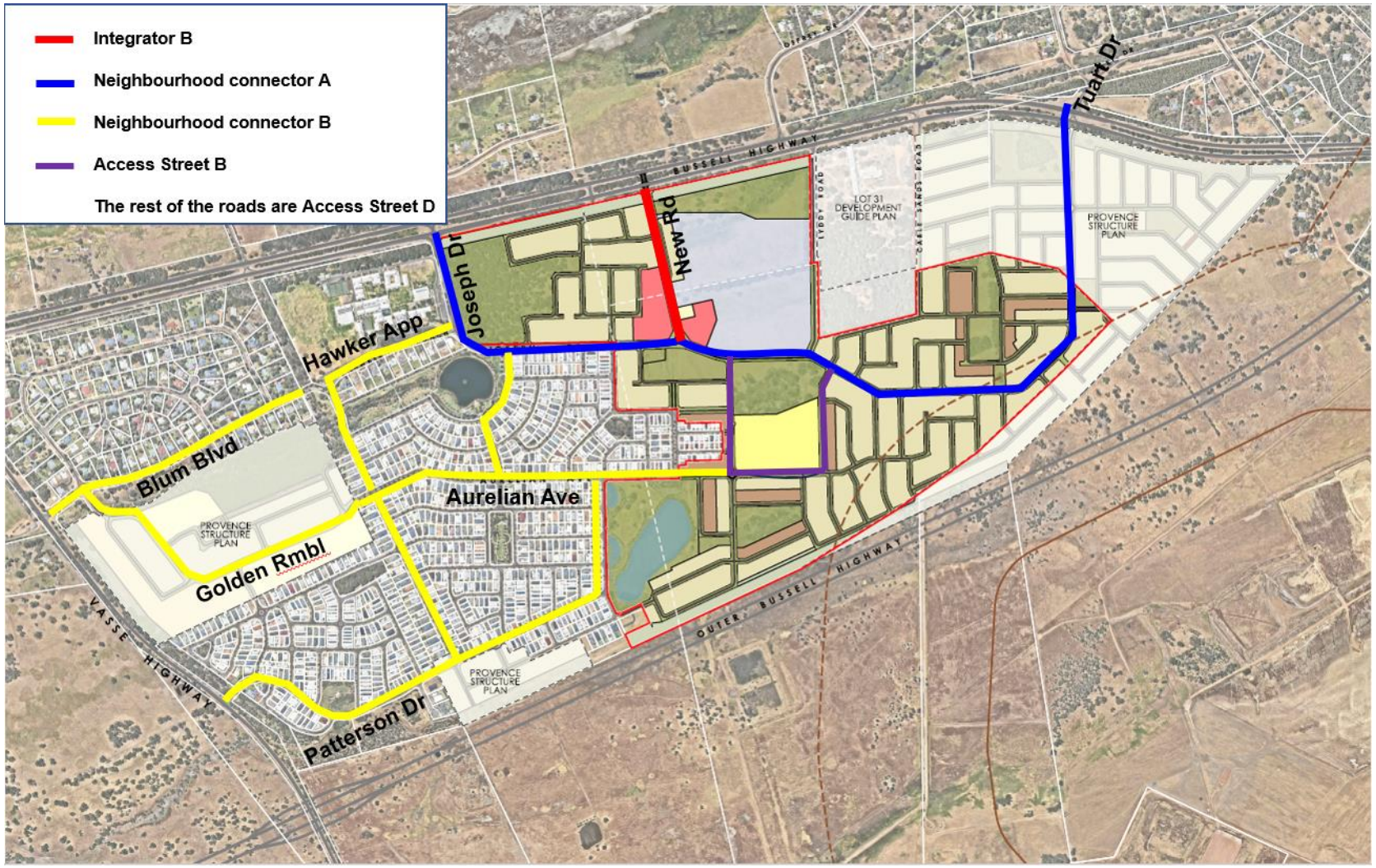


Figure 14: Proposed road hierarchy

4.2 Pedestrian and Cyclist Facilities

The overall pedestrian network within the SP amendment area is based on connecting centres of attraction within and immediately beyond the SP amendment area and providing good pedestrian links to the existing developments to the west and future developments to the east.

Footpaths are recommended on at least one side of all Access Streets within the SP amendment area. In accordance with the WAPC Liveable Neighbourhoods Policy, shared paths and footpaths are proposed along all Neighbourhood Connector roads.

4.3 Integration with Surrounding Area

The proposed SP amendment is residential in nature with a village centre, which is consistent in character with the existing and future developments in this locality. The proposed movement network will provide opportunities for connection with the existing road network of existing residential developments to the west and future urban development to the east.

4.4 Safe walk/cycle to school

The existing and proposed shared path network within the Embark Estate would provide safe and convenient routes for pedestrians and cyclists to access the existing and future school sites. In particular, the existing shared path along Joseph Drive and its continuation further east would offer connectivity, as it would pass by both the existing school and the proposed new school site. This shared path network, with the Joseph Drive path and its eastern extension, would facilitate safe and convenient active transport access to the schools located within the Embark Estate development.

Additionally, the school zone (40km/hr posted speed limit on school days from 7:30-9:00am and from 2:30-4:00pm) restrictions should be applied to the road adjacent to the schools according to standard Main Roads WA warrants.

Based on the WAPC Transport Impact Assessment Guidelines (2016), the existing and proposed roads within the Embark Estate would have acceptable traffic volumes for pedestrians to cross safely, with an undivided two-lane road able to be crossed safely by pedestrians at traffic volumes up to approximately 11,000vpd, and this threshold increases to around 28,000vpd by adding a central median or pedestrian refuge islands.

The provision of this high-quality shared path infrastructure, combined with the school zone speed restrictions and road design features, is intended to encourage and enable more students to walk or cycle to school from the existing and future developments in this locality.

5 Analysis of the Transport Network

5.1 Assessment Period

The assessment year that has been adopted for this analysis is 2044, which assumes full development of the SP amendment area and the potential future development to the east of the SP amendment area.

5.2 Traffic generation and distribution

The daily traffic generation rates used in this assessment have been derived from peak hour trip generation rates recommended in the Western Australian Planning Commission (WAPC) Transport Impact Assessment Guidelines (2016). The trip rates used are 8 vehicle trips per day (vpd) per dwelling.

For the primary school, the trip rate used is 1.0 vph per student during school peak periods (typically 8-9am and 3-4pm) and 2vpd per student daily. For this assessment, approximately 650 students have been assumed for the proposed primary school, so this primary school is assumed to attract traffic flows of about 1,300vpd or 650vph.

The proposed trip rates for the Supermarket and Specialty Shops were sourced from RTA NSW – Guide to Traffic Generating Developments. Accordingly, a trip rate of 155vpd per 100sqm NLA of the Supermarket and 46vpd per 100sqm of GFA of Specialty Shops were adopted for the assessment. The PM peak hour trips rates were assumed to be 10% of the daily trip rates.

It should be noted that since retail and specialty types of land uses typically generate minimal trips during the weekday AM peak hour of the adjacent road network (typically businesses commence operations around 9 or 10AM), adjustment factors (20% of the PM trip rates were used for AM trip rates) have been applied for such land uses to realistically represent the actual traffic generation of these land uses during this period.

Given that the Embark Estate is planned to include a primary school (in addition to the existing GMAS school) as well as a village centre, it is expected that a portion of the trips generated by Embark Estate and existing residents will be attracted to these internal destinations. On a conservative basis, it is assumed that:

- Approximately 80% of the trips to the primary school within Embark Estate will be internal to the estate.
- Around 70% of the trips to the proposed Supermarket and Specialty shops in the village centre will also be internal to Embark Estate.

The remaining 20% of primary school trips and 30% of village centre trips are anticipated to be distributed to the external intersections surrounding the Embark Estate.

Accordingly, it is estimated that after full development of all land uses, the proposed SP amendment area would generate a total of approximately 17,918 trips per weekday (total of inbound plus outbound) and approximately 1,822vph and 1,766vph during the AM and PM peak hours respectively (refer Table 5).

Table 6 summarises the total trip generation of the new developments including the potential future development to the east of the SP amendment area. The analysis undertaken in this TIA conservatively includes the trip generation and distribution of the future development to the east of the SP amendment area in 2044. The trip generation of the existing developments to the west and south of the SP amendment area were also captured by the traffic counts organised by Transcore and allowed for in the assessments.

The distribution of traffic to and from the proposed SP amendment area via each access point for year 2044 was evaluated by considering the catchment area of the proposed SP amendment as well as the available access and egress routes to and from the SP amendment area in line with the existing distribution pattern established by traffic counts:

- Trip distribution to/ from Busselton: 80%
- Trip distribution to/ from Bunbury: 15%
- Trip distribution to/ from south via Vasse Hwy: 5%

Figure 15 illustrates the trip distribution of the proposed SP amendment area on the surrounding roads and intersections during the peak hours. Trip distribution of the other future developments have also been established separately and reported in Appendix D.

Table 5: Structure Plan amendment trip generation

Structure Plan	Land use	Quantity	Daily Rate	Weekday-AM Peak	Weekday-PM Peak	Internal trips	Daily Trips	Weekday-AM trips	Weekday-PM trips	AM IN	AM OUT	PM IN	PM OUT
Proposed SP amendment	Residential	875	8	0.8	0.8	0	7000	700	700	175	525	438	262
	Specialty shops	3879	0.46	0.0092	0.046	0.7	535	36	54	18	18	27	27
	Retirement Village	300	3	0.3	0.3	0	900	90	90	45	45	45	45
	Primary School	650	2	1	0	0.8	260	130	0	65	65	0	0
	Supermarket	3628	1.55	0.031	0.155	0.7	1687	112	169	56	56	84	85
Total traffic							**10382**	**1068**	**1012**	**359**	**709**	**594**	**418**

Table 6: Total trip generation of new developments

New Developments	Land use	Quantity	Daily Rate	Weekday-AM Peak	Weekday-PM Peak	Internal trips	Daily external	Weekday-AM external trips	Weekday-PM external trips	AM IN	AM OUT	PM IN	PM OUT
Proposed SP amendment	Residential	875	8	0.8	0.8	0.00	7000	700	700	175	525	438	262
	Specialty shops	3879	0.46	0.0092	0.046	0.70	535	36	54	18	18	27	27
	Retirement Village	300	3	0.3	0.3	0.00	900	90	90	45	45	45	45
	Primary School	650	2	1	0	0.80	260	130	0	65	65	0	0
	Supermarket	3628	1.55	0.031	0.155	0.70	1687	112	169	56	56	84	85
Lot 31& 32 Busselll Hwy	Residential	213	8	0.8	0.8	0.00	1704	170	170	43	127	107	63
Lot 6	Residential	238	8	0.8	0.8	0.00	1904	190	190	48	142	119	71
South of Provence	Residential	41	8	0.8	0.8	0.00	328	33	33	8	25	21	12
Area to the East of the SP addendum	Residential	450	8	0.8	0.8	0.00	3600	360	360	90	270	225	135
Wilow Grove	Residential	112	8	0.8	0.8	0.00	896	90	90	22	68	56	34
Total traffic							**18814**	**1911**	**1855**	**570**	**1341**	**1122**	**733**

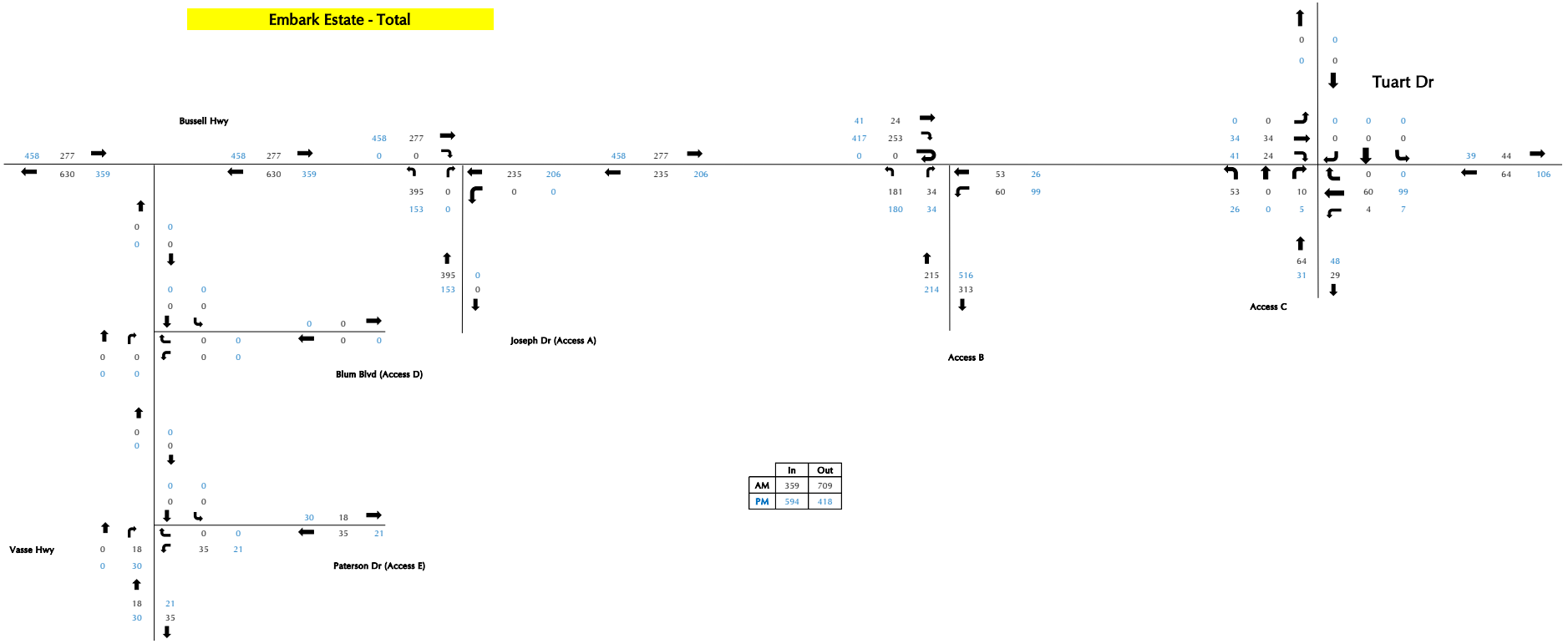


Figure 15: Structure Plan amendment trip distribution during the AM and PM peak hour

5.3 Traffic flow forecast

Figure 16 illustrates 2044 total daily traffic flows estimated for the road network of the SP amendment area and the adjacent developments.

The 2044 peak hour traffic projections on the existing and future intersections along Bussell Highway are illustrated in Figure 17.

In order to establish 2044 traffic projections on Bussell Highway and Vasse Highway the following growth rates recommended by Main Roads WA were adopted:

- 4.17% linear growth over 5 years or 3.86% compound annual growth for Vasse Highway; and,
- 4.23% linear growth over 20 years or 3.12% compound annual growth for Vasse Highway

The review of the 2044 traffic projections on Bussell Highway indicates that around the year 2044, the traffic projections on Bussell Highway immediately east of Vasse Highway would reach 40,000vpd, which is considered the capacity threshold for a 4-lane road on Bussell Highway. Based on this information, the suggestion is that Main Roads WA should plan for the construction of the BOB earlier than 2044, when the traffic projections on Bussell Highway increase to 30,000vpd, as the 2044 traffic projections show Bussell Highway will reach the 40,000vpd capacity threshold at that time.

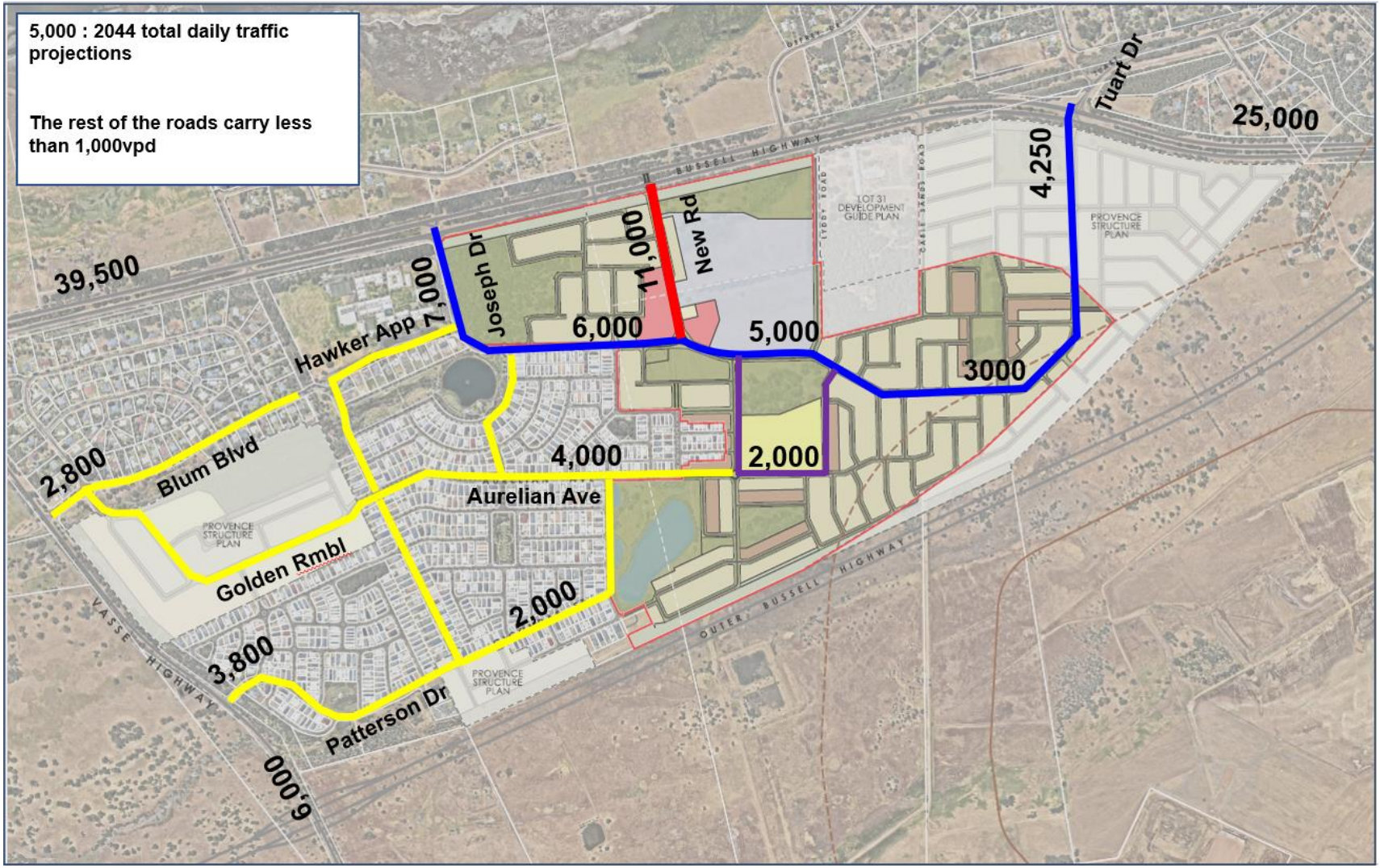


Figure 16: 2044 projected daily traffic volumes

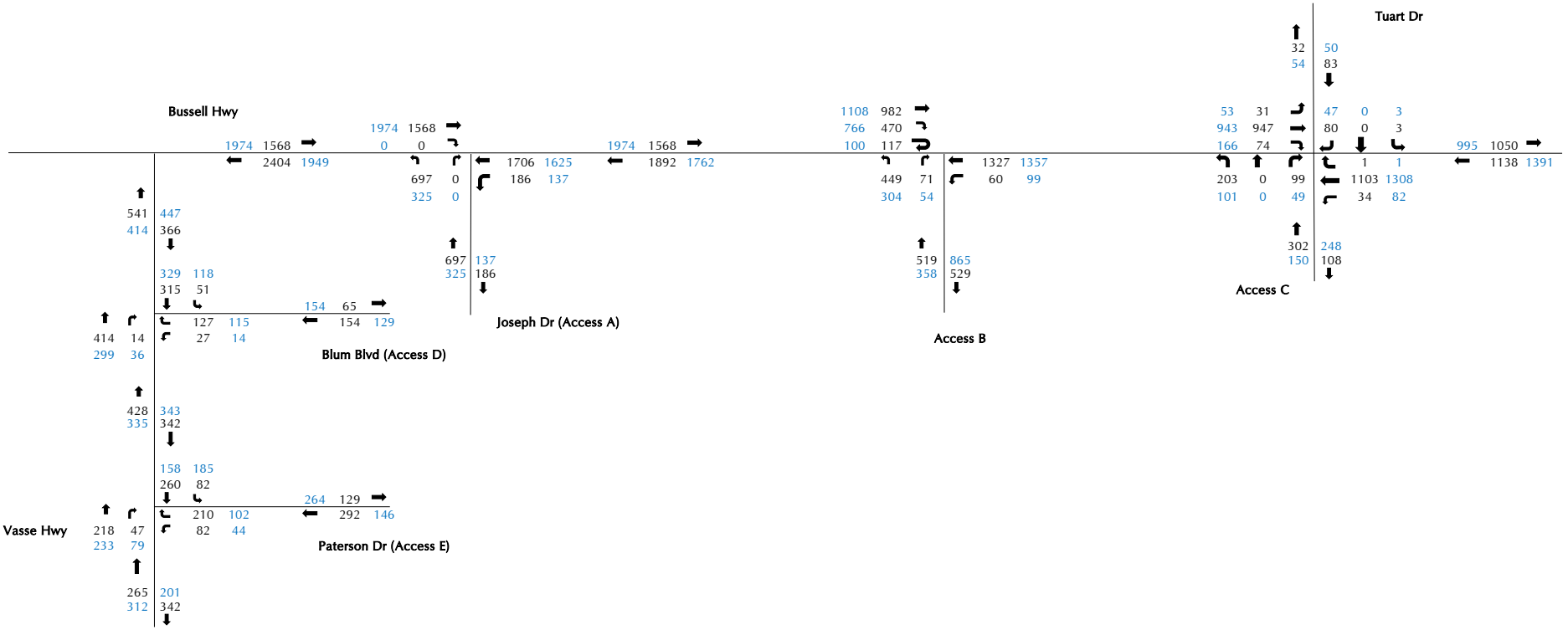


Figure 17: 2044 peak hour traffic volumes at intersections (AM/ PM peak)

5.4 Roads and Intersections

5.4.1 External intersections

The proposed SP amendment currently is accessible via the existing T-intersection of Joseph Drive/ Bussell Highway (Access A in Figure 18) and Paterson Drive intersection on Vass Highway (Access E) via Provence Estate. The Blum Blvd access on Vasse Highway (Access D) is currently used exclusively by Willow Grove.

A new signalised intersection would be provided on Bussell Highway (Access B) as part of this SP amendment. This signalised intersection would provide sufficient capacity to accommodate the SP amendment traffic and additional traffic that would be distributed via the existing and future developments in this locality.

Ultimately and after full development of the future development to the east, a roundabout intersection would be provided within the north-east part of the future development area where Tuart Drive connects to Bussell Highway (Access C).

Lyddy Road/ Bussell Highway is to be closed prior to the construction commencement of Access B and once internal road access/frontage is available from Embark.

Cable Sands Road/ Bussell Highway is to be closed prior to the construction commencement of the proposed new intersection off Tuart Drive and once internal access/frontage is available from development on Lot 22 on DP 415584.

5.4.2 Internal intersections

Roundabouts are proposed for the 4-way intersections along the Neighbourhood connector roads within the SP amendment area. These roundabouts will help manage circulation of traffic flows and assist with speed management. There are other four-way intersections shown on the SP amendment area on low-traffic-volume roads. These intersections are recommended to be constructed as priority-controlled intersections with Give Way control on the minor road approaches as suggested in Liveable Neighbourhoods guidelines. Appropriate entry treatments are recommended on the side roads to help to alert drivers to the presence of the intersections and that traffic on the major road has priority. Figure 18 shows the proposed key intersection treatments within the SP amendment area.

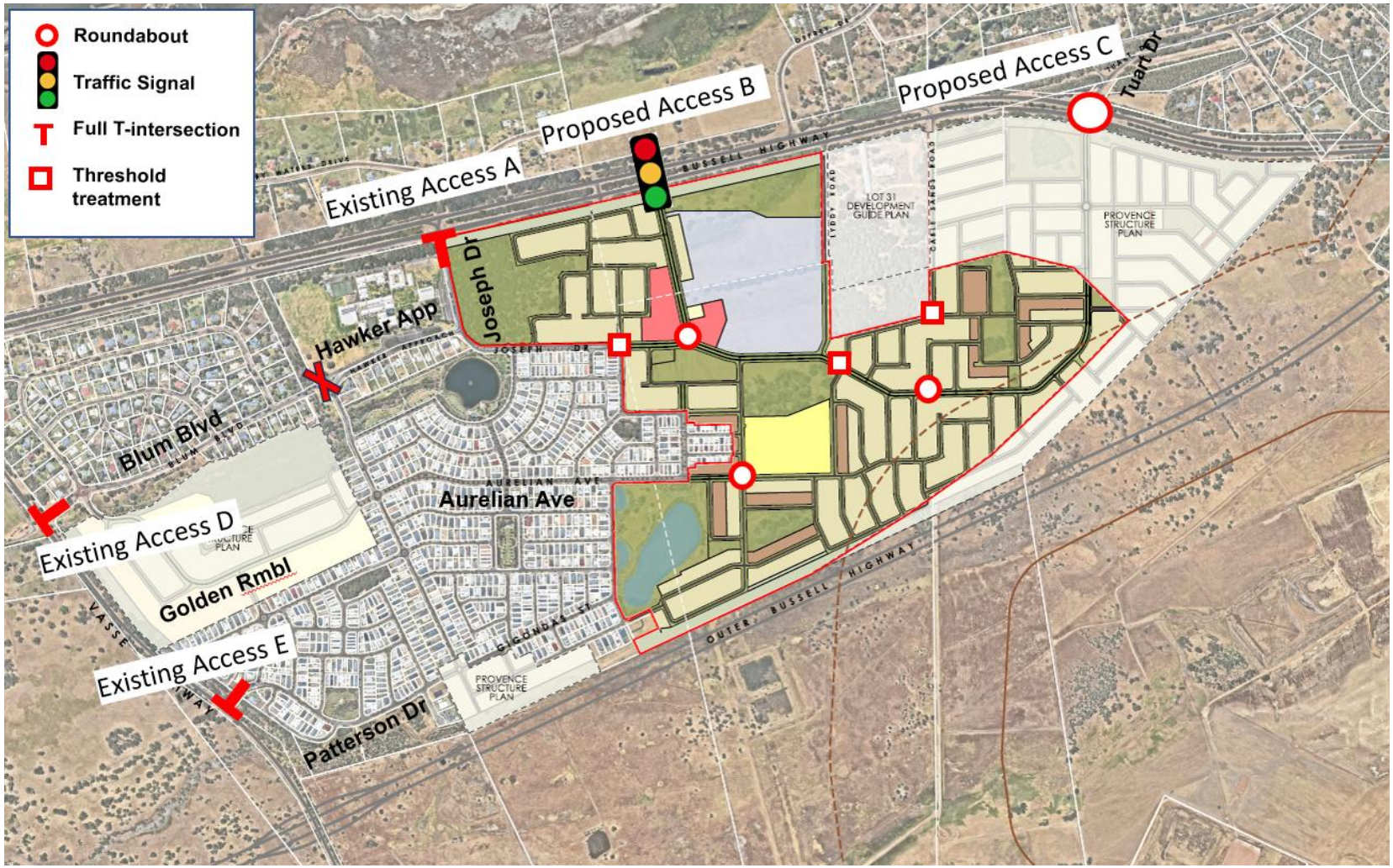


Figure 18: Intersection treatments

5.5 Intersection Analysis

Operation of the following intersections along Bussell Highway has been assessed by SIDRA intersection analysis for year 2044:

- Bussell Highway/ Joseph Drive (Access A);
- Bussell Highway/ central SP access road (Access B);
- Bussell Highway/ Tuart Road/ eastern access road (Access C);
- Vasse Highway / Blum Blvd (Access D); and,
- Vasse Highway/ Patterson Road (Access E).

SIDRA is an intersection modelling tool commonly used by traffic engineers for all types of intersections. SIDRA outputs are presented in the form of Degree of Saturation, Level of Service, Average Delay and 95% Queue. These characteristics are defined as follows:

- Degree of Saturation is the ratio of the arrival traffic flow to the capacity of the approach during the same period. The Degree of Saturation ranges from close to zero for infrequent traffic flow up to one for saturated flow or capacity.
- Level of Service is the qualitative measure describing operational conditions within a traffic stream and the perception by motorists and/or passengers. In general, there are 6 levels of service, designated from A to F, with Level of Service A representing the best operating condition (i.e. free flow) and Level of Service F the worst (i.e. forced or breakdown flow).
- Average Delay is the average of all travel time delays for vehicles through the intersection.
- 95% Queue is the queue length below which 95% of all observed queue lengths fall.

The 2044 peak hour traffic projections on the existing and future intersections along Bussell Highway and Vasse Highway are illustrated in Figure 17. The results of the SIDRA analysis are summarised in Appendix E.

5.5.1 T-Intersection of Bussell Highway / Joseph Drive (Access A)

Intersection analysis undertaken indicates that in 2044 the existing T-intersection of Bussell Highway / Joseph Drive would not operate satisfactorily during the AM peak hours with significant delays and queues at the intersection for all approaches of the intersection. However, during the peak periods due to the sheer volume of traffic on Bussell Highway in 2044 the right turn movements at the intersection would not be able to cross Bussell Highway and would use the central signalised intersection (Access B).

Accordingly, it is recommended that the Access A turning movements are restricted by 2044, with two options available to either:

1. **Option 1**: Restrict right-in movement only to become LILORI intersection; or

2. **Option 2**: Restrict right-in and right-out movements to become a LILO intersection.

The SIDRA analysis indicates that, under Option 1 (restricting the right-in movement only) in 2044, the right-turn movement from Bussell Highway to Joseph Drive (South) is expected to experience a Level of Service (LoS) of F, with average delays ranging from 55 to 60 seconds and a maximum queue length of 12 meters during both the AM and PM peak hours. In contrast, the LoS for other movements at the intersection is expected to range from A to B.

Under Option 2 (LILO), the intersection is expected to operate satisfactorily, with an overall LoS of A and minimal delays.

5.5.2 Bussell Highway/ central SP amendment access road (Access B)

The SIDRA analysis indicates that, under Option 1 (LILORI at Joseph Drive/ Bussell Hwy), the intersection of Bussell Highway/ Access B would operate with an overall LoS of C during both peak hours and LoS D for Access B approach.

Under Option 2 (LILO at Joseph Drive/ Bussell Hwy), the SIDRA analysis indicates that the overall LoS at the Bussell Highway/Access B intersection will remain at LoS C during both peak periods and LoS D for Access B approach.

5.5.3 Roundabout intersection of Bussell Highway / Tuart Drive / Future access road (Access C)

Intersection analysis undertaken indicates that in 2044 the proposed roundabout intersection at Bussell Highway / Tuart Drive / Future access road would operate satisfactorily and well within capacity during the AM and PM peak hours with overall LoS A and marginal delays and queues at this intersection.

5.5.4 Blum Blvd / Vasse Highway (Access D)

The intersection analysis undertaken indicates that the intersection of Vasse Highway/ Blum Blvd would operate satisfactorily with LoS C or better for all movements with minimum delays and queues and significant spare capacity for year 2044.

5.5.5 Patterson Drive / Vasse Highway (Access E)

The intersection analysis undertaken indicates that the intersection of Vasse Highway/ Patterson Drive would operate satisfactorily with LoS C or better for all movements with minimum delays and queues and significant spare capacity for year 2044.

5.6 Speed Limit Reduction on Bussell Highway

It is suggested that the speed limit along this section of Bussell Highway fronting the SP amendment area should be reviewed and reduced to 80kmh in order to achieve consistency for posted speed limit on both sides of Bussell Highway in this vicinity and in recognition of the progressive development along Bussell Highway. Any potential changes to the posted speed limit would impact the design parameters for the layout of the intersections along this section of Bussell Highway.

5.7 Access to Frontage Properties

The WAPC Liveable Neighbourhoods policy requires that "*Developments along neighbourhood connector roads with ultimate vehicle volumes over 5000 vehicles per day should be designed either so vehicles entering the street can do so travelling forward, or are provided with alternative forms of vehicle access. Wider lots with paired driveways and protected reversing areas in the parking lane may be used on streets with up to 7000 vehicles per day.*"

Projected traffic volumes on the majority of the SP amendment internal roads will be less than 5,000vpd, so no restriction on vehicular access is required on the SP amendment internal roads.

The proposed Main Street that connects to the proposed signalised intersection on Bussell Highway is expected to carry more than 7,000vpd and no lot frontage is recommended along this road.

Joseph Drive would carry up to 7,000vpd, therefore, lot frontage is allowed for wider lots with paired driveways and protected reversing areas in the parking lane.

5.8 Pedestrian/ Cycle Network

The proposed network of footpaths for the SP amendment area will provide excellent connectivity to the proposed village centre and the existing and proposed school sites. The SP amendment area will also be connected to the existing established residential area to the west by a highly permeable footpath network within the SP area.

6 Conclusion

This second Revised Transport Impact Assessment (RTIA) report has been prepared by Transcore for Yolk Property, assessing the proposed Structure Plan (SP) amendment for lots 2, 9032 and 9034 within the Embark Estate development in Yalyalup, Busselton.

Transcore originally prepared a TIA in December 2022 for the proposed SP amendment, with an assessment year of 2031 assuming full development of the SP area. Main Roads WA subsequently requested that a further assessment be undertaken for the year 2041 to ensure satisfactory long-term traffic operations on Bussell Highway. Transcore provided a revised TIA in June 2023 to document the 2041 traffic assessments.

After the submission of the revised TIA, Main Roads WA and the DPLH provided additional feedback, requesting that the traffic modelling and analysis be updated using a set of agreed-upon assumptions for the Embark Estate and future developments in the area. These agreed-upon assumptions are listed in Appendix A.

To fulfill the requirements of this TIA and establish the trip generation of the existing developments, Transcore also arranged video traffic counts at the following intersections in February 2024:

- Vasse Highway/ Blum Blvd
- Vasse Highway/ Patterson Drive
- Bussell Highway/ Joseph Drive.

Traffic modelling and analysis undertaken using the assumptions documented in Appendix A, indicates that:

- A 3-leg signalised intersection would be required at the central connection to Bussell Highway (Access B) to provide additional capacity for right turn movements in and out of Embark Estate, existing and future developments in this locality. The standard and layout of the proposed signalised intersection will need to be reviewed during the detailed design stage of the project.
- A 4-leg roundabout intersection is suggested further east on Bussell Highway at Tuart Drive (Access C). This roundabout intersection would need to be constructed as part of the future developments to the east of Embark Estate. The layout and standard of this intersection would also need to be further reviewed as part of the Traffic Impact Assessment that will need to be prepared for this development.
- It is recommended that the Access A (Joseph Drive/ Bussell Highway intersection) turning movements are restricted by 2044, with two options available to either:
    - Option 1: Restrict right-in movement only to become LILORI intersection; or

    - Option 2: Restrict right-in and right-out movements to become a LILO intersection.
- The existing intersection of Blum Blvd/ Vasse Highway (Access D) would be used mainly by Wattle Grove Estate residents. The existing standard of this intersection would be able to accommodate the future traffic that would be distributed to this intersection.
- The existing standard of Patterson Drive/ Vasse Highway is sufficient to accommodate the 2044 traffic projections at the intersection. No further upgrades are suggested at this intersection.

The review of the 2044 traffic projections on Bussell Highway indicates that around the year 2044, the traffic projections on Bussell Highway immediately east of Vasse Highway would reach 40,000vpd, which is considered the capacity threshold for a 4-lane road on Bussell Highway. Based on this information, the suggestion is that Main Roads WA should plan for the construction of the BOB earlier than 2044, when the traffic projections on Bussell Highway increase to 30,000vpd, as the 2044 traffic projections show Bussell Highway will reach the 40,000vpd capacity threshold around 2044.

It is suggested that the speed limit along this section of Bussell Highway fronting SP amendment area should be reviewed and reduced to 80kmh in order to achieve consistency for posted speed limit on both sides of Bussell Highway and the current posted speed limit of 80kmh further west in this vicinity and in recognition of the progressive development along Bussell Highway.

Appendix A

LIST OF ASSUMPTIONS

	Assumption for SIDRA Rev01 As Per 20.03.24	
No	Item	Discussed and to be used for 1st round of modelling 20/3/24
1	Total number of existing and proposed dwelling yield	Yield agreed as per Total Yield Tab
2	Local centre land use data	Floor Area **7500sqm** GFA and Uses as per Retail Floor Space Tab
3	Residential trip rate	8 vpd
4	Retirement village trip rate (Land Lease)	3 vpd *#Subject to review*
5	Trip distribution to/ from Busselton	0.80 Taken from video *# Subject to review*
6	Trip distribution to/ from Bunbury	0.15 Taken from video # Subject to review
7	Trip distribution to/ from south via Vasse Hwy	0.05 Taken from video # Subject to review
8	cross trade/ internal trips	This will be higher given local nature of commercial centre (i.e. 75%). Primary catchment is internal and will be trips associated with other travel (i.e. school/work). Have utilised 25% for first pass though confirm that external traffic accessing commercial centre is likely lower and **subject to further review.**
9	annual traffic growth on Bussell Hwy	4.23% linear or 3.12 compund growth rate per annum as per Annual Traffic Growth Tab
10	annual traffic growth on Vasse Hwy	4.17% linear or 3.86 compund growth rate per annum as per Annual Traffic Growth Tab
11	existing enrolments at Georgiana Molloy Anglican School	Confirmed and used for associated traffic trips.
12	Vehicle trip per student (Private & Public Schools)	2 vpd used for initial pass of model to assess outcome *#Subject to review*
13	Public Primary School Site	Internal traffic movement (sole internal catchment)
14	total enrolments at the proposed primary school	School trips modelled at 90% internal (likely 100%) but will model at 90% for first pass.
15	Assessment year	2044, and full build out. At 2044 current sales would see 52% of SP area developed. As per Development Progress 2044 Tab
16	Timing for Bypass	No Bypass included in modelling
17	Development/ sales/ buildout rate (Taken from TIA Revb)	33% of per annum Busselton Region Sales
18	Speed of Bussell Highway	Operating Speed 80kph - Design Speed 90 kph
19	Vasse/Blum Intersection	Weste Portion (Blum and Existing) run independnatly and not reuqired to contrbute to the east. Self contained. Modelling to confrim whether 'ANY' upgrade works are required.First run of model ***#subject to review*** .

Timing of Intersection 1 & 2 Closure	
Intersection Configuration A & B	Closure of 1 & 2 subject to timing. Closure of 1 & 2 Tab.
Trigger requirement (yield) for Roundabout at either A or B	Closure of 1 & 2 subject to timing. Closure of 1 & 2 Tab.
Timing of closure '1' (precedent)	Closure of 1 & 2 subject to timing. Closure of 1 & 2 Tab.
Timing of closure '2' (precedent)	Closure of 1 & 2 subject to timing. Closure of 1 & 2 Tab.
Construction of access to facilitate closure '1' (Light Blue)	Construction as per Ultimate Future Access 1 & 2
Construction of access to facilitate closure '1' (Dark Blue)	Construction as per Ultimate Future Access 1 & 2

Table 1: Development progress

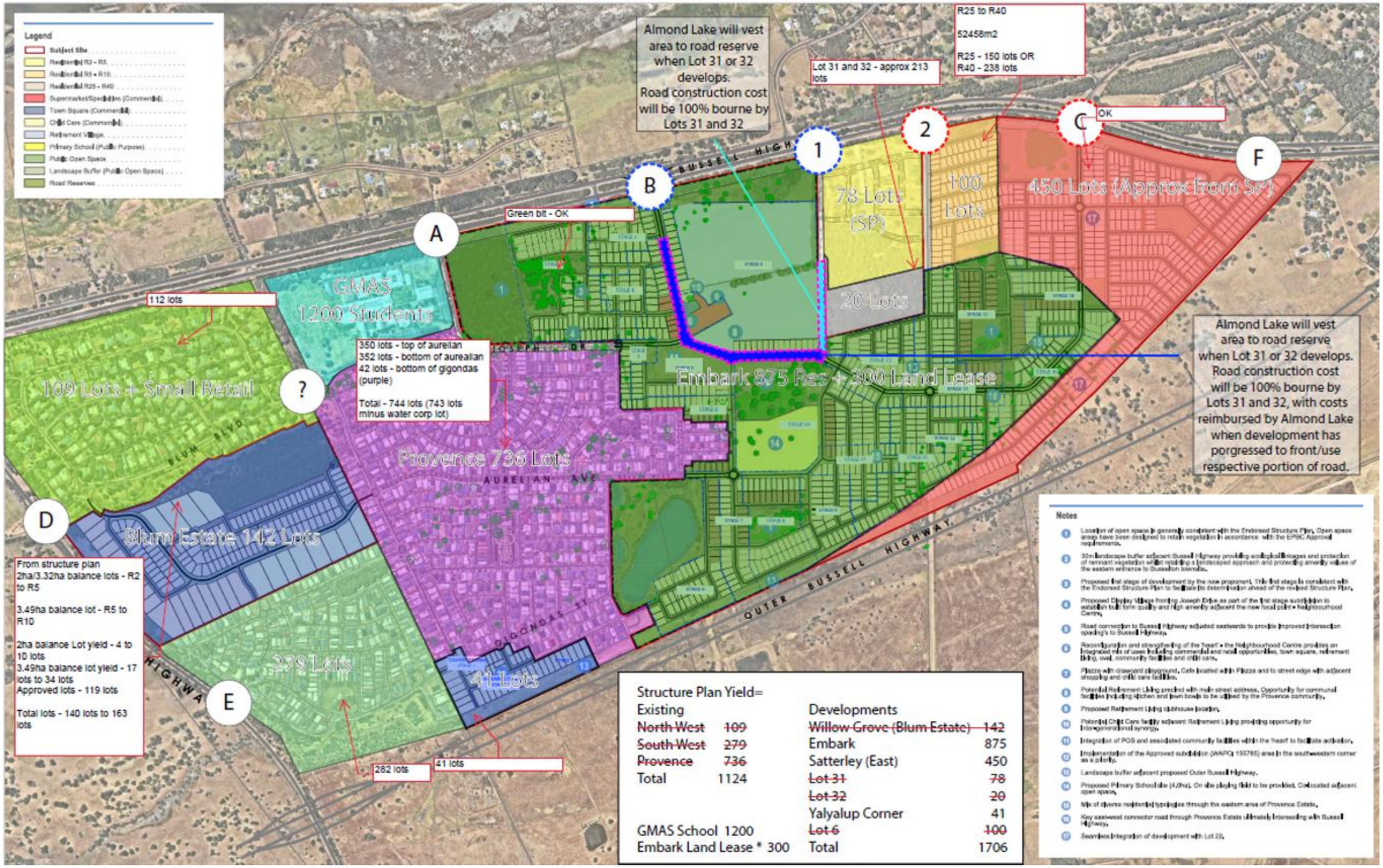
15 years Scenario	SP 33% of per annum Busselton Region Sales	SP 40% of per annum Busselton Region Sales	SP 50% of per annum Busselton Region Sales
Total Annual Sales in Structure Plan	45	54	68
Total Structure Plan (SP) Yield	1751	1751	1751
15yrs total abortion of vacant lots in SP (volume of lots/homes to be used for modelling)	678	815	1019
% of SP developed	39%	47%	58%
% of SP not developed	61%	53%	42%
20 years Scenario	**SP 33% of per annum Busselton Region Sales**	**SP 40% of per annum Busselton Region Sales**	**SP 50% of per annum Busselton Region Sales**
Total Annual Sales in Structure Plan	45	54	68
Total Structure Plan (SP) Yield	1751	1751	1751
20yrs total abortion of vacant lots in SP (volume of lots/homes to be used for modelling)	904.428	1086.4	1358
% of SP developed	52%	62%	78%
% of SP not developed	48%	38%	22%

Floor Area as taken from CHC Design Layout 25/3/24			
Medical	315	Retail	4253
Co Working	380	Non retai	3264
Pharmacy	272		
Mixed Use	300		
Health and Wellbeing	300		
Childcare	760		
Supermarket	3628		
Liquor Store	240		
Retail	625		
Food and Beverage	577		
Café	120		
	7517		



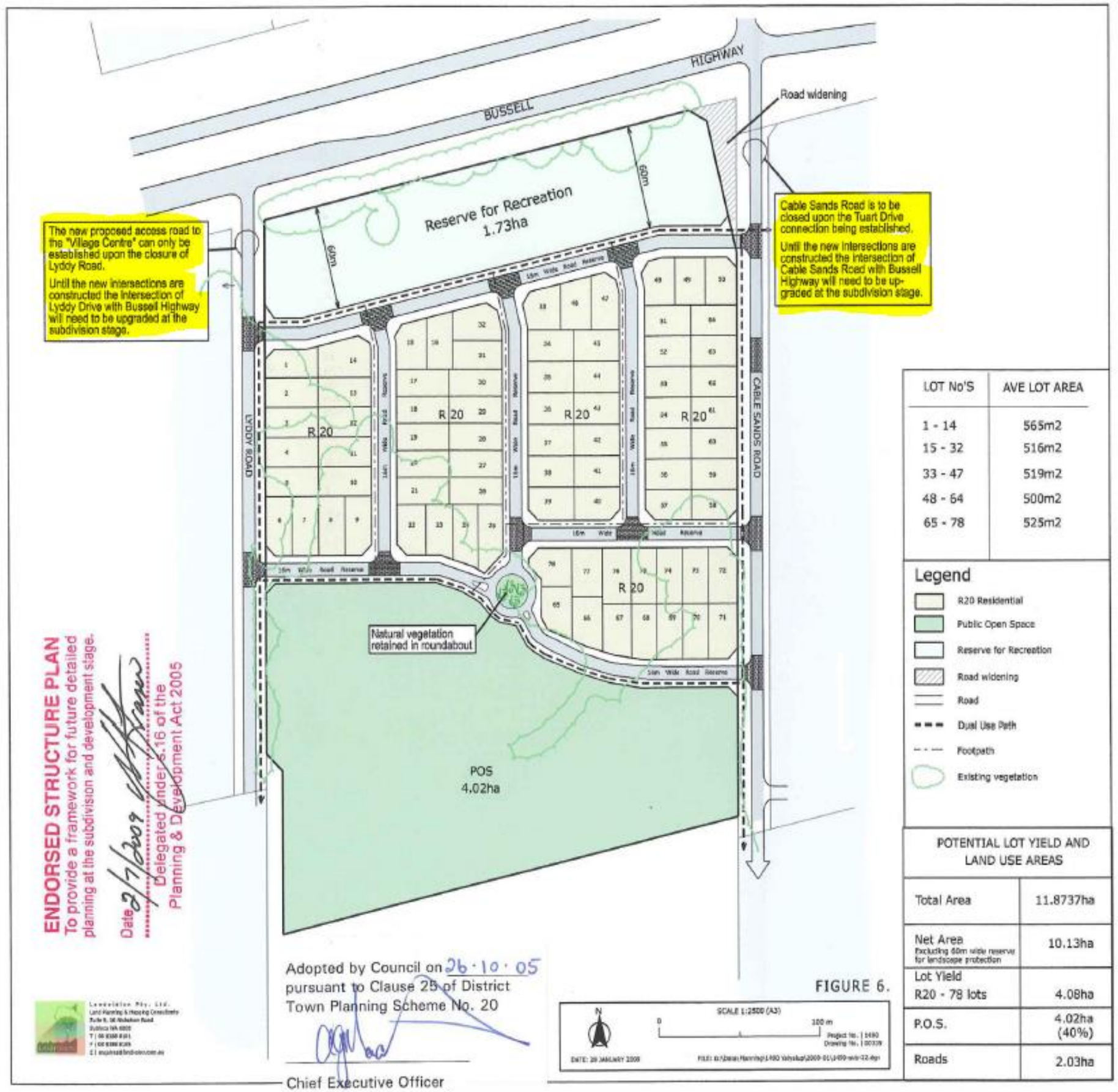
Masterplan Schedule	GFA (m²)	Efficiency	NLA (m²)	Car park Required*
Medical				
Medical (1 bay per practitioner - Assuming 6 practitioners)	315	-		6
Co-working (1 bay per 30m2 NLA + 1 loading bay)	380	85%	323	11
Pharmacy (1 bay per 30m² NLA + 1 loading bay)	272	85%	231	9
Mixed use (1 bay per 30m² NLA + 1 loading bay)	300	85%	255	10
Health & Wellbeing (1 bay per 30m² NLA + 1 loading bay)	300	85%	255	10
Childcare				
Childcare (1 bay teacher on roster - assuming 100 kids with 1:10 child to teacher ratio)	760	-		10
Childcare playground	700			
Retail				
Supermarket	3628	-		180
Liquor Shop (1 bay per 30m² NLA + 1 loading bay)	240	85%	204	8
Retail (1 bay per 30m² NLA + 1 loading bay)	625	85%	531	19
F&B (1 bay per 4 seats/6m²of public area)	577	85%	490	83
Café (1 bay per 4 seats/6m2of public area)	120	85%	102	19
Club House				
Club House (Assuming 40 parking)	1395	85%	1186	40
Total GFA	**8217**			
Total Car park required				**402**
Total Car park provided				**445**

* Car park requirement as per City of Busselton, LPP 2.1, 4.6.2.


Legend
Subject Site
Residential R2 - R5
Residential R5 - R10
Residential R25 - R40
Supermarket/Specialties (Commercial)
Town Square (Commercial)
Child Care (Commercial)
Retirement Village
Primary School (Public Purpose)
Public Open Space
Landscape Buffer (Public Open Space)
Road Reserve
Almond Lake will vest area to road reserve when Lot 31 or 32 develops. Road construction cost will be 100% bourne by Lots 31 and 32
Lot 31 and 32 - approx 213 lots
R25 to R40
52458m2
R25 - 150 lots OR
R40 - 238 lots
OK
Green bit - OK
A
B
C
D
E
F
1
2
?
78 Lots (SP)
100 Lots
450 Lots (Approx from SP)
20 Lots
GMAS
1200 Students
112 lots
109 Lots + Small Retail
350 lots - top of aurelian
352 lots - bottom of aureallan
42 lots - bottom of gigondas (purple)
Total - 744 lots (743 lots minus water corp lot)
Embark 875 Res + 200 Land Lease
Provence 736 Lots
Blum Estate 142 Lots
279 Lots
41 Lots
From structure plan
2ha/3.32ha balance lots - R2 to R5
3.49ha balance lot - R5 to R10
2ha balance Lot yield - 4 to 10 lots
3.49ha balance lot yield - 17 lots to 34 lots
Approved lots - 119 lots
Total lots - 140 lots to 163 lots
282 lots
41 lots
Almond Lake will vest area to road reserve when Lot 31 or 32 develops. Road construction cost will be 100% bourne by Lots 31 and 32, with costs reimbursed by Almond Lake when development has porgressed to front/use respective portion of road.
Outer Bussell Highway
Structure Plan Yield=
Existing
North West 109
South West 279
Provence 736
Total 1124
GMAS School 1200
Embark Land Lease * 300
Developments
Willow Grove (Blum Estate) 142
Embark 875
Satterley (East) 450
Lot 31 78
Lot 32 20
Yalyalup Corner 41
Lot 6 100
Total 1706
Notes

DEVELOPMENT GUIDE PLAN

LOT 31 BUSSELL HIGHWAY, YALYALUP
Shire of Busselton



LOT No'S	AVE LOT AREA
1 - 14	565m2
15 - 32	516m2
33 - 47	519m2
48 - 64	500m2
65 - 78	525m2

Legend

- R20 Residential
- Public Open Space
- Reserve for Recreation
- Road widening
- Road
- Dual Use Path
- Footpath
- Existing vegetation

POTENTIAL LOT YIELD AND LAND USE AREAS	
Total Area	11.8737ha
Net Area (Excluding 60m wide reserve for landscape protection)	10.13ha
Lot Yield R20 - 78 lots	4.08ha
P.O.S.	4.02ha (40%)
Roads	2.03ha

PLANNING POLICY STATEMENTS:

1. Development of land the subject of this Development Guide Plan shall generally be in accordance with the endorsed Development Guide Plan and the Shire of Busselton District Town Planning Scheme No. 20 (the Scheme). Residential densities determined by Clause 5B of District Town Planning Scheme No. 20 (the Scheme) shall not be applied to the consideration of higher residential densities for lots within this DGP.
2. All areas and dimensions, road treatments and road descriptions are indicative only and will be fully determined at the subdivision application and approval stage to the satisfaction of the Shire of Busselton.
3. At the subdivision stage, notification of landowners and prospective purchasers by way of a memorial on the title of the proposed lots is to be undertaken to inform landowners of possible airport noise with respect to nearby Busselton Airport operations. A memorial is to be inserted on the title of lots in close proximity to Bussell Highway, Vasse Highway and the proposed outer bypass to advise that the amenity of the lot may be affected by traffic noise.
4. At the subdivision stage, arrangements will be made to the satisfaction of the Shire of Busselton for appropriate notification to be placed on Certificates of Title to inform landowners that the land is in close proximity to known mosquito breeding areas. The predominent mosquito species is known to carry viruses and other diseases.
5. A condition of subdivision will require the submission and implementation of an environmental management plan which is to include revegetation, rehabilitation and management of the conservation values of the public open space, and a landscape plan for the landscape buffer and road reserves, to the satisfaction of the Shire of Busselton.
6. The planting of street trees and the development of the Reserve for Recreation will be undertaken by the developer in accordance with the approved landscaping plan to the specifications and satisfaction of the Shire of Busselton.
7. The subdivider is to submit a Drainage and Nutrient Management Plan for approval by the Shire of Busselton prior to the commencement of any development of land or subdivisional works. The approved Drainage and Nutrient Management Plan will be implemented by the subdivider and is to be cognisant of the relevent policies and ongoing management requirements.
8. The subdivider is to submit a Dust Management Plan for approval by the Shire of Busselton prior to the commencement of any development of land or subdivisional works. The Dust Management Plan will be implemented by the subdivider and is to be cognisant of the relevant policies and ongoing management requirements.
9. A Mosquito Management Strategy is to be submitted by the subdivider for approval by the Shire of Busselton prior to the commencment of any development of land or subdivisional works. The approved Mosquito Management Strategy may be integrated with the Drainage and Nutrient Management Plan and is to be implemented by the subdivider.
10. Mitigation measures are to be applied to lessen the impact of fill placement around remnant paddock trees during construction to the specifications and satisfaction of the Shire of Busselton.
11. Dual use paths and a footpath system are to be implemented by the subdivider in accordance with Liveable Neighbourhoods Version 3 Requirements to the specification and satisfaction of the Shire of Busselton.
12. The subdivider is to construct the extension of the dual use path to connect to the existing Busselton townsite path system to the specification and satisfaction of the Shire of Busselton.
13. Prior to any development or subdivision of land, a Contamination Assessment Management Plan shall be prepared. Remediation works shall be completed to the satisfaction of the Shire of Busselton, and evidence provided that the site is suitable for the intended use prior to clearance of subdivision.
14. Prior to subdivision or development the proponent is to prepare a developer contribution and staging plan to the satisfaction of the Shire to ensure the proponents appropriate and timely contribution toward service infrastructure and community facilities on a progressive and staged basis. An appeal right will exist in respect to determination of the plan pursuant to Clause 98 (2) of the Scheme.

ENDORSED STRUCTURE PLAN
To provide a framework for future detailed planning at the subdivision and development stage.
Date 2/7/2009
Delegated under S.16 of the Planning & Development Act 2005

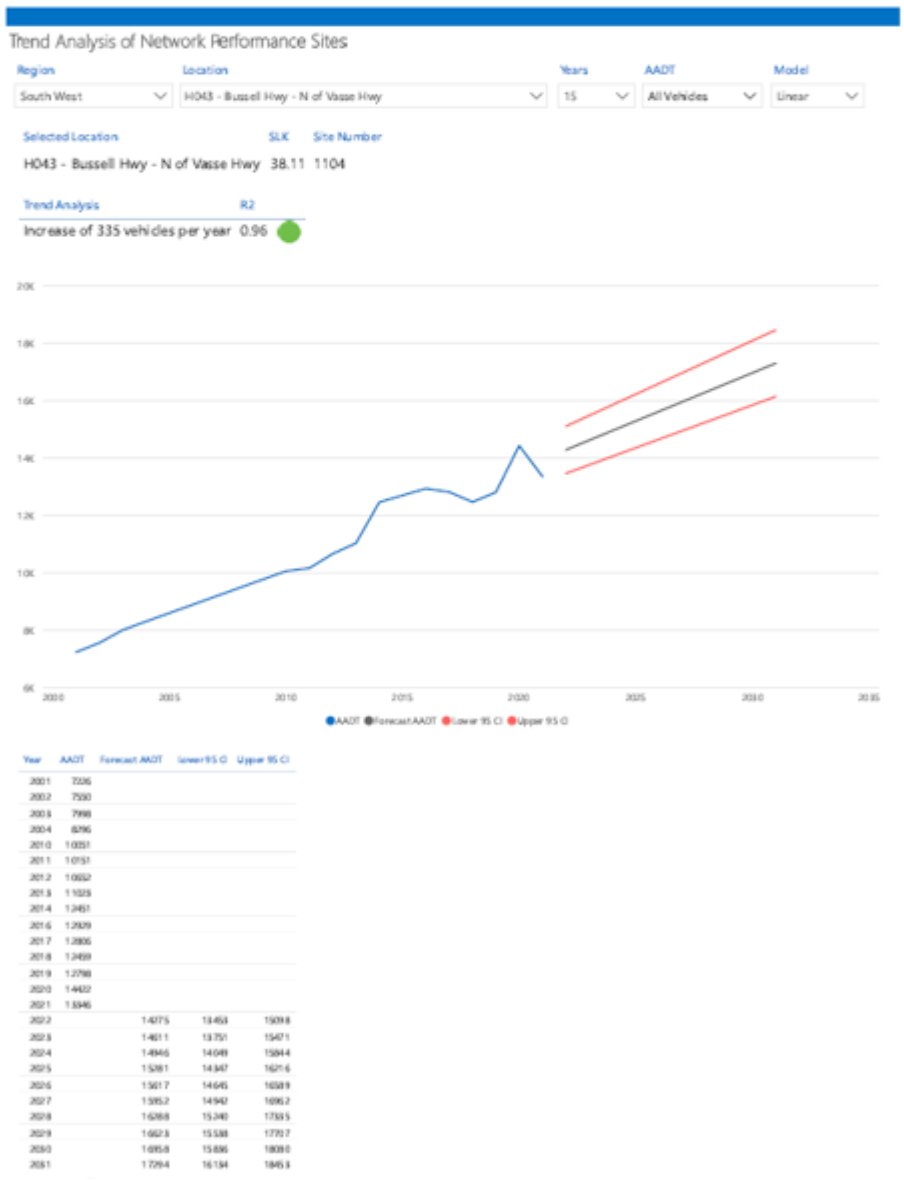
Adopted by Council on 26·10·05 pursuant to Clause 25 of District Town Planning Scheme No. 20

Chief Executive Officer

FIGURE 6.

SCALE 1:2500 (A3)

Road	Data Year 1	AADT	Data Year 2	AADT	Period (Yrs)	Linear Growth %	compound growth %
Vasse Hwy - east of NH Drive	2018	1377	2023	1664	5	**4.17%**	**3.86%**
Bussell Hwy - north of Vasse Hwy	2001	7226	2021	13346	20	**4.23%**	**3.12%**
Bussell Hwy - north of Vasse Hwy	2011	10151	2021	13346	10	**3.15%**	**2.77%**
Bussell Hwy - north of Vasse Hwy	2018	12459	2021	13346	5	**1.42%**	**1.38%**



Vasse Hwy
East of Neville Hyder Dr

Site Number	52453
Road Number	M008
SLK	4.14
Latitude	-33.692625
Longitude	115.39085

Traffic Volume | Monday to Sunday

VEHICLES	EAST	WEST	TOTAL	TRUCKS
2023/24	819	845	1,664	17.2%
2022/23	738	740	1,478	10.5%
2021/22	1,022	1,009	2,031	14.3%
2020/21	707	702	1,409	11.9%
2019/20	686	687	1,373	18.4%
2018/19	696	681	1,377	16.7%

Year	AADT	Forecast AADT	Lower 95 CI	Upper 95 CI
2001	7226			
2002	7590			
2003	7998			
2004	8296			
2010	10051			
2011	10151			
2012	10652			
2013	11025			
2014	12451			
2016	12929			
2017	12806			
2018	12459			
2019	12798			
2020	14402			
2021	13346			
2022		14275	13453	15098
2023		14611	13751	15471
2024		14946	14048	15844
2025		15281	14347	16216
2026		15617	14645	16589
2027		15952	14942	16962
2028		16288	15240	17335
2029		16623	15538	17707
2030		16958	15836	18080
2031		17294	16134	18453

Appendix B

CONTEXT OF COUNCIL APPROVED STRUCTURE PLAN



Busselton
Approved Structure Plan - Development Cells

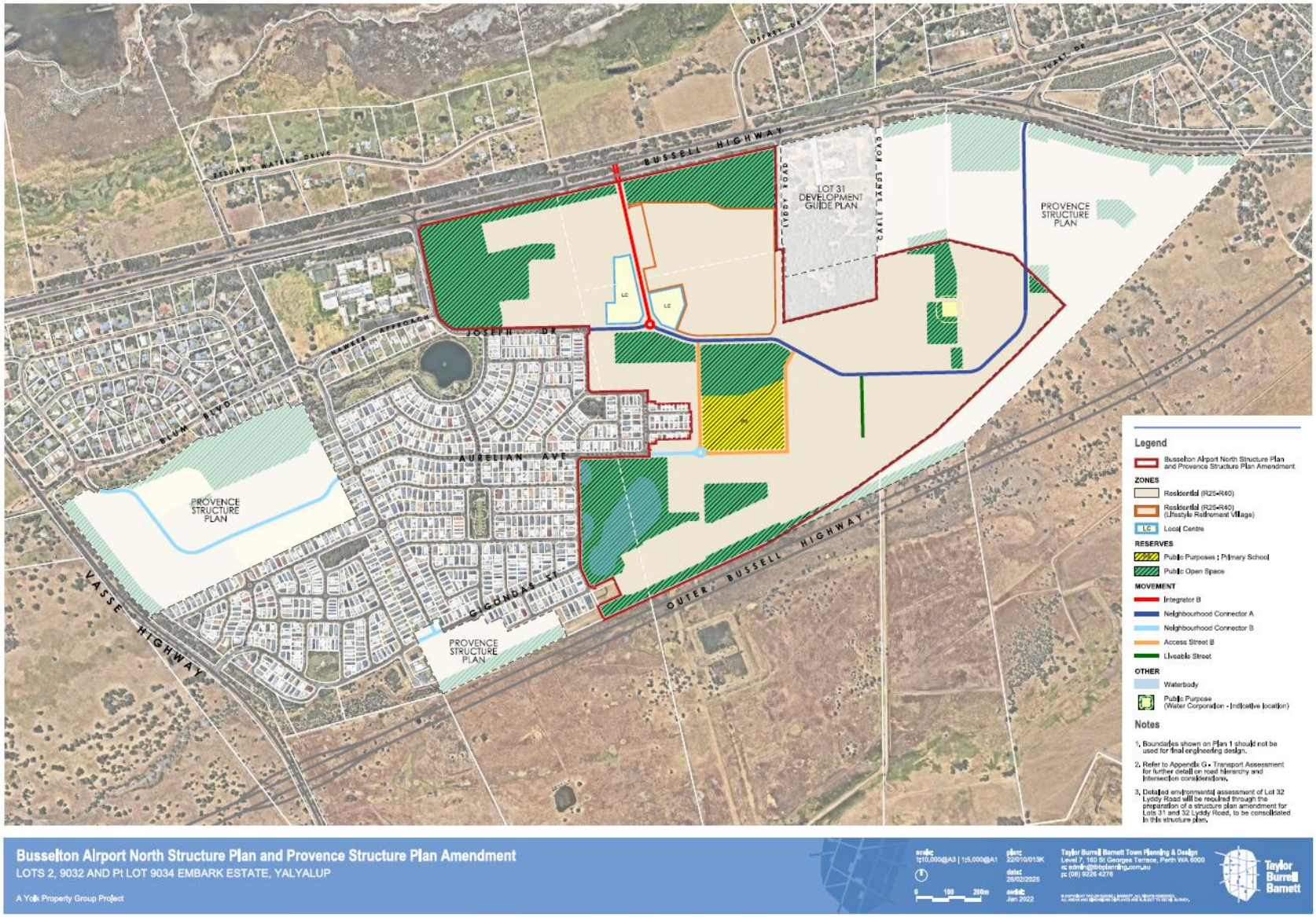
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CONCEPT PLAN FOR DISCUSSION PURPOSES ONLY Scale 1:7500@A3 / Date October 2021 / Project YOLBUFEA-1-004

HEX DESIGN | PLANNING

Appendix C

PROPOSED STRUCTURE PLAN AMENDMENT



Busselton Airport North Structure Plan and Provence Structure Plan Amendment
LOTS 2, 9032 AND Pt LOT 9034 EMBARK ESTATE, YALYALUP

A Yolk Property Group Project

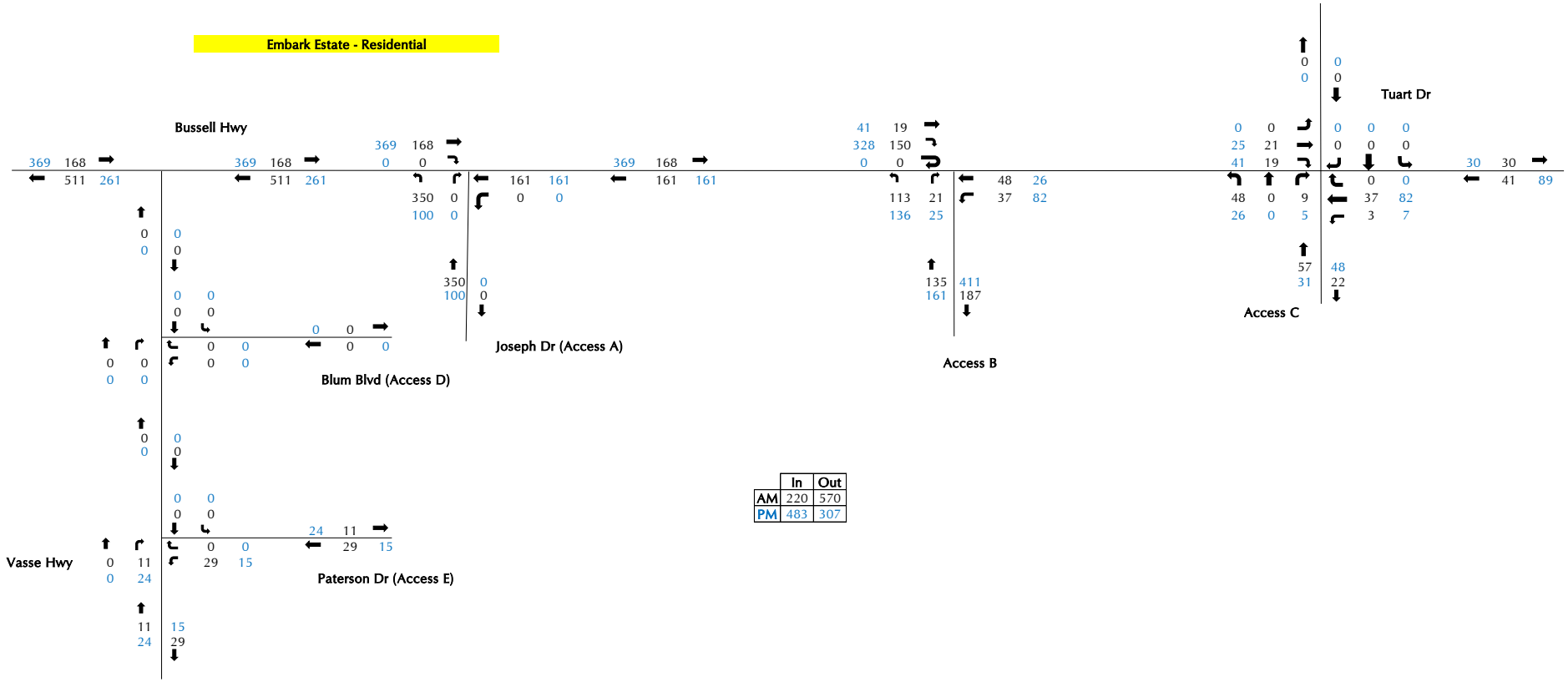
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dated: 28/02/2025
scale: Jan 2022
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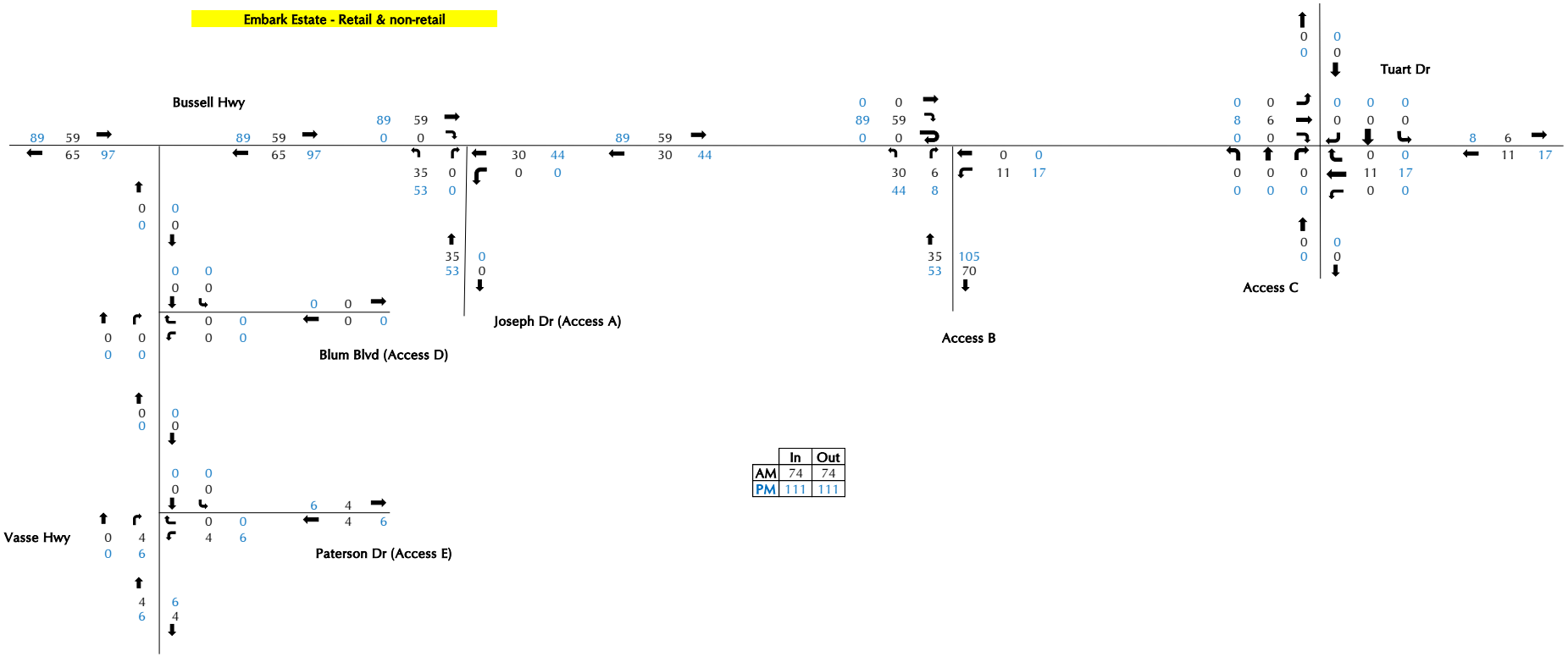
Taylor Burrell Barnett Town Planning & Design
Level 7, 160 St Georges Terrace, Perth WA 6000
e: admin@tbtplanning.com.au
p: (08) 9226 4276

Taylor Burrell Barnett

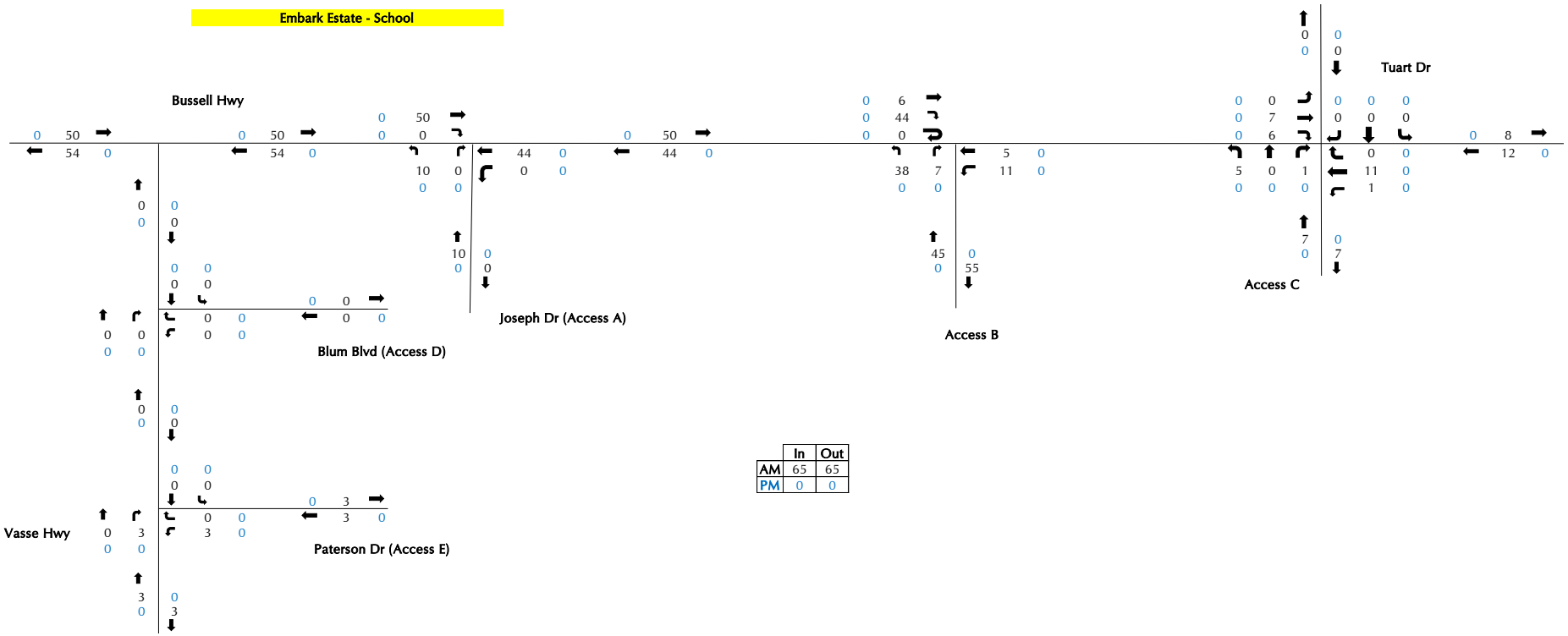
Appendix D

TRIP DISTRIBUTION OF FUTURE DEVELOPMENTS

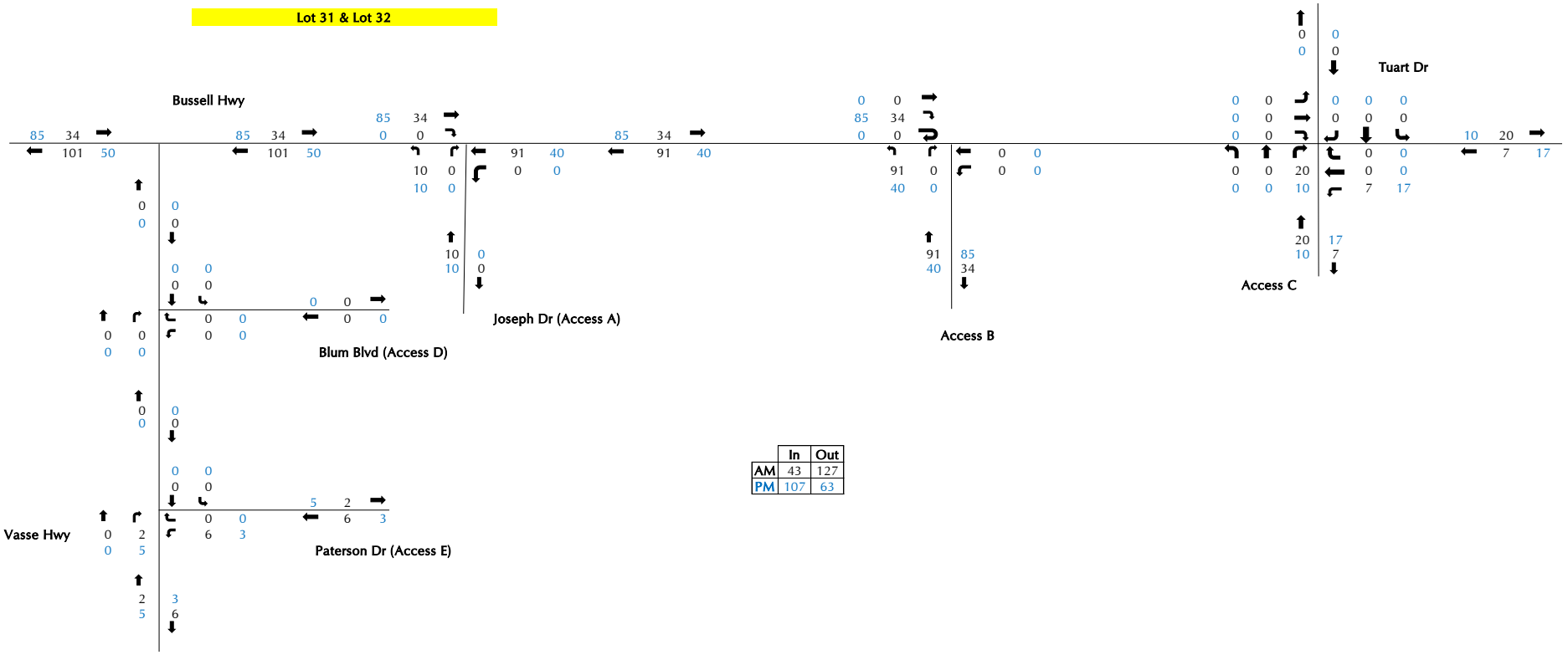

Embark Estate - Residential
Bussell Hwy
Joseph Dr (Access A)
Access B
Access C
Tuart Dr
Blum Blvd (Access D)
Paterson Dr (Access E)
Vasse Hwy
In Out
AM 220 570
PM 483 307



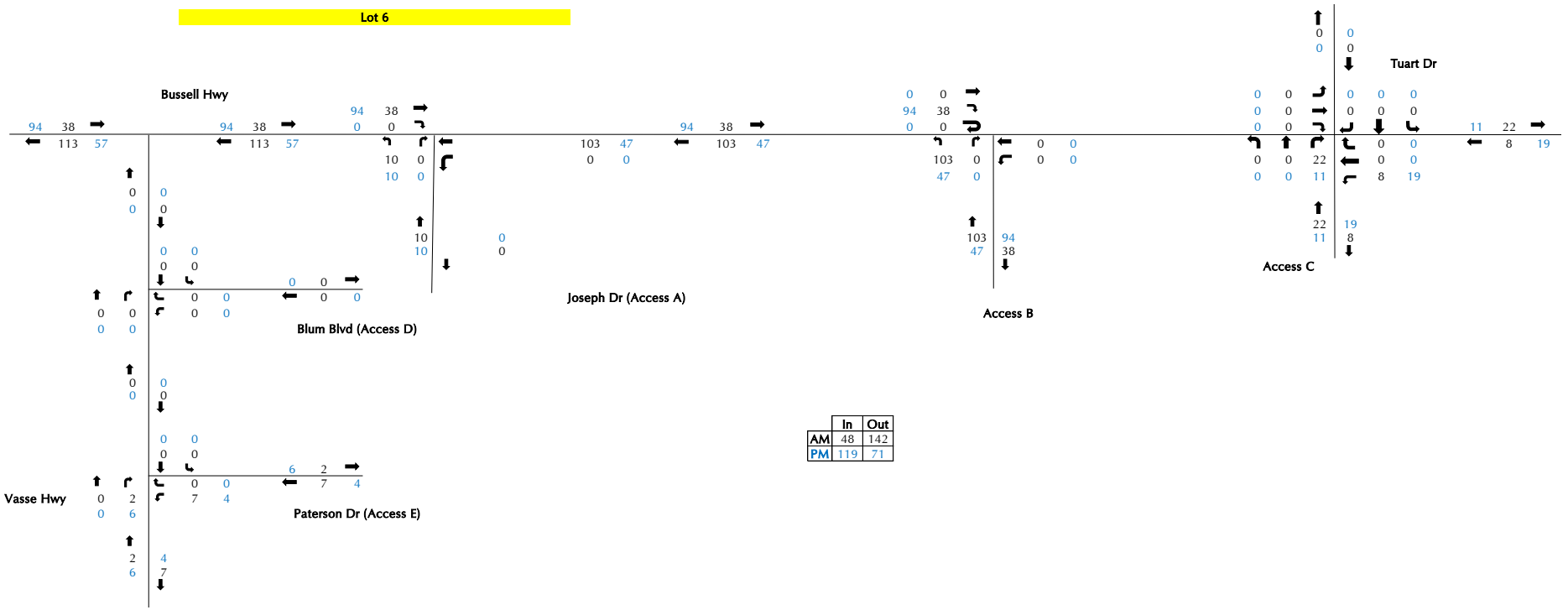
	In	Out
AM	74	74
PM	111	111



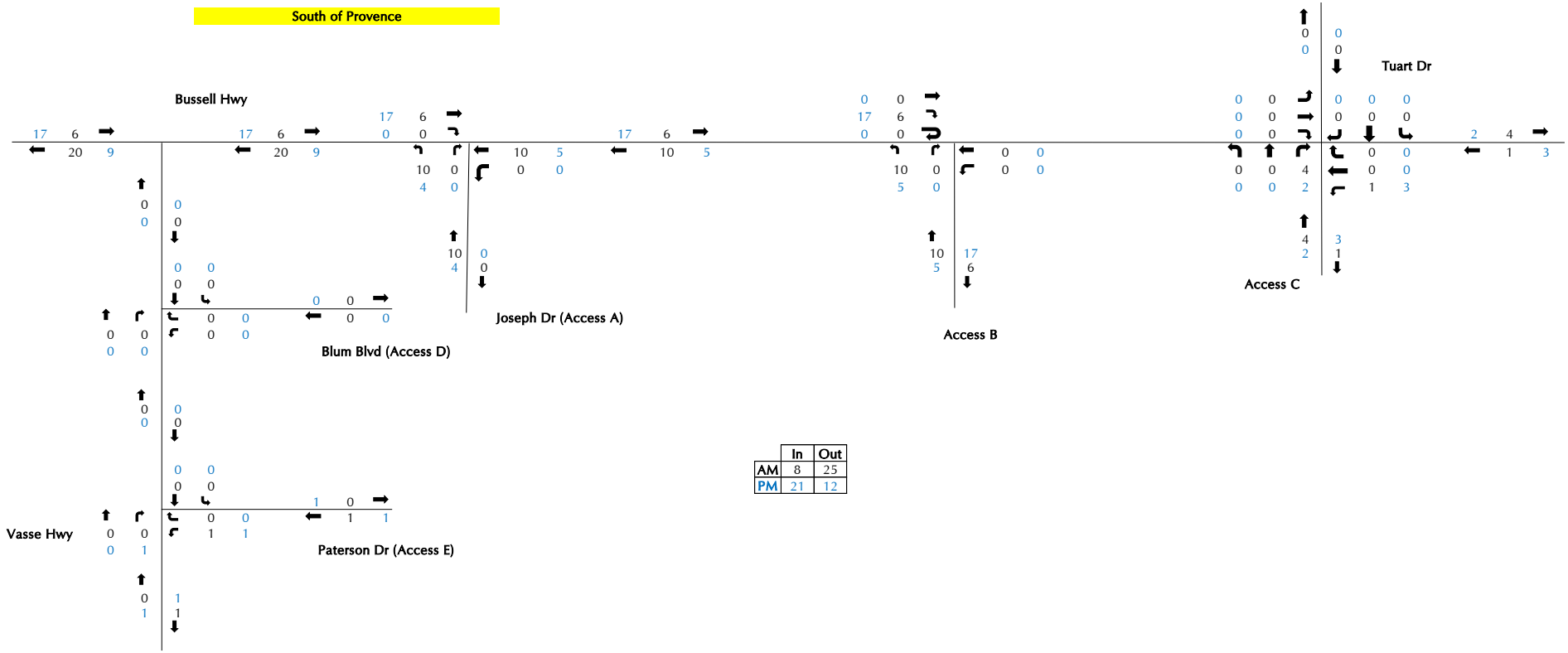
	In	Out
AM	65	65
PM	0	0



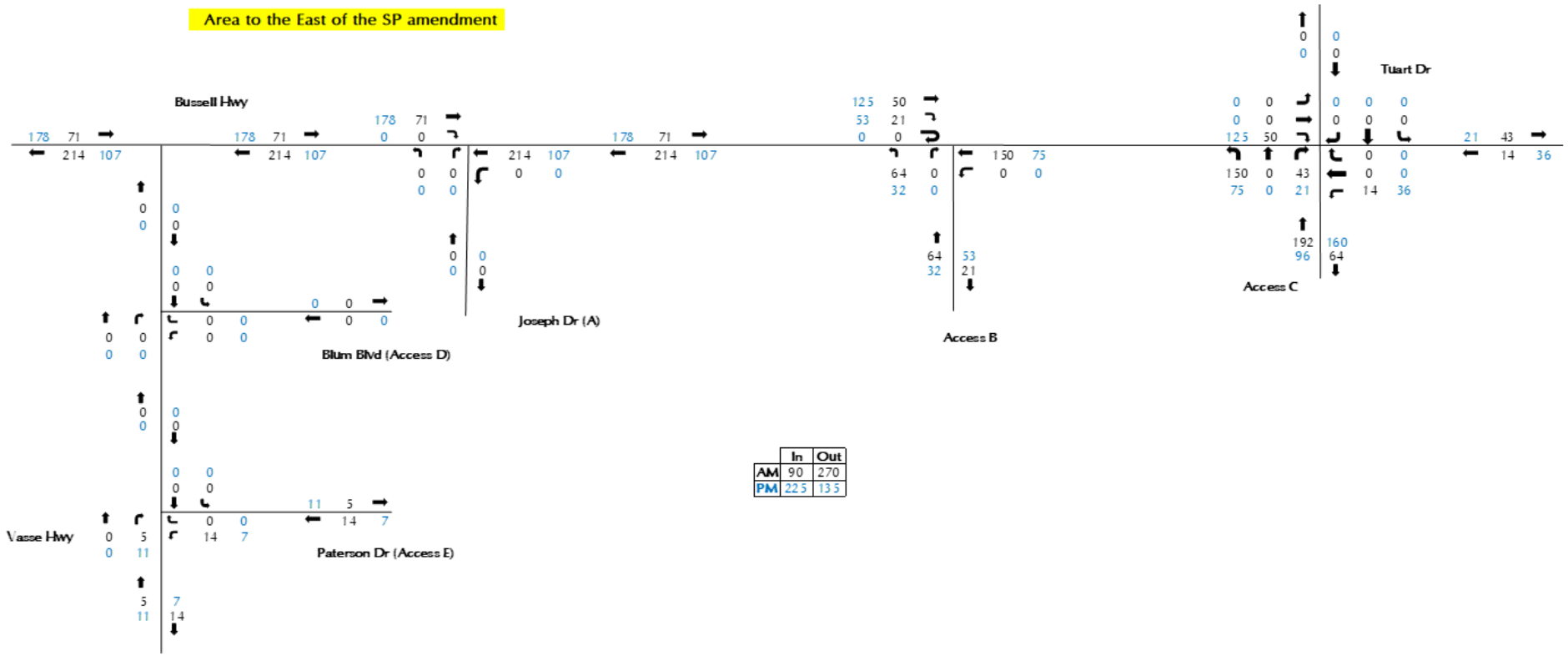
	In	Out
AM	43	127
PM	107	63



	In	Out
AM	48	142
PM	119	71

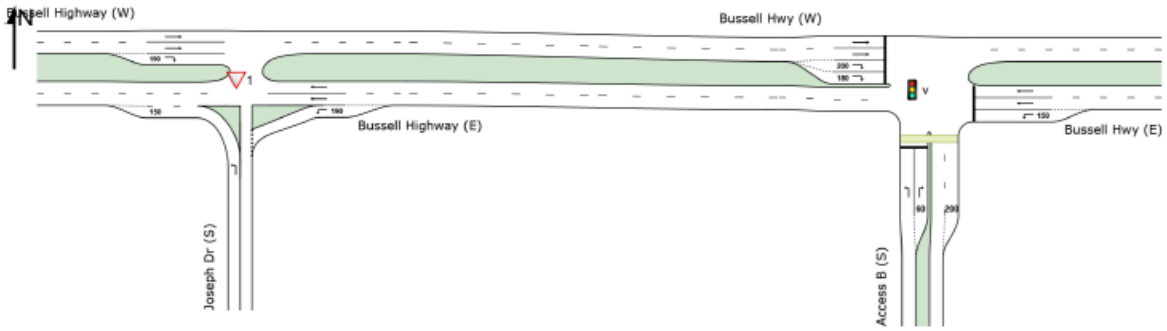


	In	Out
AM	8	25
PM	21	12

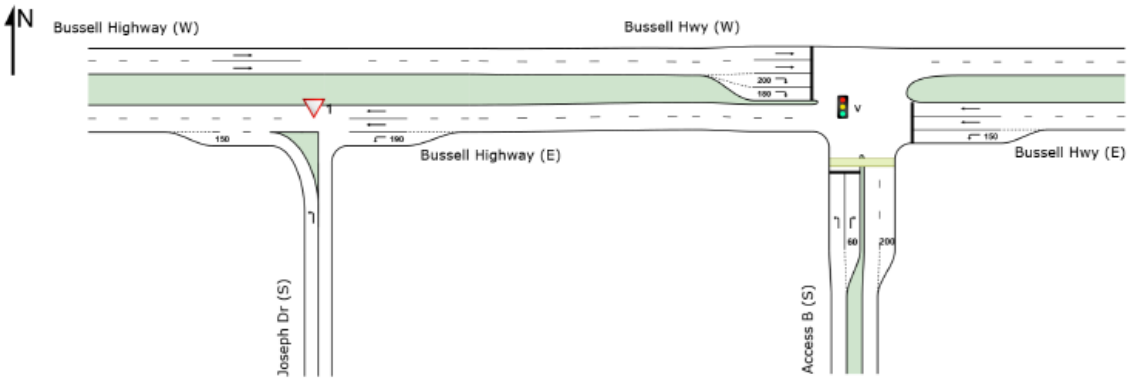

Area to the East of the SP amendment
Bussell Hwy
Joseph Dr (A)
Access B
Tuart Dr
Access C
Blum Blvd (Access D)
Vasse Hwy
Paterson Dr (Access E)
In Out
AM 90 270
PM 225 135

Appendix E

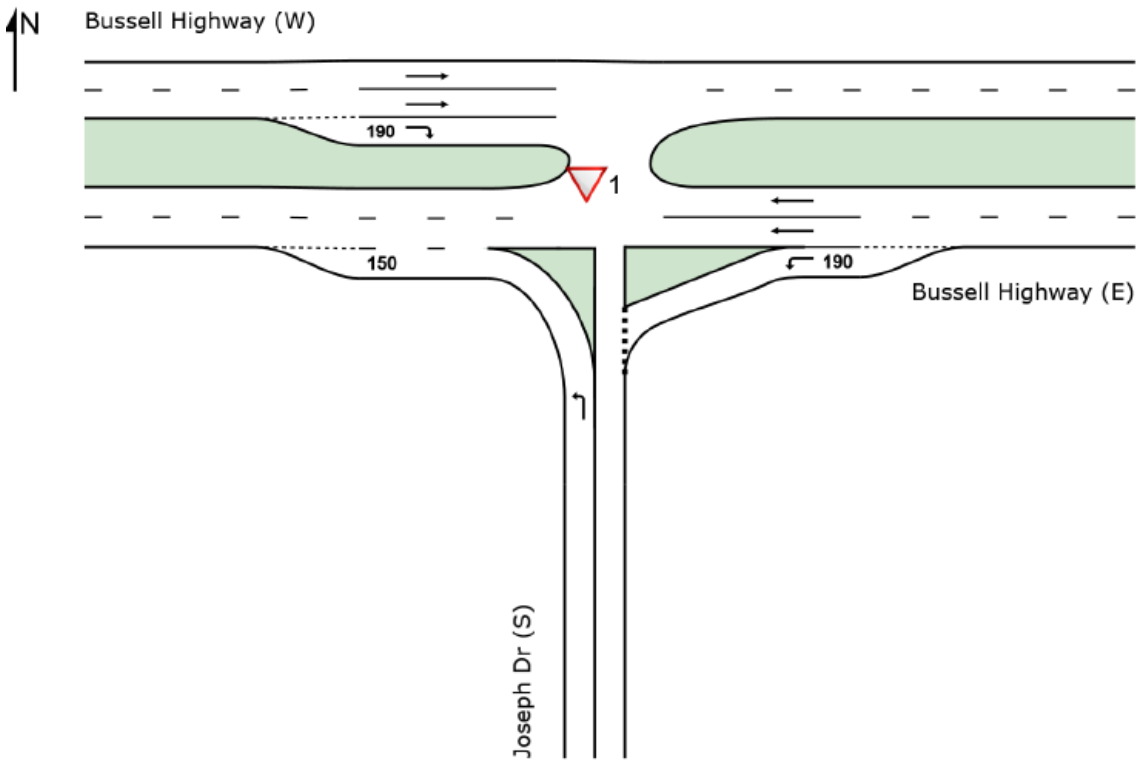
SIDRA ANALYSIS



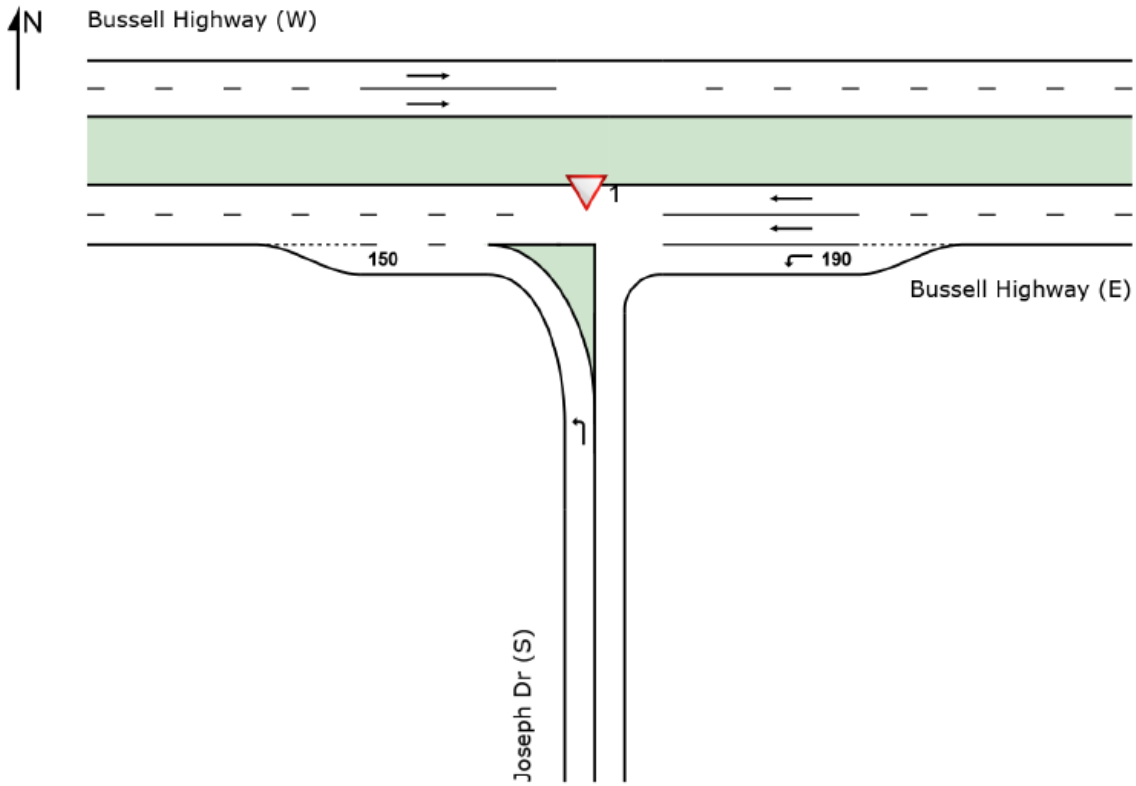
Intersection layouts under Option 1: LILORI at Joseph Drive/ Bussell Hwy



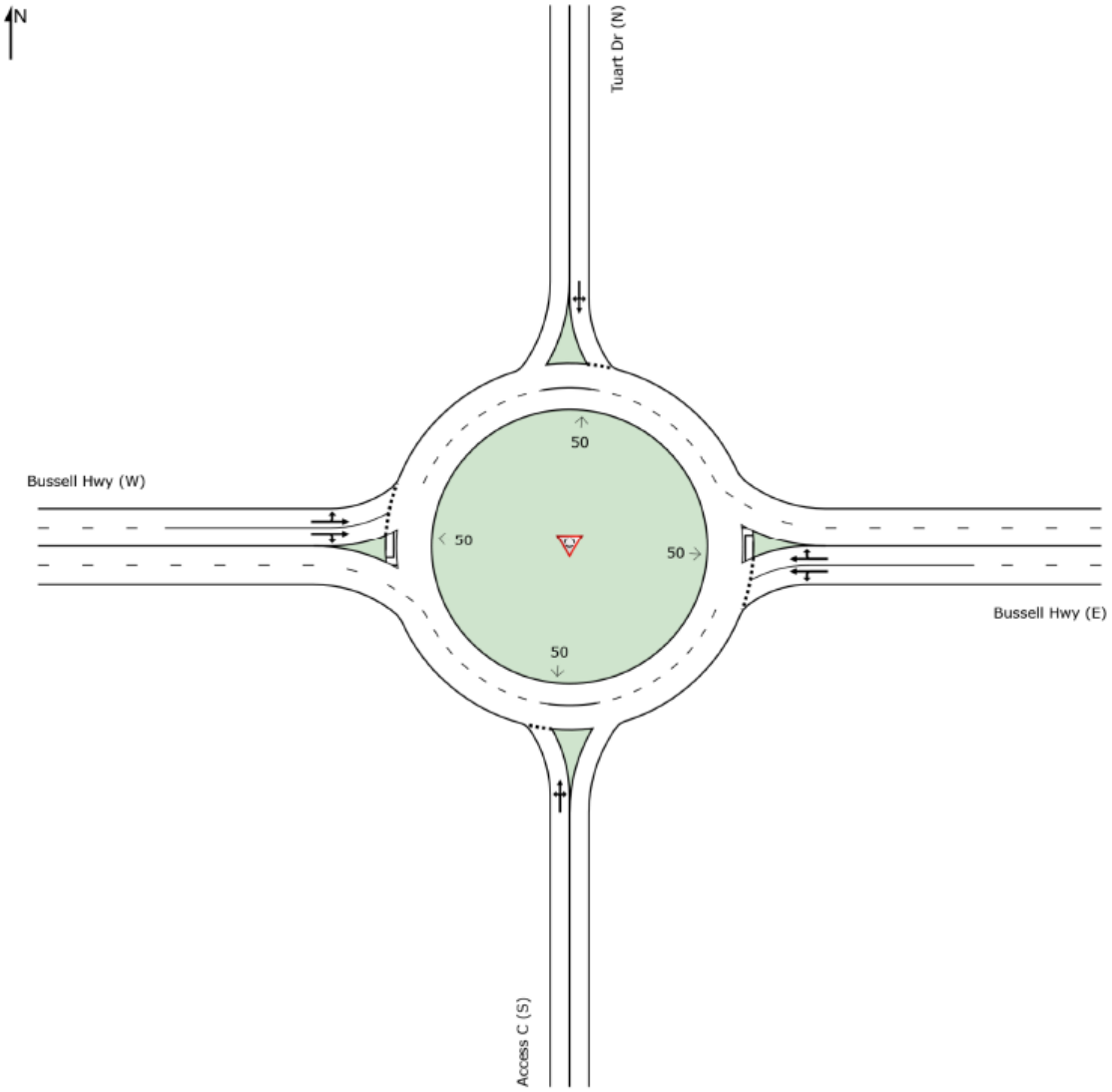
Intersection layouts under Option 2: LILO at Joseph Drive/ Bussell Hwy



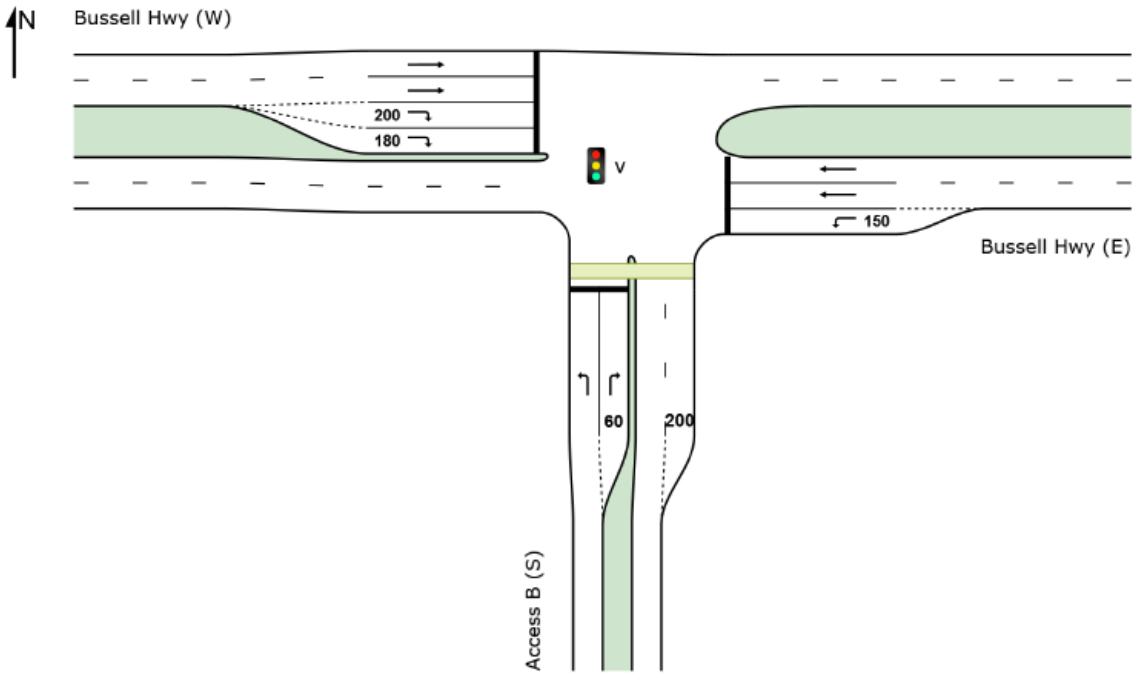
Option 1: LILORI at Joseph Drive/ Bussell Hwy



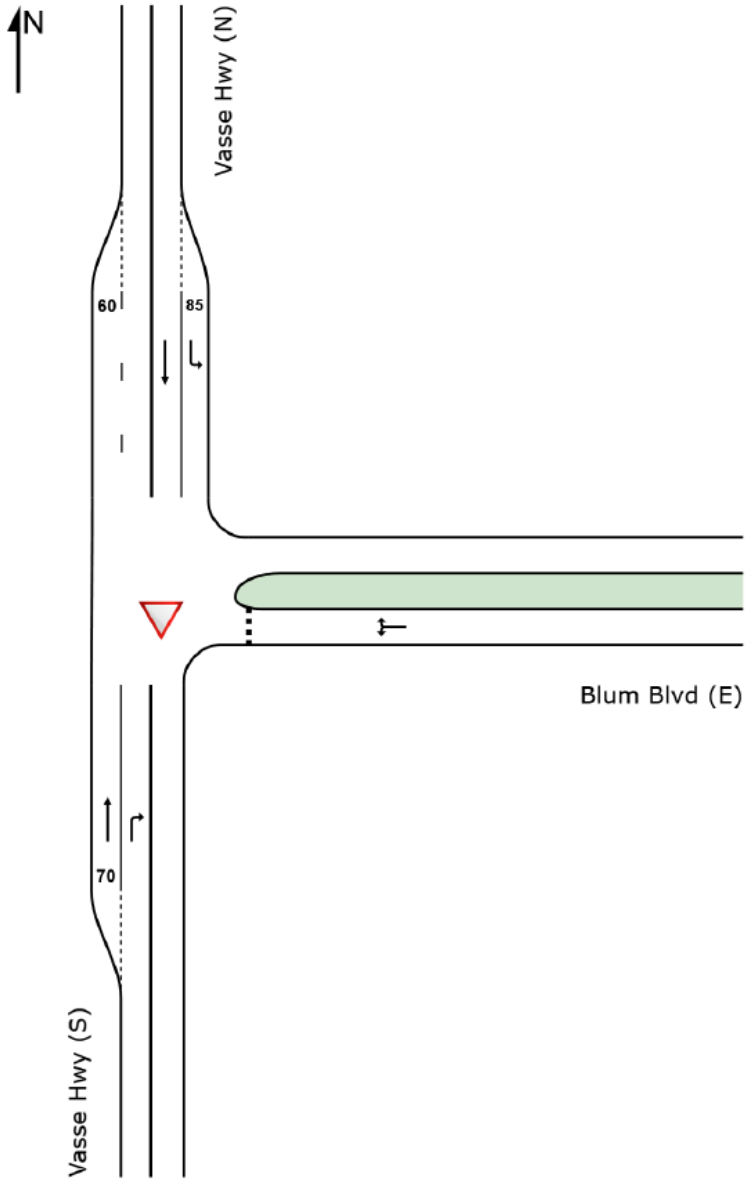
Option 2: LILO at Joseph Drive/ Bussell Hwy



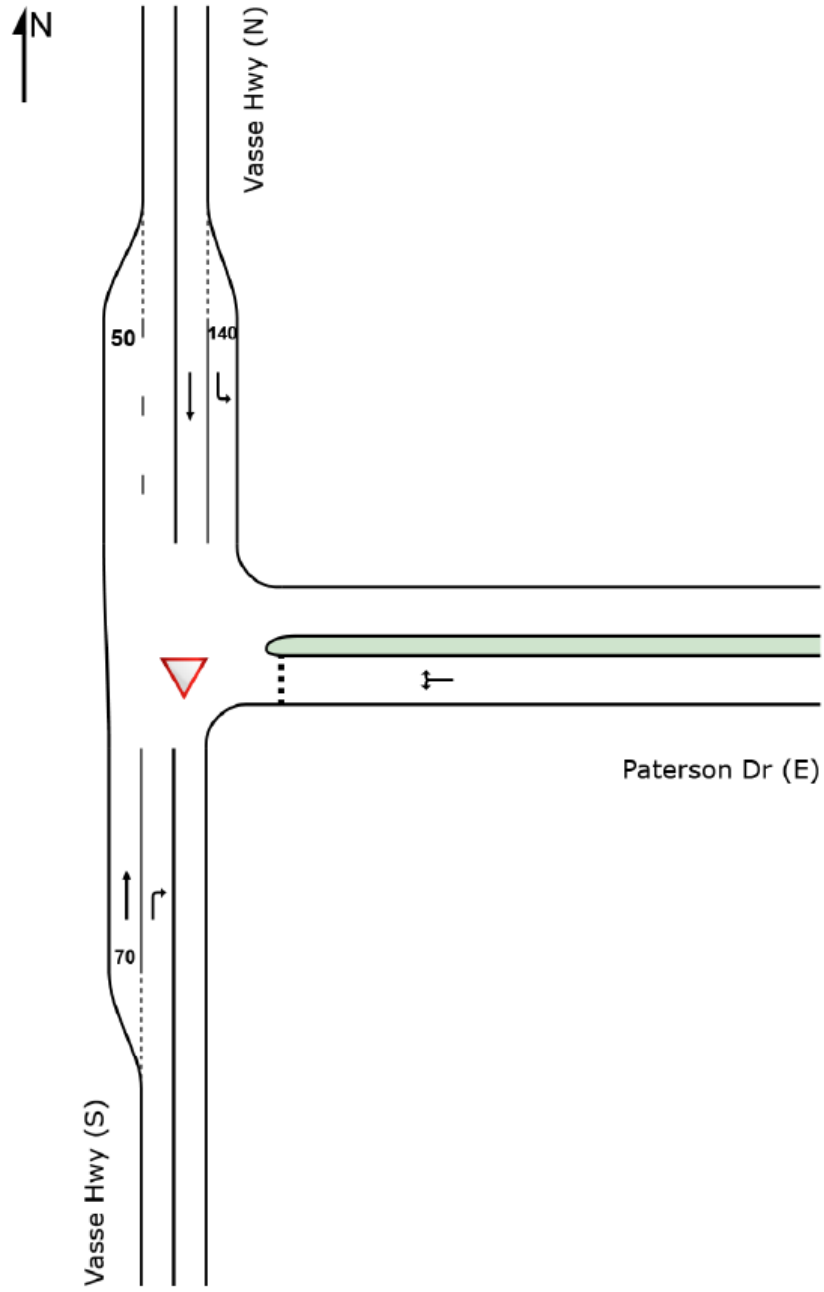
Roundabout intersection layout modelled in SIDRA at Bussell Hwy/ Tuart Dr/ Access C



Signalised intersection layout modelled in SIDRA at Bussell Hwy/ Access B



Intersection layout modelled in SIDRA at Vasse Hwy/ Blum Blvd



Intersection layout modelled in SIDRA at Vasse Hwy/ Paterson Dr

MOVEMENT SUMMARY

Site: [Blum Blvd & Vasse Hwy - 2044 - AM (Site Folder: DPLH - 2044 - AM)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND 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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Vasse Hwy (S)														
2	T1	414	16.9	436	16.9	0.271	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	99.8
3	R2	14	2.0	15	2.0	0.016	9.6	LOS A	0.1	0.5	0.45	0.67	0.45	59.8
Approach		428	16.4	451	16.4	0.271	0.6	NA	0.1	0.5	0.01	0.02	0.01	98.5
East: Blum Blvd (E)														
4	L2	27	2.0	28	2.0	0.507	10.7	LOS B	2.5	19.1	0.80	1.05	1.23	42.6
6	R2	127	2.0	134	2.0	0.507	22.7	LOS C	2.5	19.1	0.80	1.05	1.23	42.5
Approach		154	2.0	162	2.0	0.507	20.6	LOS C	2.5	19.1	0.80	1.05	1.23	42.5
North: Vasse Hwy (N)														
7	L2	51	2.0	54	2.0	0.030	7.9	LOS A	0.0	0.0	0.00	0.66	0.00	63.2
8	T1	315	21.0	332	21.0	0.214	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
Approach		366	18.4	385	18.4	0.214	1.1	NA	0.0	0.0	0.00	0.09	0.00	94.7
All Vehicles		948	14.8	998	14.8	0.507	4.1	NA	2.5	19.1	0.14	0.22	0.21	84.6

MOVEMENT SUMMARY

Site: v [Scenario 2 Bussell Hwy & Access B - 2044 - AM (Site Folder: Scenario 2 - TIA Volume)]

Network: N101 [Scenario 2AM - RI only at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Signals - Actuated Coordinated Cycle Time = 100 seconds (Network Optimum Cycle Time - Minimum Delay)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Access B (S)														
1	L2	473	2.0	473	2.0	*0.726	33.5	LOS C	19.2	145.4	0.87	0.83	0.87	13.1
3	R2	75	2.0	75	2.0	0.334	51.1	LOS D	3.5	26.3	0.93	0.75	0.93	27.0
Approach		547	2.0	547	2.0	0.726	35.9	LOS D	19.2	145.4	0.88	0.82	0.88	16.4
East: Bussell Hwy (E)														
4	L2	63	2.0	63	2.0	0.052	13.8	LOS B	1.0	7.8	0.35	0.69	0.35	49.9
5	T1	1397	22.8	1397	22.8	*0.909	31.4	LOS C	35.2	335.3	0.97	0.95	1.05	34.2
Approach		1460	21.9	1460	21.9	0.909	30.6	LOS C	35.2	335.3	0.94	0.94	1.02	34.8
West: Bussell Hwy (W)														
11	T1	1034	21.5	1034	21.5	0.438	4.8	LOS A	9.0	85.0	0.38	0.34	0.38	72.5
12	R2	576	2.0	576	2.0	0.792	51.1	LOS D	13.7	103.8	0.98	0.84	0.98	28.1
Approach		1609	14.5	1609	14.5	0.792	21.3	LOS C	13.7	103.8	0.60	0.52	0.60	51.0
All Vehicles		3617	15.6	3617	15.6	0.909	27.3	LOS C	35.2	335.3	0.78	0.73	0.81	40.2

MOVEMENT SUMMARY

Site: v [Scenario 1a Bussell Hwy & Access B - 2044 - AM (Site Folder: Scenario 2a)]

Network: N101 [Scenario 2aAM - LILO at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 100 seconds (Network Optimum Cycle Time - Minimum Delay)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Access B (S)														
1	L2	473	2.0	473	2.0	0.828	42.8	LOS D	23.0	174.3	0.96	0.93	1.09	10.9
3	R2	75	2.0	75	2.0	*0.667	59.0	LOS E	3.9	29.6	1.00	0.82	1.14	24.8
Approach		547	2.0	547	2.0	0.828	45.0	LOS D	23.0	174.3	0.97	0.91	1.10	14.0
East: Bussell Hwy (E)														
4	L2	63	2.0	63	2.0	0.064	19.3	LOS B	1.4	10.9	0.50	0.71	0.50	44.8
5	T1	1397	22.8	1397	22.8	*0.823	24.3	LOS C	30.7	292.4	0.89	0.87	0.96	39.3
Approach		1460	21.9	1460	21.9	0.823	24.0	LOS C	30.7	292.4	0.87	0.86	0.94	39.5
West: Bussell Hwy (W)														
11	T1	1034	21.5	1034	21.5	0.406	2.6	LOS A	6.7	63.6	0.29	0.26	0.29	75.7
12	R2	618	2.0	618	2.0	*0.809	53.3	LOS D	15.8	119.6	1.00	0.90	1.16	27.4
Approach		1652	14.2	1652	14.2	0.809	21.6	LOS C	15.8	119.6	0.56	0.50	0.62	50.6
All Vehicles		3659	15.4	3659	15.4	0.828	26.1	LOS C	30.7	292.4	0.74	0.71	0.82	41.0

MOVEMENT SUMMARY

Site: 1 [Bussell Hwy & Joseph Dr - 2044 - AM - RI LI LO (Site Folder: Scenario 2 - TIA Volume)]

Network: N101 [Scenario 2AM - RI only at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Joseph Dr (S)														
1	L2	734	2.0	734	2.0	0.403	14.0	LOS B	0.0	0.0	0.00	0.46	0.00	47.1
Approach		734	2.0	734	2.0	0.403	14.0	NA	0.0	0.0	0.00	0.46	0.00	47.1
East: Bussell Highway (E)														
3	L2	73	2.0	73	2.0	0.047	8.0	LOS A	0.2	1.2	0.09	0.60	0.09	58.0
4	T1	1796	22.8	1796	22.8	0.581	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	89.2
Approach		1868	22.0	1868	22.0	0.581	0.5	LOS A	0.2	1.2	0.00	0.02	0.00	87.7
West: Bussell Highway (W)														
11	T1	1609	21.5	1609	21.5	0.523	0.1	LOS A	0.0	0.0	0.00	0.00	0.00	89.4
12	R2	42	2.0	42	2.0	0.438	59.7	LOS F	1.5	11.0	0.96	1.02	1.16	29.3
Approach		1652	21.0	1652	21.0	0.523	1.7	NA	1.5	11.0	0.02	0.03	0.03	82.6
All Vehicles		4254	18.2	4254	18.2	0.581	3.3	NA	1.5	11.0	0.01	0.10	0.01	74.7

MOVEMENT SUMMARY

Site: 1 [Bussell Hwy & Joseph Dr - 2044 - AM - LI LO (Site Folder: Scenario 2a)]

Network: N101 [Scenario 2aAM - LILO at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Joseph Dr (S)														
1	L2	734	2.0	734	2.0	0.403	14.0	LOS B	0.0	0.0	0.00	0.46	0.00	47.1
Approach		734	2.0	734	2.0	0.403	14.0	NA	0.0	0.0	0.00	0.46	0.00	47.1
East: Bussell Highway (E)														
3	L2	73	2.0	73	2.0	0.040	7.5	LOS A	0.0	0.0	0.00	0.65	0.00	66.3
4	T1	1796	22.8	1796	22.8	0.581	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	89.2
Approach		1868	22.0	1868	22.0	0.581	0.5	NA	0.0	0.0	0.00	0.03	0.00	88.2
West: Bussell Highway (W)														
11	T1	1651	21.5	1651	21.5	0.537	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	89.3
Approach		1651	21.5	1651	21.5	0.537	0.2	NA	0.0	0.0	0.00	0.00	0.00	89.3
All Vehicles		4253	18.4	4253	18.4	0.581	2.7	NA	0.0	0.0	0.00	0.09	0.00	76.3

MOVEMENT SUMMARY

Site: [Bussell Hwy & Tuart Dr & Access C - 2044 - AM (Site Folder: DPLH - 2044 - AM)]

Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND 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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Access C (S)														
1	L2	203	2.0	214	2.0	0.543	9.0	LOS A	3.4	25.6	0.84	1.00	1.09	51.0
2	T1	1	2.0	1	2.0	0.543	7.9	LOS A	3.4	25.6	0.84	1.00	1.09	44.2
3	R2	99	2.0	104	2.0	0.543	14.9	LOS B	3.4	25.6	0.84	1.00	1.09	53.8
Approach		303	2.0	319	2.0	0.543	10.9	LOS B	3.4	25.6	0.84	1.00	1.09	51.8
East: Bussell Hwy (E)														
4	L2	34	2.0	36	2.0	0.458	5.7	LOS A	3.8	36.1	0.48	0.49	0.48	59.6
5	T1	1103	22.8	1161	22.8	0.458	6.2	LOS A	3.8	36.1	0.50	0.50	0.50	63.1
6	R2	1	2.0	1	2.0	0.458	13.9	LOS B	3.7	35.2	0.52	0.52	0.52	60.6
Approach		1138	22.2	1198	22.2	0.458	6.2	LOS A	3.8	36.1	0.50	0.50	0.50	63.0
North: Tuart Dr (N)														
7	L2	3	2.0	3	2.0	0.139	5.5	LOS A	0.6	4.7	0.70	0.87	0.70	50.4
8	T1	1	2.0	1	2.0	0.139	4.4	LOS A	0.6	4.7	0.70	0.87	0.70	44.3
9	R2	80	2.0	84	2.0	0.139	11.5	LOS B	0.6	4.7	0.70	0.87	0.70	52.1
Approach		84	2.0	88	2.0	0.139	11.2	LOS B	0.6	4.7	0.70	0.87	0.70	52.0
West: Bussell Hwy (W)														
10	L2	31	2.0	33	2.0	0.401	5.4	LOS A	3.6	33.9	0.41	0.44	0.41	56.6
11	T1	947	21.5	997	21.5	0.401	5.7	LOS A	3.6	33.9	0.43	0.46	0.43	63.6
12	R2	74	2.0	78	2.0	0.401	13.4	LOS B	3.5	31.9	0.44	0.50	0.44	57.7
Approach		1052	19.6	1107	19.6	0.401	6.2	LOS A	3.6	33.9	0.43	0.47	0.43	63.0
All Vehicles		2577	18.1	2713	18.1	0.543	6.9	LOS A	3.8	36.1	0.52	0.56	0.55	61.5

MOVEMENT SUMMARY

▽ Site: [Paterson Dr & Vasse Hwy - 2044 - AM (Site Folder: DPLH - 2044 - AM)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND 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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Vasse Hwy (S)														
2	T1	218	16.9	229	16.9	0.143	0.4	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
3	R2	47	2.0	49	2.0	0.053	9.6	LOS A	0.2	1.5	0.44	0.69	0.44	60.2
Approach		265	14.3	279	14.3	0.143	2.1	NA	0.2	1.5	0.08	0.12	0.08	92.6
East: Paterson Dr (E)														
4	L2	82	2.0	86	2.0	0.599	10.1	LOS B	4.3	32.3	0.70	1.06	1.27	47.2
6	R2	210	2.0	221	2.0	0.599	17.4	LOS C	4.3	32.3	0.70	1.06	1.27	47.2
Approach		292	2.0	307	2.0	0.599	15.3	LOS C	4.3	32.3	0.70	1.06	1.27	47.2
North: Vasse Hwy (N)														
7	L2	82	2.0	86	2.0	0.049	7.9	LOS A	0.0	0.0	0.00	0.66	0.00	63.2
8	T1	260	21.0	274	21.0	0.177	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
Approach		342	16.4	360	16.4	0.177	1.9	NA	0.0	0.0	0.00	0.16	0.00	91.1
All Vehicles		899	11.1	946	11.1	0.599	6.3	NA	4.3	32.3	0.25	0.44	0.44	74.3

MOVEMENT SUMMARY

▽ Site: [Blum Blvd & Vasse Hwy - 2044 - PM (Site Folder: DPLH - 2044 - PM)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND 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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Vasse Hwy (S)														
2	T1	299	16.9	315	16.9	0.196	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
3	R2	36	2.0	38	2.0	0.047	10.2	LOS B	0.2	1.3	0.50	0.73	0.50	58.8
Approach		335	15.3	353	15.3	0.196	1.3	NA	0.2	1.3	0.05	0.08	0.05	95.2
East: Blum Blvd (E)														
4	L2	14	2.0	15	2.0	0.396	8.9	LOS A	1.8	13.6	0.77	0.98	1.03	45.3
6	R2	115	2.0	121	2.0	0.396	18.4	LOS C	1.8	13.6	0.77	0.98	1.03	45.2
Approach		129	2.0	136	2.0	0.396	17.3	LOS C	1.8	13.6	0.77	0.98	1.03	45.2
North: Vasse Hwy (N)														
7	L2	118	2.0	124	2.0	0.070	7.9	LOS A	0.0	0.0	0.00	0.66	0.00	63.2
8	T1	329	21.0	346	21.0	0.224	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
Approach		447	16.0	471	16.0	0.224	2.1	NA	0.0	0.0	0.00	0.17	0.00	90.2
All Vehicles		911	13.8	959	13.8	0.396	4.0	NA	1.8	13.6	0.13	0.25	0.17	83.5

MOVEMENT SUMMARY

Site: v [Scenario 2 Bussell Hwy & Access B - 2044 - PM (Site Folder: Scenario 2 - TIA Volume)]

Network: N101 [Scenario 2PM - RI only at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 140 seconds (Network Optimum Cycle Time - Minimum Delay)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Access B (S)														
1	L2	320	2.0	320	2.0	0.526	41.0	LOS D	16.6	125.8	0.82	0.80	0.82	11.3
3	R2	57	2.0	57	2.0	*0.711	82.5	LOS F	4.2	31.7	1.00	0.83	1.18	19.9
Approach		377	2.0	377	2.0	0.711	47.2	LOS D	16.6	125.8	0.85	0.81	0.87	13.8
East: Bussell Hwy (E)														
4	L2	104	2.0	104	2.0	0.107	25.2	LOS C	3.4	25.9	0.52	0.73	0.52	40.8
5	T1	1428	22.8	1428	22.8	*0.858	33.9	LOS C	45.4	433.1	0.91	0.88	0.97	32.6
Approach		1533	21.4	1533	21.4	0.858	33.3	LOS C	45.4	433.1	0.88	0.87	0.94	33.2
West: Bussell Hwy (W)														
11	T1	1166	21.5	1166	21.5	0.431	1.9	LOS A	8.0	75.9	0.22	0.21	0.22	76.7
12	R2	859	2.0	859	2.0	*0.848	65.8	LOS E	30.1	227.8	1.00	0.92	1.12	24.1
Approach		2025	13.2	2025	13.2	0.848	29.0	LOS C	30.1	227.8	0.55	0.51	0.60	44.8
All Vehicles		3935	15.3	3935	15.3	0.858	32.4	LOS C	45.4	433.1	0.71	0.68	0.76	37.9

MOVEMENT SUMMARY

Site: v [Scenario 1a Bussell Hwy & Access B - 2044 - PM (Site Folder: Scenario 2a)]

Network: N101 [Scenario 2aPM - LILO at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Signals - EQUISAT (Fixed-Time/SCATS) Coordinated Cycle Time = 140 seconds (Network Optimum Cycle Time - Minimum Delay)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Access B (S)														
1	L2	320	2.0	320	2.0	0.517	40.1	LOS D	16.4	124.3	0.81	0.80	0.81	11.5
3	R2	57	2.0	57	2.0	*0.711	82.5	LOS F	4.2	31.7	1.00	0.83	1.18	19.9
Approach		377	2.0	377	2.0	0.711	46.5	LOS D	16.4	124.3	0.84	0.80	0.87	13.9
East: Bussell Hwy (E)														
4	L2	104	2.0	104	2.0	0.108	25.9	LOS C	3.5	26.3	0.53	0.73	0.53	40.5
5	T1	1428	22.8	1428	22.8	*0.870	36.8	LOS D	47.3	450.8	0.92	0.91	1.00	31.1
Approach		1533	21.4	1533	21.4	0.870	36.0	LOS D	47.3	450.8	0.90	0.90	0.97	31.7
West: Bussell Hwy (W)														
11	T1	1166	21.5	1166	21.5	0.431	1.9	LOS A	8.0	75.9	0.22	0.21	0.22	76.7
12	R2	912	2.0	912	2.0	*0.877	69.3	LOS E	33.3	252.1	1.00	0.93	1.16	23.3
Approach		2078	12.9	2078	12.9	0.877	31.5	LOS C	33.3	252.1	0.56	0.52	0.63	43.2
All Vehicles		3987	15.2	3987	15.2	0.877	34.7	LOS C	47.3	450.8	0.72	0.69	0.78	36.6

MOVEMENT SUMMARY

Site: 1 [Bussell Hwy & Joseph Dr - 2044 - PM - RI LI LO (Site Folder: Scenario 2 - TIA Volume)]

Network: N101 [Scenario 2PM - RI only at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Joseph Dr (S)														
1	L2	342	2.0	342	2.0	0.188	7.9	LOS A	0.0	0.0	0.00	0.47	0.00	47.2
Approach		342	2.0	342	2.0	0.188	7.9	NA	0.0	0.0	0.00	0.47	0.00	47.2
East: Bussell Highway (E)														
3	L2	39	2.0	39	2.0	0.025	8.1	LOS A	0.1	0.6	0.10	0.60	0.10	58.0
4	T1	1711	22.8	1711	22.8	0.554	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	89.3
Approach		1749	22.3	1749	22.3	0.554	0.3	LOS A	0.1	0.6	0.00	0.01	0.00	88.4
West: Bussell Highway (W)														
11	T1	2025	21.5	2025	21.5	0.664	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	88.9
12	R2	53	2.0	53	2.0	0.474	54.5	LOS F	1.6	12.4	0.96	1.03	1.20	30.9
Approach		2078	21.0	2078	21.0	0.664	1.6	NA	1.6	12.4	0.02	0.03	0.03	82.7
All Vehicles		4169	20.0	4169	20.0	0.664	1.6	NA	1.6	12.4	0.01	0.06	0.02	80.1

MOVEMENT SUMMARY

Site: 1 [Bussell Hwy & Joseph Dr - 2044 - PM - LI LO (Site Folder: Scenario 2a)]

Network: N101 [Scenario 2aPM - LILO at Joseph with TIA volumes (Network Folder: 2044)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Joseph Dr (S)														
1	L2	342	2.0	342	2.0	0.188	7.9	LOS A	0.0	0.0	0.00	0.47	0.00	47.2
Approach		342	2.0	342	2.0	0.188	7.9	NA	0.0	0.0	0.00	0.47	0.00	47.2
East: Bussell Highway (E)														
3	L2	39	2.0	39	2.0	0.021	7.9	LOS A	0.0	0.0	0.00	0.63	0.00	58.5
4	T1	1711	22.8	1711	22.8	0.554	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	89.3
Approach		1749	22.3	1749	22.3	0.554	0.3	LOS A	0.0	0.0	0.00	0.01	0.00	88.4
West: Bussell Highway (W)														
11	T1	2078	21.5	2078	21.5	0.676	0.3	LOS A	0.0	0.0	0.00	0.00	0.00	88.8
Approach		2078	21.5	2078	21.5	0.676	0.3	NA	0.0	0.0	0.00	0.00	0.00	88.8
All Vehicles		4169	20.3	4169	20.3	0.676	0.9	NA	0.0	0.0	0.00	0.04	0.00	82.0

MOVEMENT SUMMARY

Site: [Bussell Hwy & Tuart Dr & Access C - 2044 - PM (Site Folder: DPLH - 2044 - PM)]

Site Category: (None)
Roundabout

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND 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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Access C (S)														
1	L2	101	2.0	106	2.0	0.327	7.5	LOS A	1.7	13.0	0.83	0.91	0.88	52.6
2	T1	1	2.0	1	2.0	0.327	6.3	LOS A	1.7	13.0	0.83	0.91	0.88	45.4
3	R2	49	2.0	52	2.0	0.327	13.4	LOS B	1.7	13.0	0.83	0.91	0.88	55.6
Approach		151	2.0	159	2.0	0.327	9.4	LOS A	1.7	13.0	0.83	0.91	0.88	53.5
East: Bussell Hwy (E)														
4	L2	82	2.0	86	2.0	0.585	6.2	LOS A	5.4	50.4	0.62	0.54	0.62	58.4
5	T1	1308	22.8	1377	22.8	0.585	7.0	LOS A	5.4	50.4	0.64	0.57	0.64	62.1
6	R2	1	2.0	1	2.0	0.585	14.6	LOS B	5.2	49.3	0.67	0.60	0.67	59.6
Approach		1391	21.6	1464	21.6	0.585	6.9	LOS A	5.4	50.4	0.64	0.57	0.64	62.0
North: Tuart Dr (N)														
7	L2	3	2.0	3	2.0	0.083	5.5	LOS A	0.4	2.7	0.68	0.83	0.68	50.5
8	T1	1	2.0	1	2.0	0.083	4.4	LOS A	0.4	2.7	0.68	0.83	0.68	44.4
9	R2	47	2.0	49	2.0	0.083	11.5	LOS B	0.4	2.7	0.68	0.83	0.68	52.2
Approach		51	2.0	54	2.0	0.083	11.0	LOS B	0.4	2.7	0.68	0.83	0.68	52.0
West: Bussell Hwy (W)														
10	L2	53	2.0	56	2.0	0.412	5.1	LOS A	3.9	36.5	0.30	0.40	0.30	57.2
11	T1	943	21.5	993	21.5	0.412	5.4	LOS A	3.9	36.5	0.31	0.44	0.31	64.0
12	R2	166	2.0	175	2.0	0.412	13.1	LOS B	3.8	33.8	0.32	0.49	0.32	57.3
Approach		1162	17.8	1223	17.8	0.412	6.4	LOS A	3.9	36.5	0.31	0.44	0.31	62.9
All Vehicles		2755	18.5	2900	18.5	0.585	6.9	LOS A	5.4	50.4	0.51	0.54	0.51	61.8

MOVEMENT SUMMARY

Site: [Paterson Dr & Vasse Hwy - 2044 - PM (Site Folder: DPLH - 2044 - PM)]

Site Category: (None)
Give-Way (Two-Way)

Vehicle Movement Performance

Mov ID	Turn	INPUT VOLUMES [Total veh/h	HV] %	DEMAND 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	Effective Stop Rate	Aver. No. Cycles	Aver. Speed km/h
South: Vasse Hwy (S)														
2	T1	233	16.9	245	16.9	0.153	0.2	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
3	R2	79	2.0	83	2.0	0.087	9.5	LOS A	0.3	2.6	0.44	0.70	0.44	60.2
Approach		312	13.1	328	13.1	0.153	2.6	NA	0.3	2.6	0.11	0.18	0.11	89.5
East: Paterson Dr (E)														
4	L2	44	2.0	46	2.0	0.283	5.8	LOS A	1.2	9.2	0.53	0.75	0.58	52.6
6	R2	102	2.0	107	2.0	0.283	12.2	LOS B	1.2	9.2	0.53	0.75	0.58	52.6
Approach		146	2.0	154	2.0	0.283	10.3	LOS B	1.2	9.2	0.53	0.75	0.58	52.6
North: Vasse Hwy (N)														
7	L2	185	2.0	195	2.0	0.110	7.9	LOS A	0.0	0.0	0.00	0.66	0.00	63.2
8	T1	158	21.0	166	21.0	0.107	0.0	LOS A	0.0	0.0	0.00	0.00	0.00	99.9
Approach		343	10.8	361	10.8	0.110	4.3	NA	0.0	0.0	0.00	0.35	0.00	80.1
All Vehicles		801	10.1	843	10.1	0.283	4.7	NA	1.2	9.2	0.14	0.36	0.15	77.9

Appendix E

Site Works and Infrastructure Report

Embark Estate, Yalyalup

Civil, Electrical and Communications Engineering Servicing Report

Revision 001

Ref: 301270470

PREPARED FOR:

Yolk Property Group
Attn: Tao Bourton

PREPARED BY:

Richard Martin

Stantec

Revision

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Appendix D ATCO Gas Correspondence

Executive Summary

Appendix A

1. General

1.1 Introduction

Appendix A

1.2 Site Description

1.2.1 Site Location, Topography, and Existing Features

Figure 1



Figure 1: Site Location

Figure 2

Figure 3 of '*moderate to low risk of ASS occurring within 3m of natural soil surface but high to moderate risk of ASS beyond 3m of natural surface'*

'*high to moderate risk of ASS occurring within 3m of natural soil surface'*

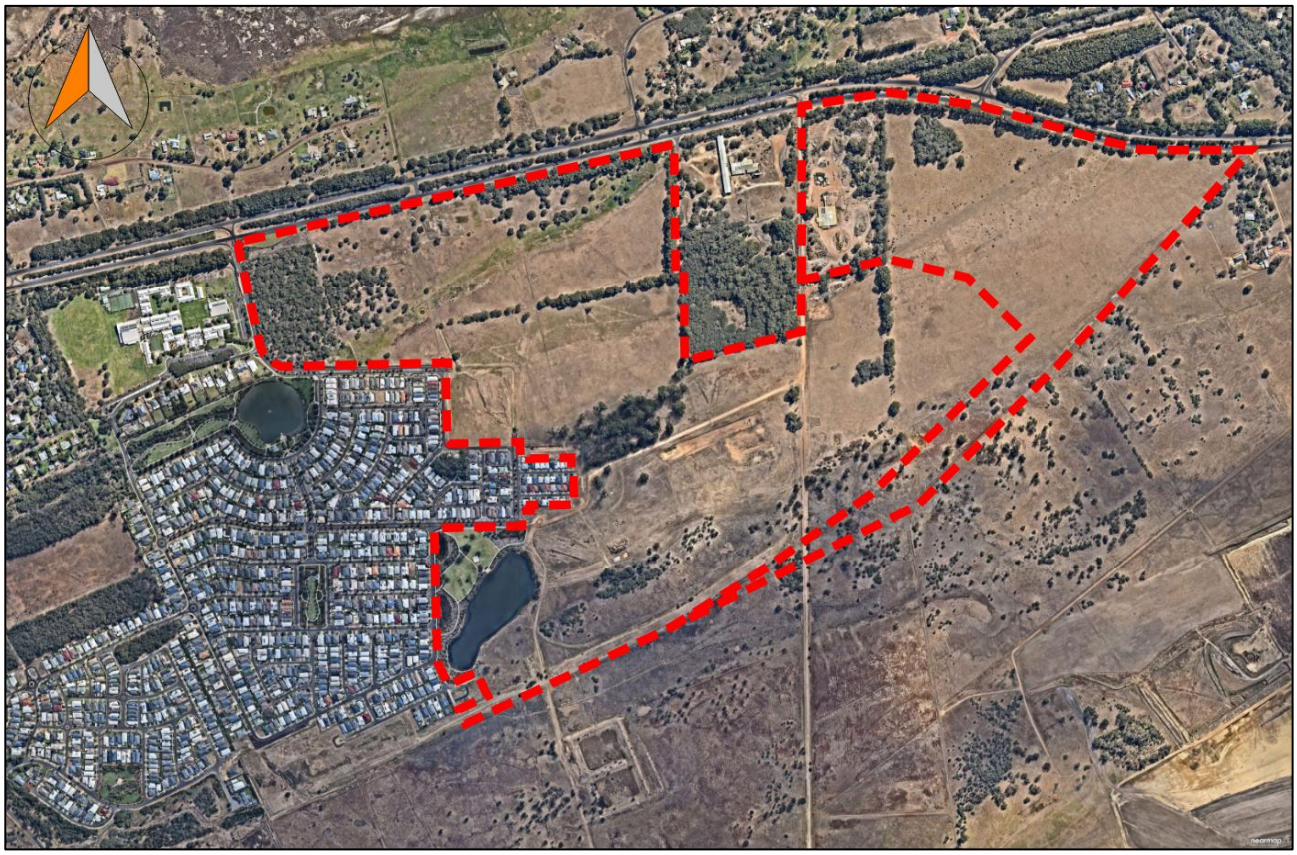


Figure 2: Site Overview (Imagery: Nearmap, dated 06/04/2022)

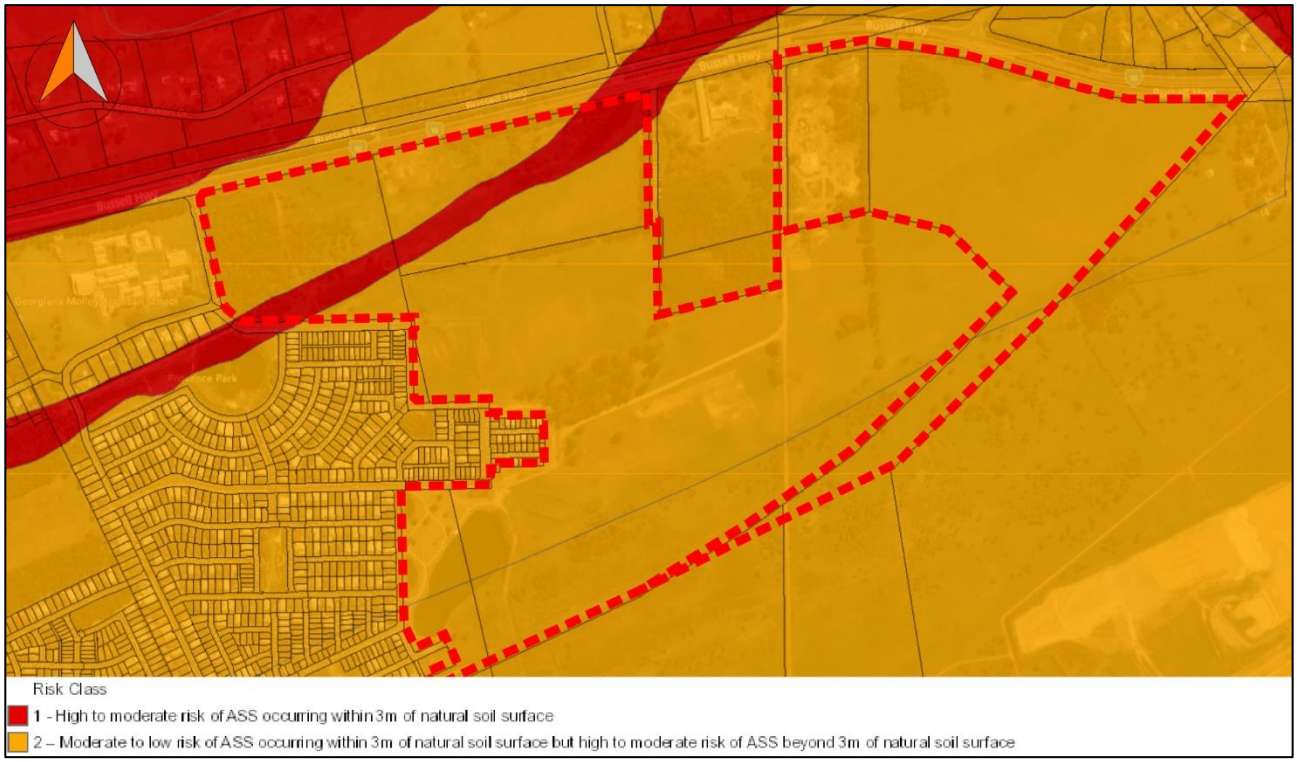


Figure 3: ASS Risk Mapping (Department of Water and Environmental Regulation)

2. Sewerage

2.1 Existing Infrastructure

2.2 Proposed Development Servicing

The Site is located within Water Corporation's SD
meaning that allowance has been made within Water Corporation's planning

Water Corporation's SD *Figure 4*

Water Corporation's SD090 indicates the Site is located across three sewer pump stations

proposed development. Water Corporation's SD090 indicates that PSU is to

Water Corporation's SD090

Appendix B

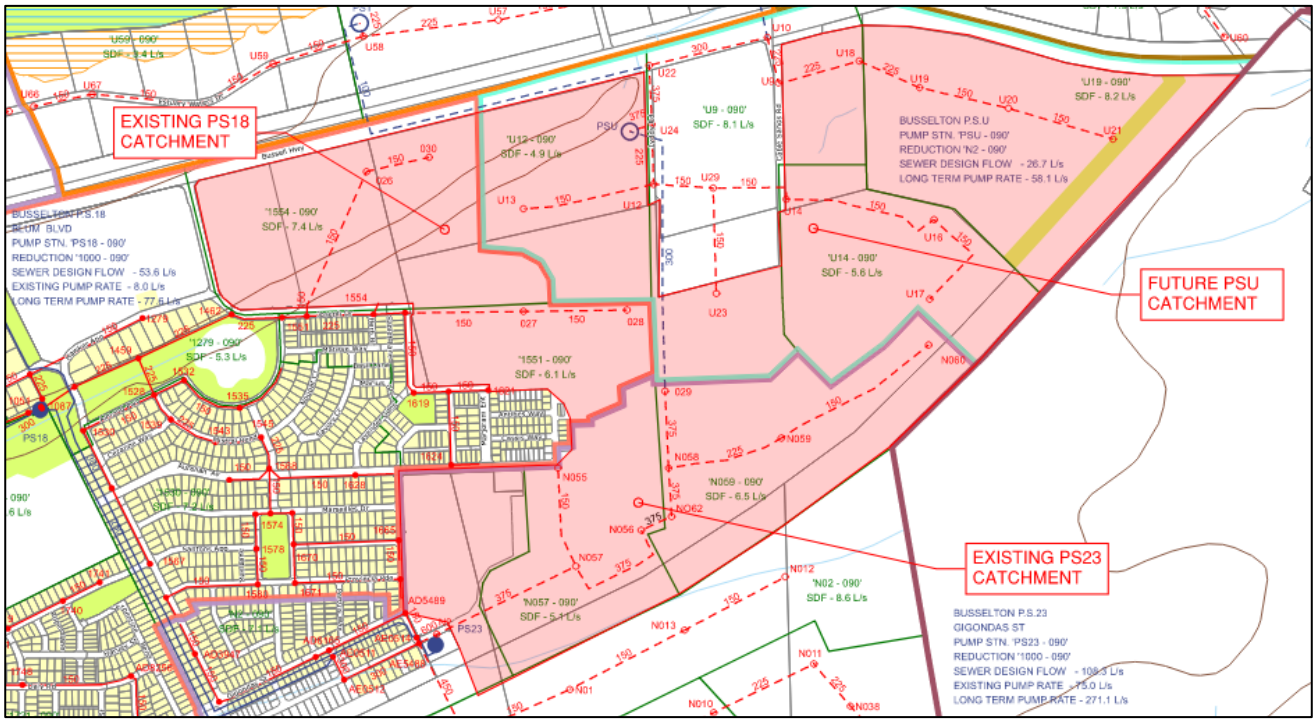


Figure 4: Extract from Water Corporation's SD090

3. Potable Water

3.1 Existing Infrastructure

Figure 5

Figure 5

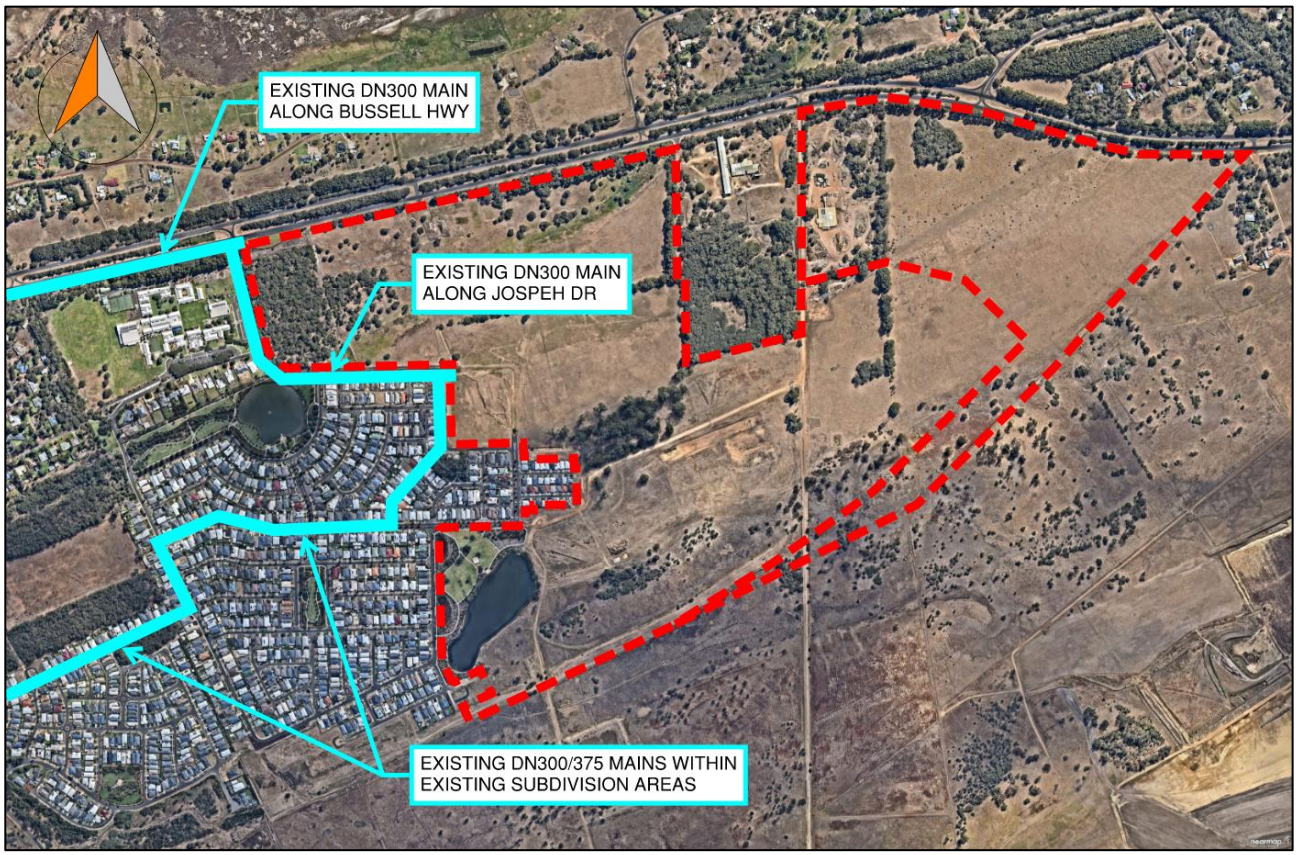


Figure 5: Existing Busselton Water Trunk Infrastructure

3.2 Proposed Development Servicing

Figure 6

Appendix C

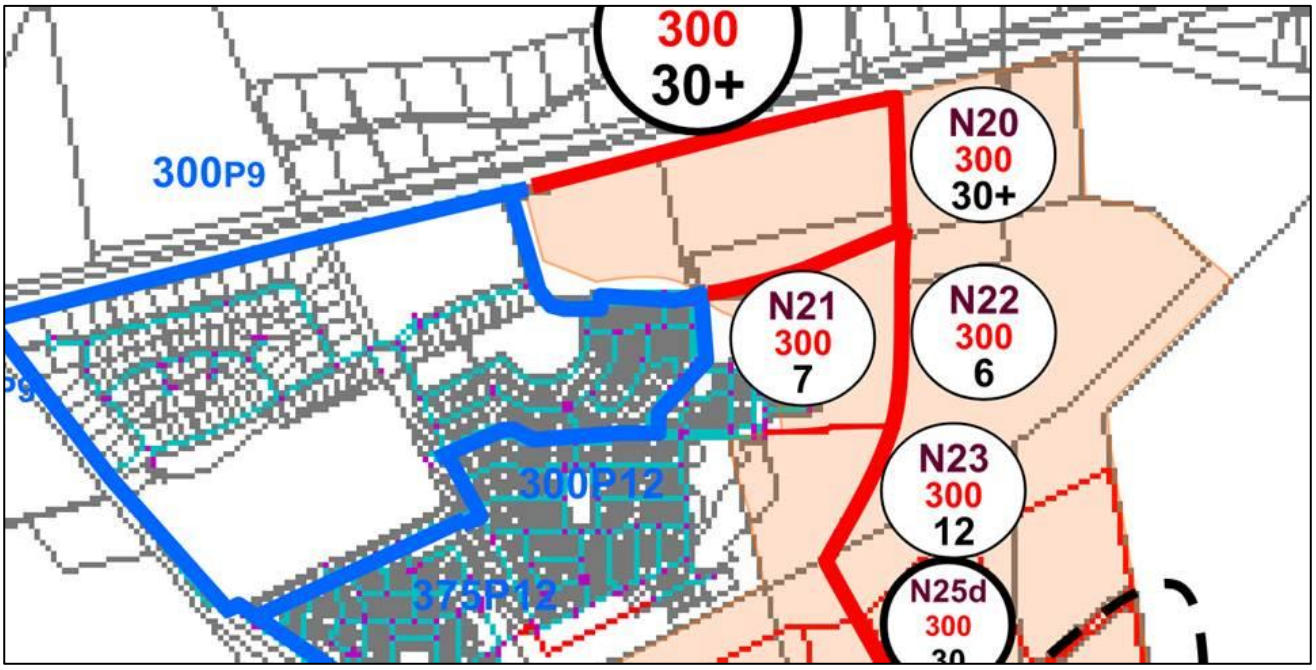


Figure 6: Busselton Water's 2017 Planning

4. Gas

Appendix D

5. Underground Power

5.1 Existing Infrastructure

An analysis of Western Power's DFIS system has been conducted to determine the existing power supply configuration

-
-
-
-

5.2 Infrastructure Capacity / Proposed Upgrades

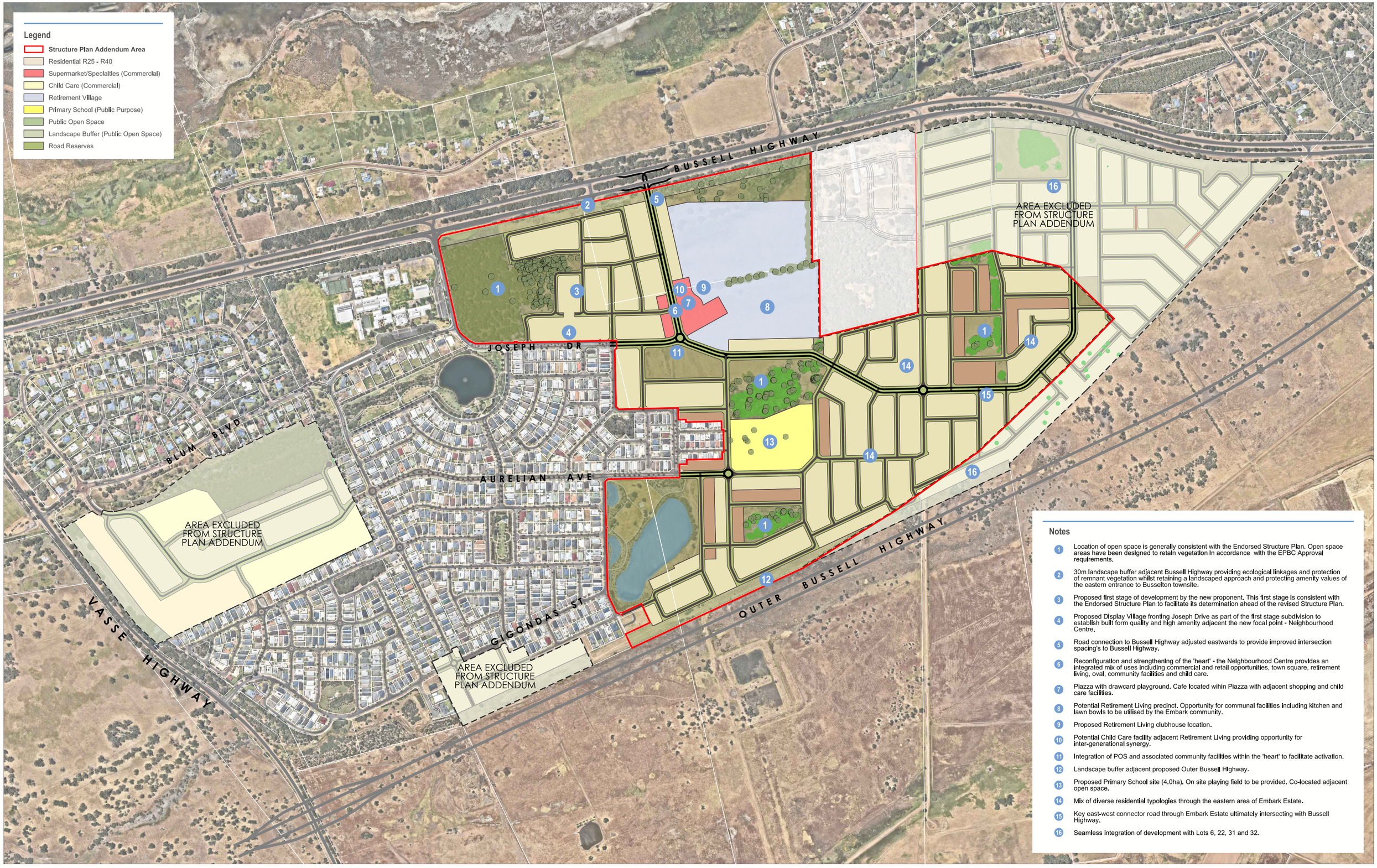
namic nature of Western Power's network, infrastructure requirements and connection

6. Communications

For the purpose of this confirmation “fibre ready telecommunications facilities” means.

-

Appendix A
Concept Development Layout



Notes

1. Location of open space is generally consistent with the Endorsed Structure Plan. Open space areas have been designed to retain vegetation in accordance with the EPBC Approval requirements.
2. 30m landscape buffer adjacent Bussell Highway providing ecological linkages and protection of remnant vegetation whilst retaining a landscaped approach and protecting amenity values of the eastern entrance to Busselton townsite.
3. Proposed first stage of development by the new proponent. This first stage is consistent with the Endorsed Structure Plan to facilitate its determination ahead of the revised Structure Plan.
4. Proposed Display Village fronting Joseph Drive as part of the first stage subdivision to establish built form quality and high amenity adjacent the new focal point - Neighbourhood Centre.
5. Road connection to Bussell Highway adjusted eastwards to provide improved intersection spacing's to Bussell Highway.
6. Reconfiguration and strengthening of the 'heart' - the Neighbourhood Centre provides an integrated mix of uses including commercial and retail opportunities, town square, retirement living, oval, community facilities and child care.
7. Piazza with drawcard playground. Cafe located wihin Piazza with adjacent shopping and child care facilities.
8. Potential Retirement Living precinct. Opportunity for communal facilities including kitchen and lawn bowls to be utilised by the Embark community.
9. Proposed Retirement Living clubhouse location.
10. Potential Child Care facility adjacent Retirement Living providing opportunity for inter-generational synergy.
11. Integration of POS and associated community facilities within the 'heart' to facilitate activation.
12. Landscape buffer adjacent proposed Outer Bussell Highway.
13. Proposed Primary School site (4.0ha). On site playing field to be provided. Co-located adjacent open space.
14. Mix of diverse residential typologies through the eastern area of Embark Estate.
15. Key east-west connector road through Embark Estate ultimately intersecting with Bussell Highway.
16. Seamless integration of development with Lots 6, 22, 31 and 32.

Development Concept Plan - Structure Plan Addendum Area

EMBARK ESTATE, YALYALUP

A Yolk Property Group Project

scale: 1:10,000@A3 | 1:5,000@A1

0 100 200m

plan: 22/010/022A

date: 17/11/2022

aerial: Jan 2022

Taylor Burrell Barnett Town Planning & Design
Level 7, 160 St Georges Terrace, Perth WA 6000
e: admin@tbbplanning.com.au
p: (08) 9226 4276

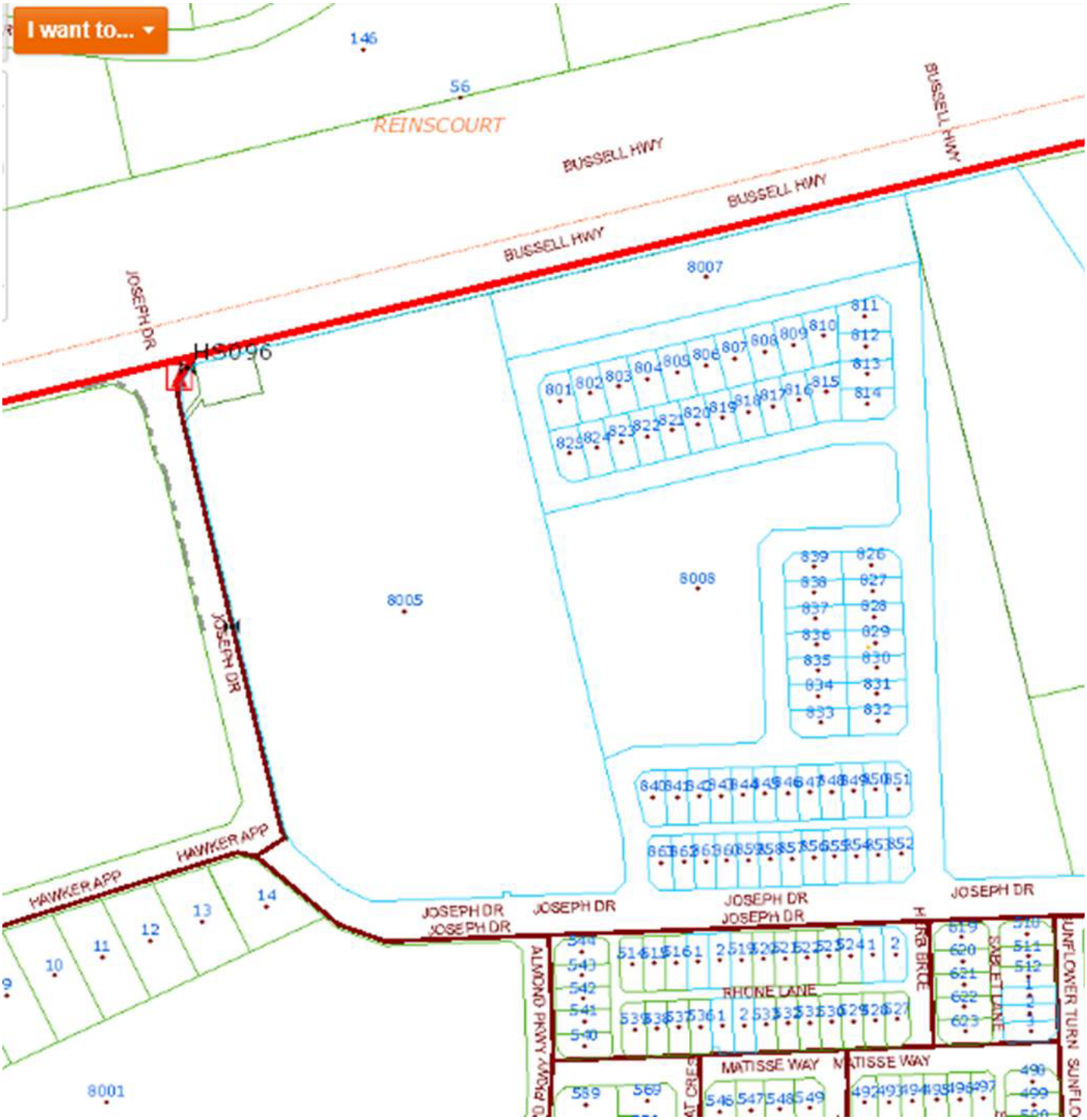
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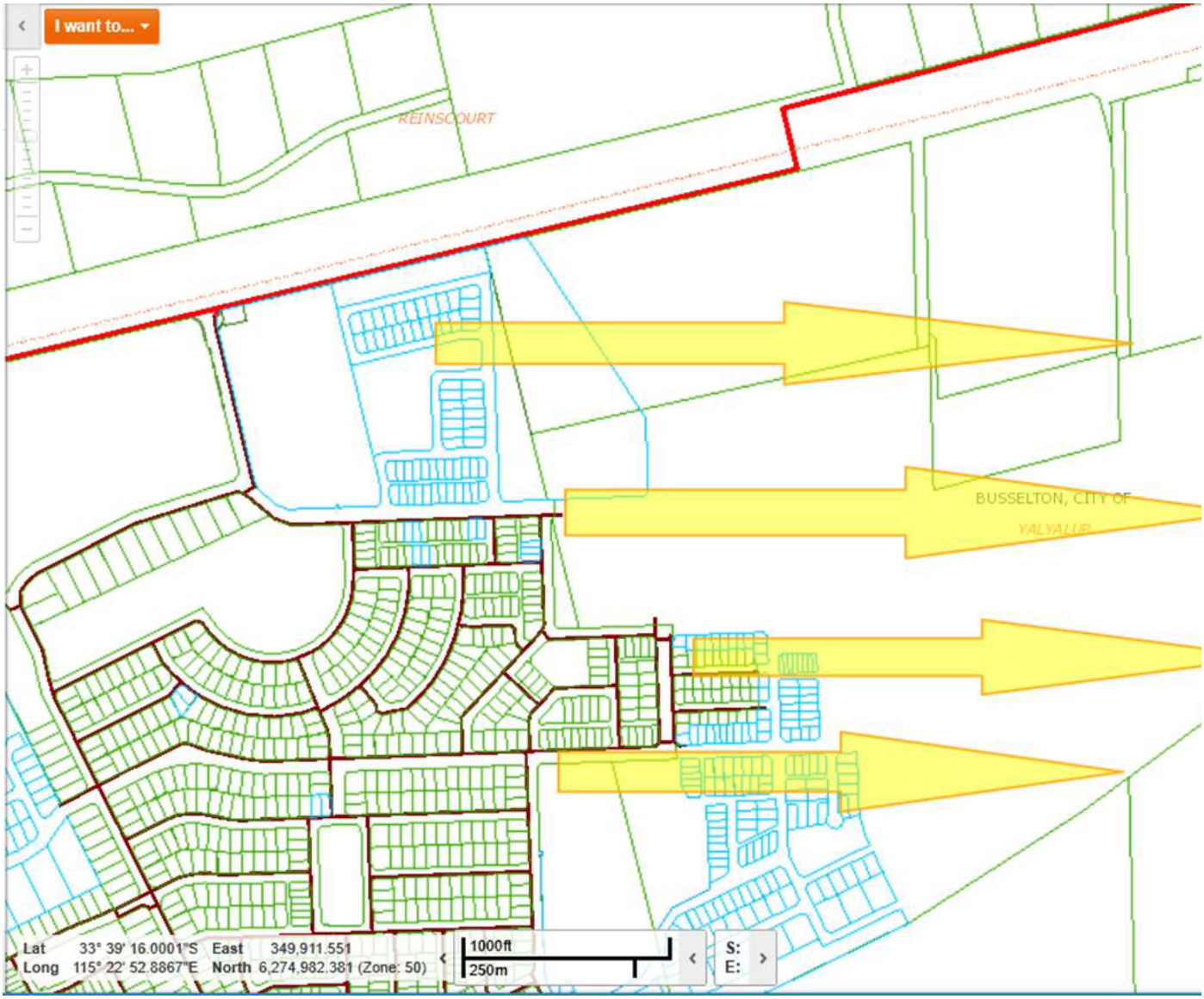
Taylor Burrell Barnett

Appendix B
Water Corporation Correspondence

Appendix C
Busselton Water Correspondence

Appendix D
ATCO Gas Correspondence


I want to...
146
56
REINSCOURT
BUSSELL HWY
BUSSELL HWY
BUSSELL HWY
BUSSELL HWY
JOSEPH DR
H30096
8007
8005
8008
JOSEPH DR
HAWKER APP
HAWKER APP
10
11
12
13
14
8001
JOSEPH DR
JOSEPH DR
JOSEPH DR
JOSEPH DR
JOSEPH DR
RHONE LANE
MATISSE WAY
MATISSE WAY
SUNFLOWER TURN



PLANNING – Once you have drawings ready (WATER PDF or CAD DWG), please forward these through to Land.Development@atco.com

I'll get back to you on the capacity matter ASAP.

Regards,
Ben

Benjamin Hoyne
Business Development Manager
ATCO, Gas Division, Australia

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ATCO always there. anywhere.

ATCO acknowledges Aboriginal people as the Traditional Custodians of country throughout Australia including Torres Strait Islander peoples.
We pay respect to their cultures, Elders past and present, and in the spirit of reconciliation, we commit to working together for our shared future.

w

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Stantec

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Appendix F

Environmental Assessment Report

MAKING COMPLEX EASY

A TETRA TECH COMPANY

ENVIRONMENTAL ASSESSMENT REPORT

Embark, Busselton

AU213002666.001
Rev 2
03 February 2023

rpsgroup.com

Document status

Version	Purpose of document	Authored by	Reviewed by	Approved by	Review date
Draft A	Draft for client review	RebDaw	SteRol	NA	07/12/2022
Rev 0	Final for issue	RebDaw	GleYea	GleYea	27/01/2023
Rev 1	Final for issue	RebDaw	GleYea	GleYea	01/02/2023
Rev 2	Final for issue	RebDaw	GleYea	GleYea	02/02/2023

Approval for issue

G. Yeatman  3 February 2023

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Appendix B: EPA advice
Appendix C: Flora, vegetation and fauna reports
Appendix D: Western Grey Kangaroo (*Macropus fuliginosus*) Survey and Management Plan
Appendix E: Landscape concept plan

1 INTRODUCTION

This Environmental Assessment Report (EAR) has been prepared to support the Embark Structure Plan, which encompasses Lots 2, 9032, and 9034 Bussell Highway, Yalyalup (the site) (Figure 1). The site comprises approximately 249 hectares and is located within the City of Busselton, approximately four kilometres (km) south-east of the Busselton town site.

1.1 Background

The key components of the Embark Structure Plan (which was previously referred to as the Provence Estate Structure Plan) are detailed in Section 1.5. Environmental assessment reports have historically been prepared to support the previous Provence Estate Structure Plans as summarised below:

- An EAR was prepared to support the Provence Residential Estate Structure Plan (RPS, 2017) for Lots 9021, 9029, 2, 501 and Part Lot 203 Vasse Highway, Yalyalup.
- An EAR was prepared to support a revised Provence Estate Structure Plan in 2020 by RPS. The Structure Plan encompassed Lots 501, 9033, 9032, 2 and 6 Vasse Highway, Yalyalup. Areas subject to redesign included Lots 9033, 9032, and 2.
- An EAR was prepared in 2020 to update the previous 2020 EAR and address the inclusion of Part Lot 75 in the Provence Estate Structure Plan.

1.2 Purpose of report

This Embark Structure Plan Environmental Assessment Report has updated the previous EARs noted above, where applicable. The purpose of this EAR is to:

- Describe the existing environmental attributes of the Embark Structure Plan, in accordance with the EPA's environmental factors.
- Outline the management measures that will be adopted to mitigate any potentially significant environmental impacts from future development.
- Support and facilitate the approval of the Embark Structure Plan to provide a framework to coordinate residential subdivision and development.

1.3 Planning context

1.3.1 Development Guide Plan – Busselton Airport (North)

A Development Guide Plan – Busselton Airport (North) (DGP) was prepared to provide a framework for future land use and development of land within the plan area. The original DGP was modified and endorsed by the City of Busselton and Western Australian Planning Commission (WAPC) on 1 June 2012. Further minor "interim" revisions of the DGP were subsequently undertaken and endorsed by the WAPC to ensure that all subdivision works could be completed in a manner that meets the developer's ambitions, current market demand and development time frames moving forward.

To date, development of the endorsed DGP area has been facilitated through the approval of Detailed Area Plans (DAPs) and conditional subdivision approvals. DAPs 1 to 4 have previously been adopted by Council in accordance with provisions of the Scheme. The site comprises DAPs 2, 3, 4, 6 ,7, and 8. However, as this naming convention has been superseded, it is not discussed further in this report.

1.3.2 Local planning scheme context

Under Local Planning Scheme (LPS) No. 21, the site is 'Urban Development' and is located within Special Provision Area SP23 (Figure 2).



Figure 1: Embark structure plan site boundary



Figure 2: Local planning scheme zoning

1.3.3 Environmental approval history

1.3.3.1 Federal approvals

The previous Provence Structure Plan (comprising Lots 501, 9033, 9032, 2 and 6) was referred to the (then) Commonwealth Department of Environment and Heritage (now the Department of Climate Change, Energy, the Environment and Water (DCCEEW)) for assessment under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) in 2004 due to potential impacts to the following Matters of National Environmental Significance (MNES):

- Wetlands of international importance
- Listed threatened species and communities
- Listed migratory species.

The referral was approved, subject to conditions, in 2006. A request for extension to the EPBC approval was made in 2021. DCCEEW granted the extension request, extending the period of effect of the approval to 31 December 2036.

In 2008, a variation that provided for an update to the Water Management Strategy was approved by the (then) Department of the Environment, Water, Heritage and the Arts (now DCCEEW).

EPBC approval documents are provided in Appendix A.

1.3.3.2 Planning scheme amendment

In October 2004, the City of Busselton referred Amendment No. 83 – Rezone from Agriculture, Residential and Rural Residential to Special Purpose with Provisions for Busselton Airport Structure Plan to the Environmental Protection Authority (EPA) for assessment under Section 48 of the *Environmental Protection Act 1986* (EP Act). In August 2005, the EPA determined that the likely environmental impacts of Amendment No. 83 should be treated as “Scheme Not Assessed – Advice Given (no appeals)”.

The EPA identified that the key environmental factors requiring management at the site include:

- Contamination
- Environmental Protection Policy (EPP) wetland (policy now revoked)
- Nutrient export and drainage
- Noise.

The EPA’s advice is provided in Appendix B.

1.4 Relevant management plans and technical investigations

The following management plans and technical investigations have been prepared for the current site, or to support previous structure plans:

- Embark Acid Sulfate Soil and Dewatering Management Plan (RPS, 2022a)
- Western Ringtail Possum Management Plan (Coffey 2009)
- Mosquito Management Plan, Provence Estate, Busselton (ATA Environmental 2007)
- Acid Sulfate Soil Management Plan – Provence residential development (Coffey 2010)
- Excavation Treatment Procedure Plan, Provence Residential Estate Detailed Area Plans DAP 3 and 4 (RPS 2013)
- Addendum to Acid Sulfate Soil Management Plan, Provence Residential Development (RPS 2015a)
- Preliminary Site Investigation and Sampling Analysis Quality Plan, DAP 3 – Provence estate, Yalyalup, Western Australia (RPS 2015b)
- Acid Sulfate Soils and Dewatering Management Plan Addendum: Provence Stage 13 (RPS 2018)

- Western Grey Kangaroo (*Macropus fuliginosus*) Survey and Management Plan (Ecosystem Solutions 2015)
- Provence Estate, Yalyalup, Bushfire Management Plan (Ecosystem Solutions 2017)
- Bushfire Management Plan, Provence Estate, part lot 75 Bussell Highway, Yalyalup (Ecosystem Solutions 2019).

1.5 Embark Structure Plan

The Embark Structure Plan includes residential lots, Public Open Space (POS), Special Use – retirement village, a primary school and local centre (Figure 3).

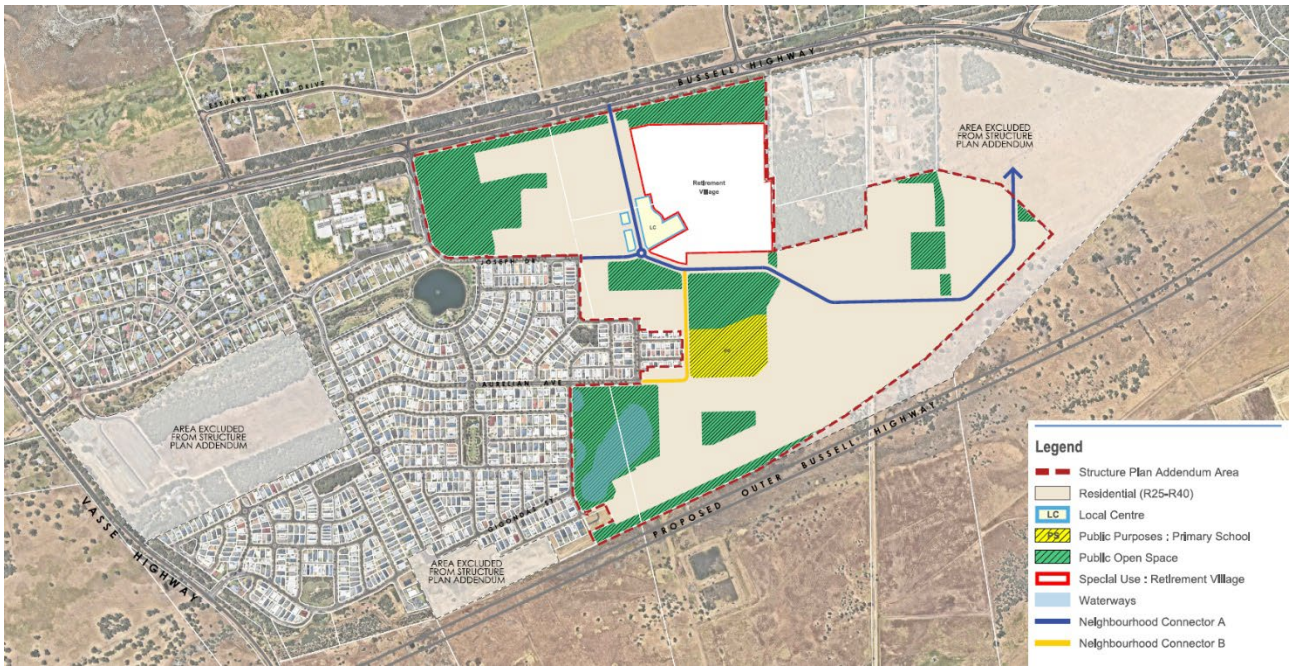


Figure 3 Embark Structure Plan

The site is strategically located at the south-eastern edge of the existing Busselton urban front and provides convenient access to the existing commercial, retail, medical and shopping facilities of the Busselton town centre and the recreational areas of Geographe Bay, Busselton Golf Course, Bovell Park Sporting Complex and the Busselton foreshore reserve.

1.5.1 Response to Environmental Protection Bulletin No. 20

The Embark Structure Plan responds to the EPA's design guidelines for planning and development, as outlined in the Environmental Protection Bulletin No. 20: Protection of Natural Areas through Planning and Development (EPA 2013) through:

- Locating proposed future development in historically cleared areas, where possible
- Protecting the consolidated areas of remnant vegetation from future development
- Maintaining the existing ecological linkage along the site's northern boundary, which connects fauna habitat
- Minimising development in naturally vegetated areas to minimise the risk of fire and its potential impacts on the future residential community.

1.6 Land use

1.6.1 Previous and existing land uses

A review of historical aerial photography between 1996 and 2022 shows that the site has primarily been used for agricultural purposes, with most of the site cleared of native vegetation since prior to 1996.

The site has also been subject to extensive sand mining activities, resulting in the creation of an artificial lake.

The Busselton Meats Facility was formerly located within the site and is discussed further in Section 3.3.2.

1.6.2 Surrounding land uses

The site is bordered by agricultural paddocks on the eastern and southern boundaries (also proposed Outer Bussell Highway to the south, Figure 3), residential properties (developed as part of the previous Provence Structure Plan) to the west, and Bussell Highway to the north.

The Vasse-Wonnerup Estuary is located approximately 750 metres to the north of the site, with the Sabina River is located approximately 350 m east.

The Busselton-Margaret River Regional Airport is situated approximately 1.5 km to the south, and the Cable Sands mineral sands mine is operating 1 km east of the site.

2 LEGISLATIVE AND POLICY FRAMEWORK

2.1 Legislation and regulations

Urban development within the site is required to comply with environmental legislation and regulations. A summary of the key state and Commonwealth legislation and regulations is listed in Table 1.

Table 1: Key state and Commonwealth legislation and regulations

State legislation	
Aboriginal Heritage Act 1972	*Fire and Emergency Services Act 1998*
Aboriginal Heritage Regulations 1974	*Bush Fires Act 1954*
Biodiversity Conservation Act 2016	*Heritage Act 2018*
Contaminated Sites Act 2003	*Land Administration Act 1997*
Environmental Protection Act 1986	*Planning and Development Act 2005*
Environment Protection Regulations 1987	*Rights in Water and Irrigation Act 1914*
Environmental Protection (Noise) Regulations 1997	Biodiversity Conservation Regulations 2018
Commonwealth legislation	
Environment Protection and Biodiversity Conservation Act 1999	Environment Protection and Biodiversity Conservation Regulations 2000

2.1.1 Applicable guidelines and standards

Future development of the site will be subject to compliance with applicable guidance developed by the EPA to assist proponents and the public to understand the minimum requirements for the protection of elements of the environment that the EPA expects to be met during the assessment process.

State Planning Policies (SPPs) are prepared under Part 3 of the *Planning and Development Act 2005* to provide planning policy control and guidance to proponents.

Table 2 details the EPA factor guidelines, and state planning policies relevant to future development of the site.

Table 2: Applicable EPA standards, guidelines and state planning policies

EPA Environmental Protection Bulletin
Environmental Protection Bulletin No. 20: Protection of Natural Areas through Planning and Development
EPA guidance
Environmental Factor Guideline: Flora and Vegetation
Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment
Environmental Factor Guideline: Terrestrial Environmental Quality
Environmental Factor Guideline: Terrestrial Fauna
Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna
Technical Guidance: Terrestrial Fauna Surveys
Environmental Factor Guideline: Inland Waters
Environmental Factor Guideline: Social Surroundings
Guidance Statement No. 41: Aboriginal Heritage Assessment
State Planning Policies
SPP No. 3.7: Planning in Bushfire Prone Areas

Each factor is considered in the following sections.

3 EXISTING ENVIRONMENT

3.1 Flora and vegetation

The following flora and vegetation assessments have been undertaken to support the Embark Structure Plan (and previous Provence Structure Plan):

- Flora and vegetation assessment (ATA Environmental 2004a)
- A supplementary Level 1 Flora and Vegetation Survey (Ecosystem Solutions, 2016)
- An addendum to Ecosystem Solutions (2016) was prepared to respond to the revision of the SP in Lots 9033, 9032 and 2 (Appendix C; Ecosystem Solutions 2018)
- Revegetation monitoring report; Provence Estate, Busselton (Ecosystem Solutions, 2022a).

Sections 3.1.1 to 3.1.4 provide an overview of the information contained in these reports.

3.1.1 Regional vegetation

Vegetation mapping undertaken by Havel and Mattiske (2000) describes the vegetation complex across the site as Ludlow (Lw) – Open woodland of *Melaleuca rhaphiophylla* and sedgelands of Cyperaceae and Restionaceae species on broad depressions in the subhumid zone.

It is estimated that 24% of this vegetation type remains (Webb et al. 2009, cited in Ecosystem Solutions 2016). Vegetation types are considered underrepresented by the EPA if there is less than 30% of its original distribution remaining.

3.1.2 Vegetation types

Ecosystem Solutions (2016) identified ten vegetation types across site as summarised in Table 3 and shown in Figure 4.

Table 3: Vegetation types

Vegetation type	Vegetation condition	Area within structure plan	Vegetation retained	
			Area retained within POS	Area retained outside POS
Melaleuca woodland	Degraded to Good	2.38	1.06	-
Melaleuca/flooded gum/non-native eucalypts	Degraded	0.18	0.18	-
Melaleuca/peppermint woodland	Degraded	0.52	0.05	-
Melaleuca/flooded gum trees	Completely Degraded	1.51	-	-
Non-native eucalypts/peppermint woodland	Degraded	1.20	0.88	-
Non-native eucalypts/melaleuca/peppermint woodland	Degraded to Good	3.53	1.80	1.33 ha
Peppermint/marri woodland	Good	8.02	7.41	-
Tuart/peppermint forest	Good	3.7	3.03	-

3.1.3 Vegetation condition

The majority of the site has been historically cleared and comprises grassed paddocks and small areas of remnant vegetation. Remnant vegetation within the site was classified by Ecosystem Solutions (2016) as being in Good to Completely Degraded condition as shown in Figure 4 and summarised in Table 3.

3.1.4 Conservation significant flora

No Threatened or Priority species have been recorded at the site during flora or vegetation surveys (Ecosystem Solutions, 2016).

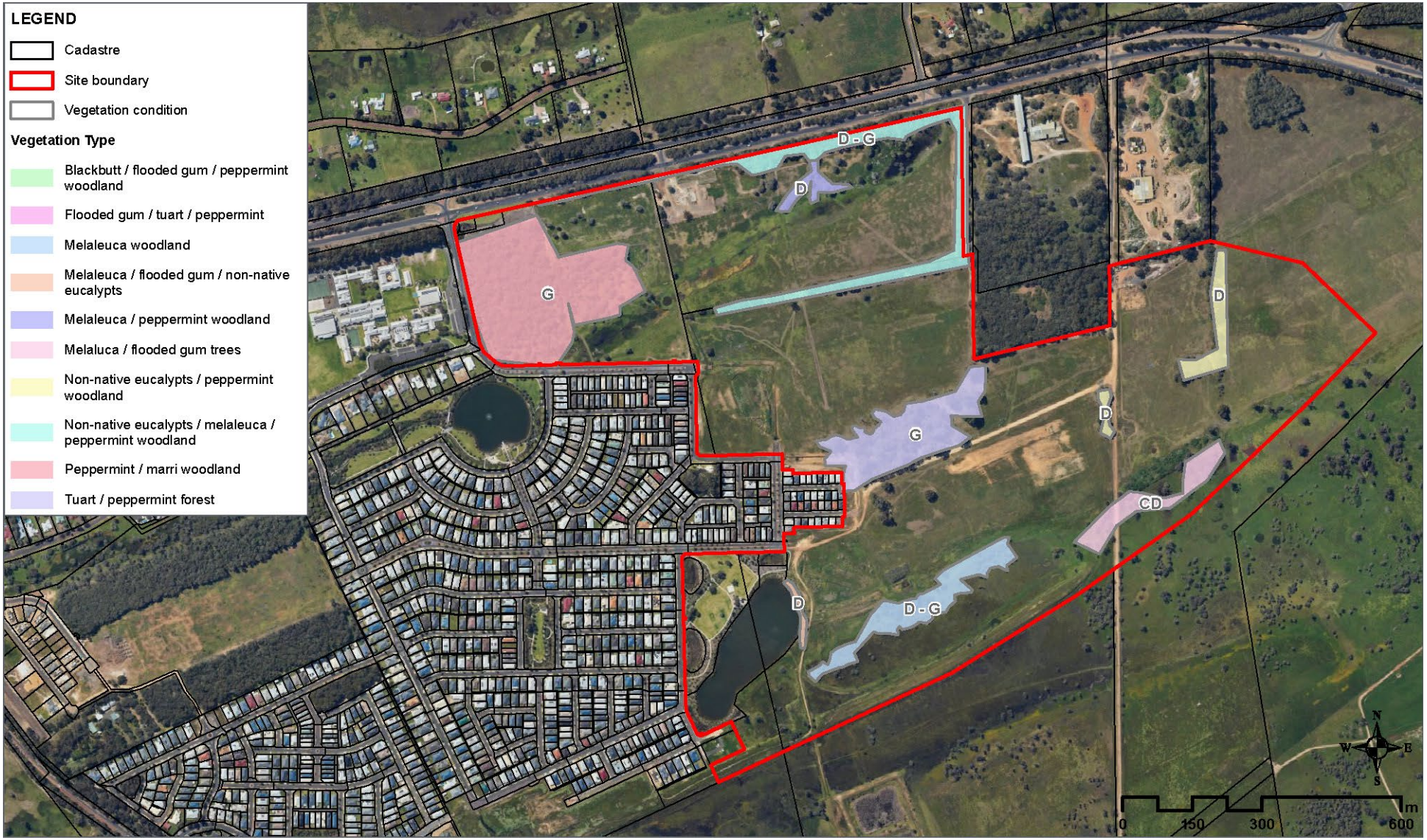


Figure 4: Remnant vegetation

3.2 Landforms

3.2.1 Topography

The site is characterised by low-lying flat topography with a slight slope increasing to the south (Coffey 2010). Elevation ranges from approximately three metres Australian Height Datum (m AHD) in the north to approximately 9.0 m AHD in the south (Figure 5).

3.2.2 Soils and geology

The Ludlow Plain land system underlies the site (Coffey 2010). Ludlow Plain is formed on aeolianite and calcarenite of the Tamala limestone (Tille and Lantske 1990, cited in Coffey 2010).

Geology within the site is characterised by four geological units (Figure 5):

- Limestone (LS7) – light yellow brown fine, fine to coarse grained, sub-angular to well-rounded quartz, shell and corals common, of marine origin
- Clayey Peaty Sand (Spc1) – grey to black quartz sand with variable organic content, minor clays of lacustrine origin
- Sand (S7) – pale and olive yellow, medium to coarse grained sub-angular to sub-rounded quartz, traces of feldspar, moderately sorted, of residual origin
- Sandy Silt (Ms2) – strong brown to mid-grey, mottled, blocky, disseminated fine sand, hard when dry, variable clay content of alluvial origin.

3.3 Terrestrial environmental quality

3.3.1 Acid sulfate soils

3.3.1.1 Regional acid sulfate soil risk mapping

A review of the Department of Water and Environmental Regulation's (DWER) Acid Sulfate Soil (ASS) risk mapping indicates that there is a 'moderate to low risk of ASS within 3 m of the ground surface' at the site, with the northern portion bisected by an area of 'high to moderate ASS disturbance risk within 3 m from surface' (Figure 6.

3.3.1.2 Acid sulfate soil investigations within the site

Soils were initially characterised in the Acid Sulfate Soil Management Plan (Coffey, 2010), with information compiled from the historical ASS investigation undertaken by ATA Environmental (2005) and geotechnical investigation (Golder, 2007).

Subsequent investigations undertaken across different areas of the Embark and previous Provence Structure Plan have enabled the refinement and further characterisation of soils that require management should they be disturbed. The presence of potential ASS has been identified at two primary locations within the site, however, may also be present across other areas (RPS, 2022a).

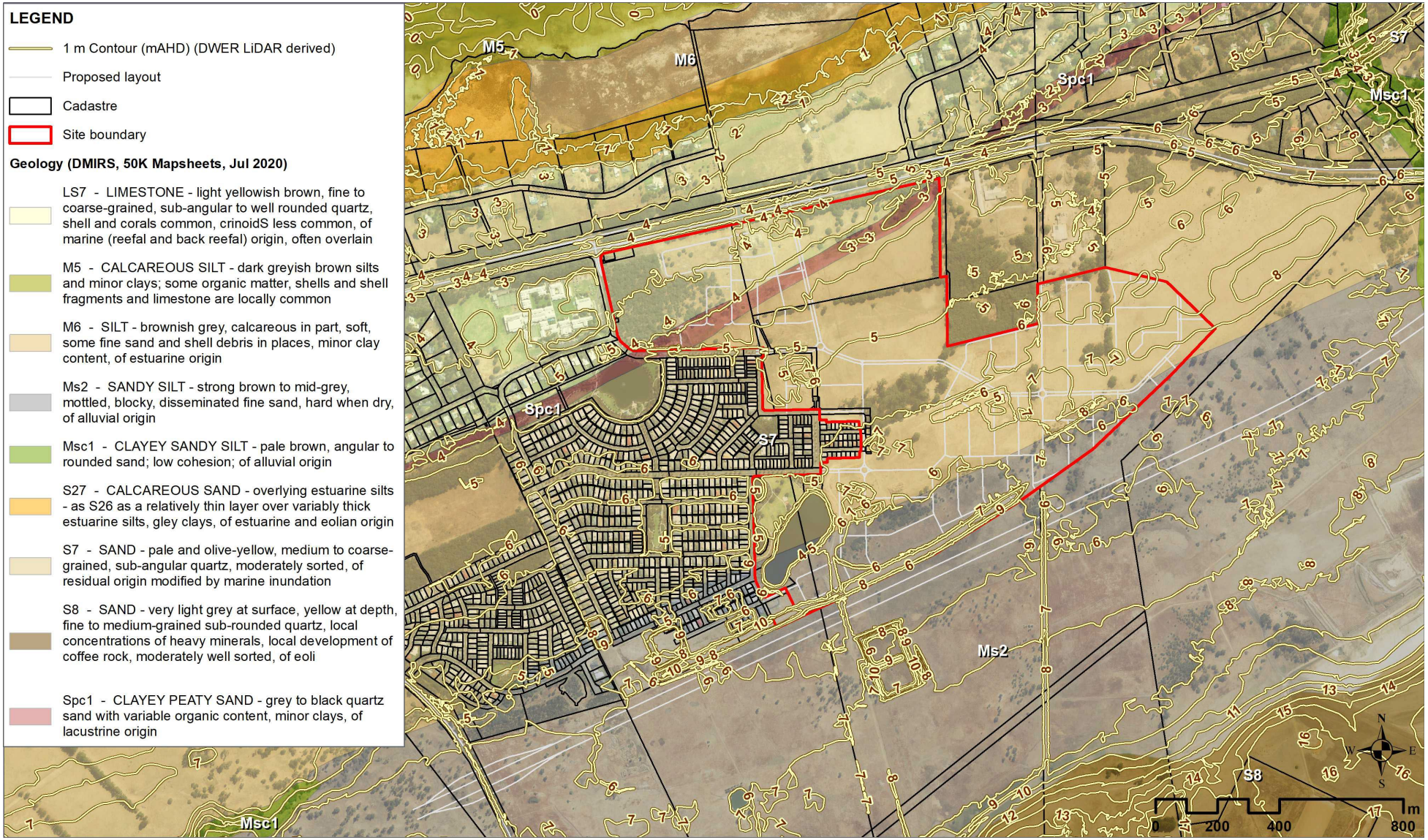


Figure 5: Geology and topography

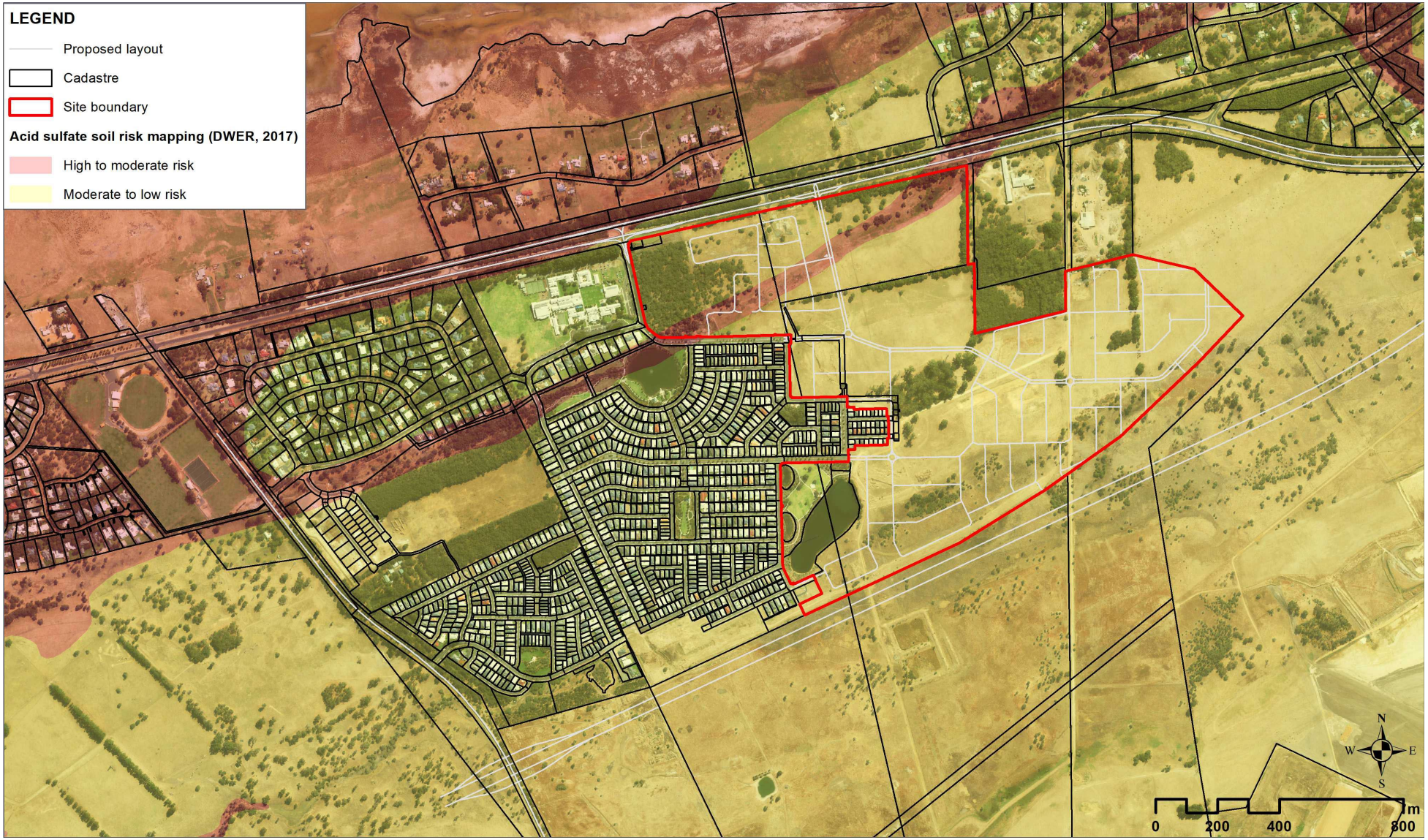


Figure 6: Acid sulfate soils

3.3.2 Potential contamination

3.3.2.1 Contaminated Sites Database

The DWER online Contaminated Sites Database shows that, as of 27 July 2022, the site is not registered as a contaminated site (Figure 7), indicating that it has not been formally classified under the *Contaminated Sites Act 2003* (CS Act 2003).

The closest contaminated sites (site ID 3822 and 136) are located over 3 km to the west. As groundwater flows in a north to north-west direction towards Geographe Bay, contaminated groundwater at the registered sites will not impact the site.

3.3.2.2 Busselton Meats Facility

The Busselton Meats Facility formerly occupied a 1.9 ha area in the north-west corner of Lot 2 (Figure 7). A series of contamination assessments were undertaken over this site in 2004 by ATA Environmental. The assessment identified zinc and copper in soil above Ecological Investigation Levels (EILs), and arsenic and nutrients in groundwater above ANZECC Freshwater and Australian Drinking Water Guidelines.

Due to the site's historical use and the associated soil and groundwater impacts identified in previous investigations, the site was classified by the then Department of Environment and Conservation (DEC, now DWER), as "Possibly Contaminated – Investigation Required" under the *Contaminated Sites Act 2003*.

3.3.2.3 Contaminated sites investigations to satisfy Condition 13 of WAPC application no. 151654

The south-western corner of Lot 9032 (referred to as Detailed Area Plan 3 in historical planning documents) was subject to Condition 13 of WAPC application no. 151654, which relates to contamination.

A Preliminary Site Investigation (PSI), a Sampling and Analysis Plan (SAQP) and targeted Detailed Site Investigation (DSI) (RPS 2015b) were undertaken to address this condition. On 16 September 2016, the area investigated was classified as "Not contaminated – unrestricted use".



Figure 7: Contaminated sites

3.4 Terrestrial fauna

In February 2003, ATA Environmental undertook a targeted western ringtail possum survey for the site (ATA Environmental 2004b). As the western ringtail possum is highly mobile, with assemblages subject to fluctuation in local populations, RPS considered it appropriate to undertake a supplementary survey of significant fauna within the site. Ecosystem Solutions undertook a Significant Fauna Assessment in accordance with the EPA's Gu*idance Statement No. 56: Terrestrial Fauna Surveys for Environmental Impact in Western Australia* (EPA 2004b) in December 2015 to January 2016 (Appendix C; Ecosystem Solutions 2016). An addendum to Ecosystem Solutions (2016) was prepared to respond to the revision of the previous Provence Structure Plan.

Conservation significant fauna species identified at the site during these investigations are discussed in the sections below.

3.4.1 Conservation significant fauna species

3.4.1.1 Western ringtail possum

Ecosystem Solutions (2016) identified three key western ringtail possum habitat areas within the site (Figures 8 and 9) (Appendix C). During surveys undertaken by Ecosystem Solutions larger numbers of western ringtail possum were observed during the night surveys than could utilise the number of dreys observed during the day survey. Consequently, western ringtail possums may be utilising tree hollows in *Agonis flexuosa* and dead Eucalyptus trees more than dreys to rest in.

3.4.1.2 Black cockatoos

During the Flora, Vegetation and Fauna Assessment (Ecosystem Solutions, 2016), 81 potential breeding trees (with a diameter at breast height greater than 500 mm) were identified within the survey area. Of these, 77 are located within the site. Potential breeding trees within the site are shown in Figure 8.

No black cockatoos were seen or heard during any of the surveys and no signs of feeding or feathers was recorded (Ecosystems Solutions 2016). This is likely due to fact that there is minimal foraging habitat present within the site, as well as the presence of better-quality habitat in the Tuart Forest National Park (2 km north-east) and other state forests nearby (10 km south). As the broader area contains a large amount of potential habitat, it is unlikely that black cockatoos are reliant on habitat in the site. However, they may use the site opportunistically and breed in potential habitat trees within the site in the future (Ecosystems Solutions 2016).

Ecosystem Solutions (2016) concluded that no nest hollows are currently being used at the site and there is minimal foraging habitat present. This is unlikely to have changed over recent years as there have been no significant changes to the biological values at the site.

3.4.2 Other conservation significant species

Other conservation significant fauna species identified in desktop assessments were not detected during field surveys. Ecosystem Solutions (2016) concluded that conservation significant species other than the western ringtail possum and black cockatoo species are unlikely to be impacted by the development of the site.

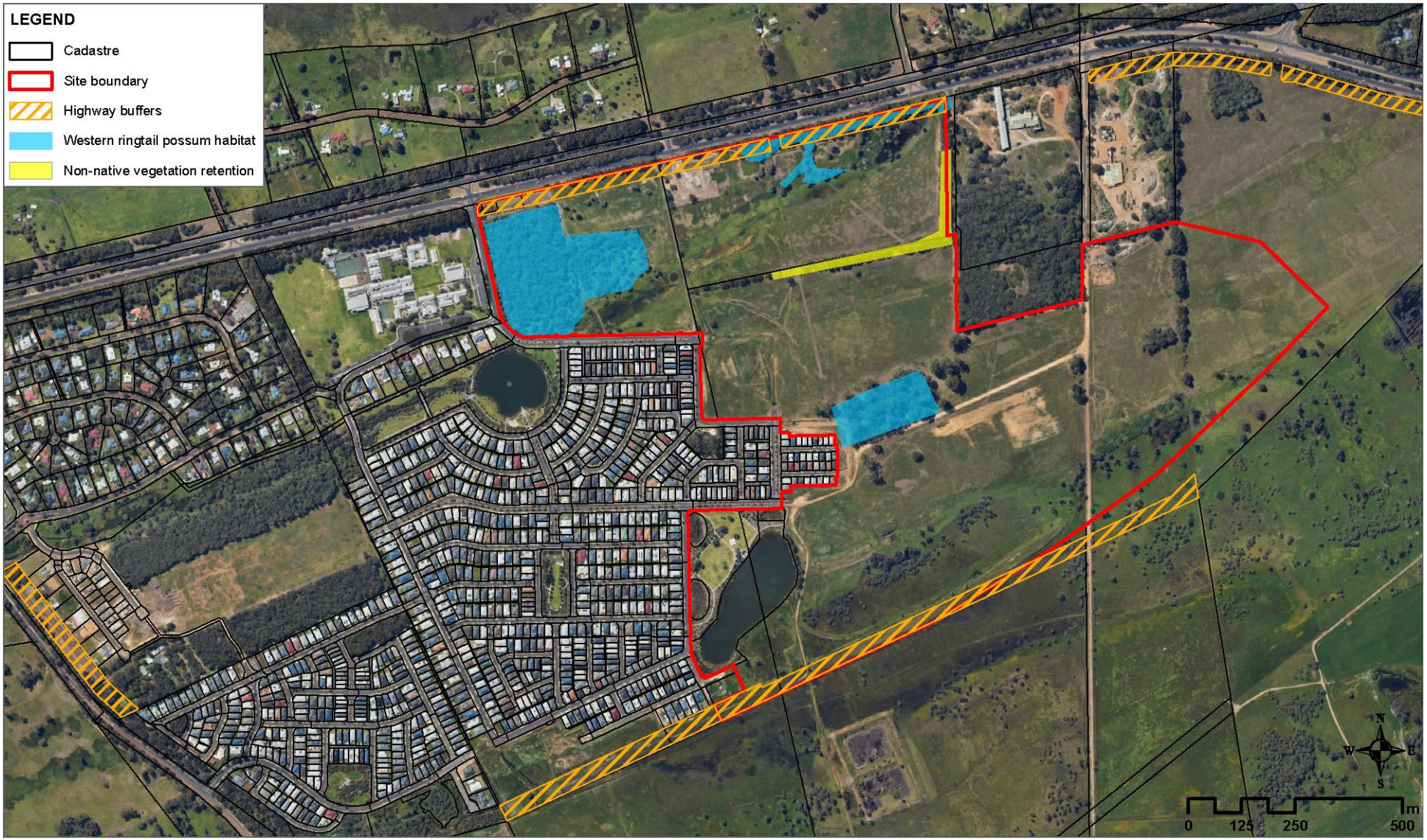


Figure 8: Significant fauna habitat



Figure 9: Western ringtail possum distribution in 2022 (Ecosystem Solutions, 2022b)

3.4.3 Other fauna species

3.4.3.1 Western grey kangaroos

The western grey kangaroo is not listed as protected under state or Commonwealth legislation. However, conditions for subdivision provided by the WAPC in June 2006 included the requirement to implement a Western Grey Kangaroo Management and Relocation Strategy.

Coffey Environments developed the Western Grey Kangaroo Management and Relocation Strategy in 2008. In June 2015, the Western Grey Kangaroo Management and Relocation Strategy was reviewed and updated by Ecosystem Solutions.

The Western Grey Kangaroo (*Macropus fuliginosus*) Survey and Management Plan (Ecosystem Solutions, 2015) is considered appropriate to support the Embark Structure Plan and is provided as Appendix D.

3.5 Inland waters

3.5.1 Groundwater

The site is in the Busselton Capel Groundwater Area and Busselton-Yarragadee groundwater sub-area. The unconfined Superficial aquifer has a saturated thickness of approximately 5 m, which overlies confined aquifers within the Leederville and Yarragadee formations at depth.

Historical groundwater monitoring identified that the approximate groundwater elevation ranges from 3 mAHD to 5 mAHD (Coffey, 2010). Groundwater flow is towards the coast (Geographe Bay) in a north to north-west direction.

Groundwater quality is fresh to brackish (i.e., between ~500 to 1,000 mg/L), with salinity increasing towards the Indian Ocean (RPS, 2022a).

3.5.2 Surface water

The key natural surface water features in the area are the Sabina River, situated approximately 350 metres to the east and the Vasse-Wonnerup Estuary, approximately 750 metres north of the site. Due to the distance from the Embark Structure Plan, neither of these surface water features will impact, or be impacted by development of the site.

An artificial lake is located within the site. This water body is not mapped as a wetland and is unlikely to have any ecological values due to the lack of fringing vegetation.

A search of the Department of Biodiversity, Conservation and Attractions (DBCA's) Geomorphic Wetlands of the Swan Coastal Plain dataset identified linear Multiple Use wetlands (UFI 383, 394 and 466) orientated across the site in an east to west direction. The southern boundary of the site intersects the northern perimeter of a large Multiple Use palusplain (UFI 466) (Figure 10).

Multiple Use wetlands have few important ecological attributes and functions remaining and present no restrictions to development.

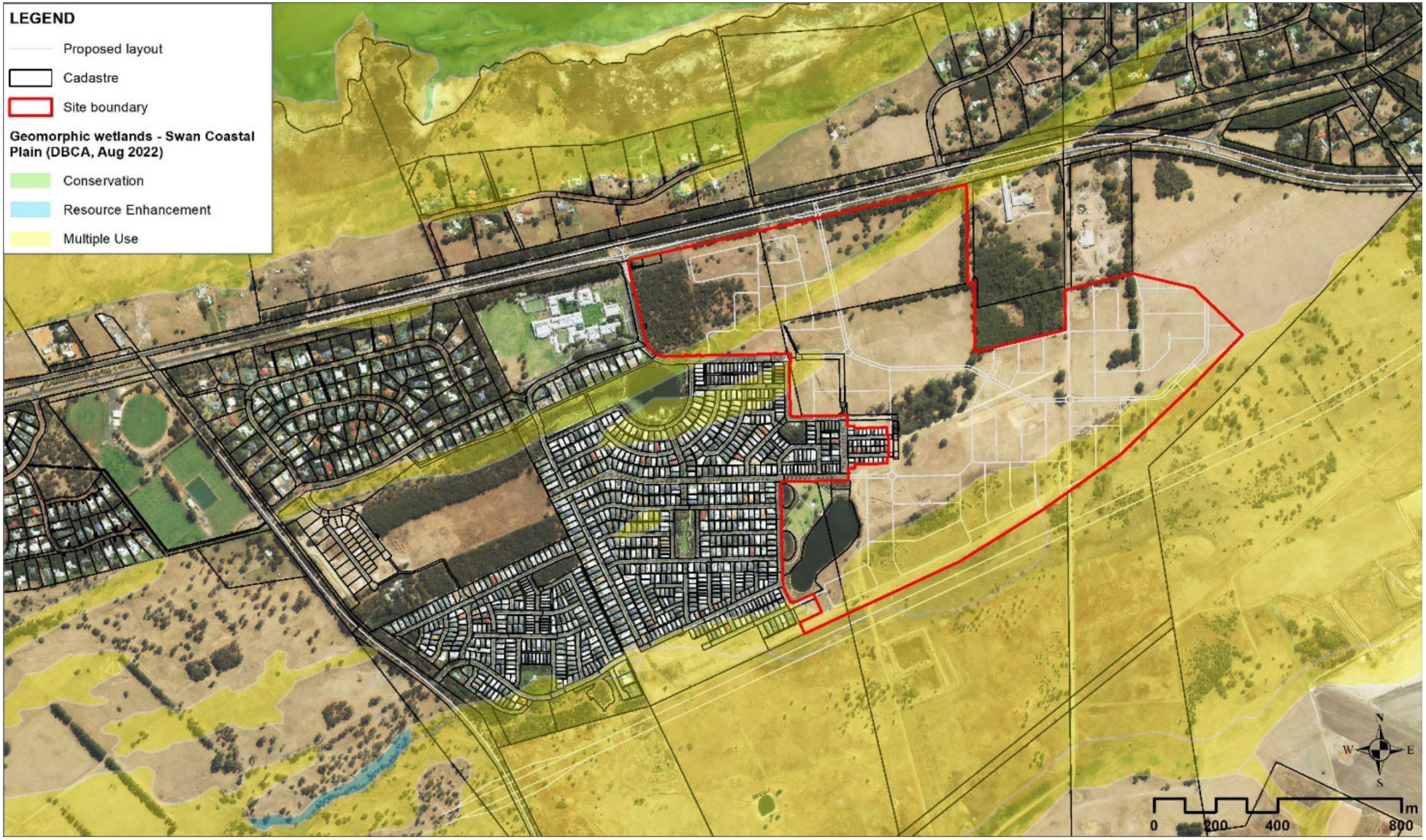


Figure 10: Wetlands

3.6 Social surroundings

3.6.1 Heritage

3.6.1.1 Aboriginal heritage and culture

A search of the Department of Planning, Lands and Heritage (DPLH) Aboriginal Heritage Inquiry System database was undertaken in August 2022. No Registered Heritage Places were recorded within the Structure Plan boundary. The closest heritage places are (Figure 11):

- Other heritage place: Hill's Campsite (ID 18985) located approximately 2.3 km to the west
- Registered site: Busselton wetlands (ID 38904), located approximately 700 m to the north, on the other side of Bussell Highway
- Other heritage place: Sabina River Camp Ground (ID 17350), located approximately 650 m to the east
- Other heritage place (lodged): Vasse Highway Camp (ID 21571), located approximately 1.2 km to the west.

3.6.1.2 Natural and historical heritage

A search of the Heritage Council's inHerit database and the City of Busselton's Heritage List was undertaken in August 2022. No matches were recorded for the site.



Figure 11: Aboriginal heritage

3.6.2 Amenity

3.6.2.1 Noise

Surrounding land uses that have potential to have noise impacts on the site are summarised below:

- Bussell Highway runs along the site's northern boundary and the proposed Outer Bussell Highway lies directly to the south of the site. Noise associated with current and future road traffic has the potential to impact the amenity of future residents within the site.
- The Busselton Regional Airport is located approximately 2 km south of the site. A review of the Busselton-Margaret River Regional Airport Noise Modelling Technical Report (Aviation Consultants, 2019) indicates that the site is not located within the ANEC 20 contours or greater of the airport and is therefore unlikely to be significantly impacted by noise associated with the airport. Furthermore, the site is located outside the Local Planning Scheme No. 21 Airport Protection Area, which generally contains all lands likely to be within the predicted 55dB(A) L_{dn} noise contour for the Busselton Regional Airport.
- An inert waste recycling facility has been proposed adjacent to the site, at Lot 6, Cable Sands Road. There is potential for future residents within to be impacted by noise from the facility. The facility is yet to be approved. If it is, environmental approvals for the facility would need to show that surrounding land uses would not be impacted by construction and operation of the facility. This potential inert waste facility is not discussed further in this EAR.
- If the proposal is constructed, noise management measures will need to be implemented by the operator of the facility to mitigate potential noise impacts to existing residents.

Impacts from noise at the site have historically been assessed at the subdivision stage of the previous Provence Structure Plan, with previous stages subject to WAPC conditions (e.g. conditions 19 and 20 of WAPC application No. 151654) requiring preparation of acoustic noise traffic reports and implementation of noise management plans for areas adjacent to major road and freight infrastructure. Subdivision specific traffic noise assessments have been undertaken in accordance with SPP 5.4.

3.6.2.2 Mosquitoes

The site is low-lying and includes wetlands and areas susceptible to high groundwater levels that can be conducive to mosquito breeding. Mosquitoes are known to present health risks and cause considerable nuisance to residents and visitors to the City of Busselton (ATA Environmental 2007).

3.6.2.3 Bushfire risk

A search of the Department of Fire and Emergency Services' (DFES) Bush Fire Prone Areas Map was undertaken in August 2022. It identified all the site, except for a small portion of Lot 9034 adjacent to the lake, as bushfire prone (Figure 12).

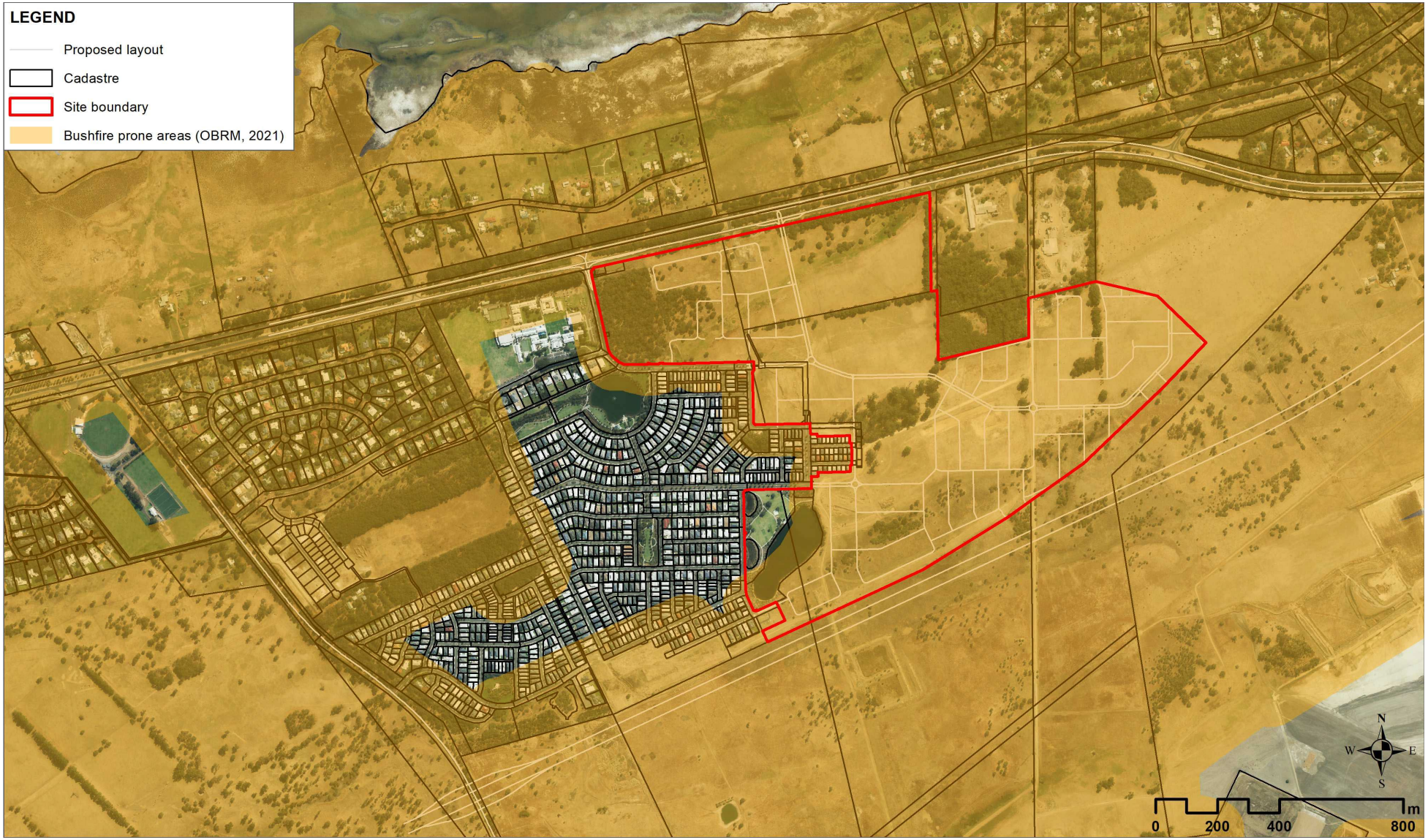


Figure 12: Bushfire prone areas

4 POTENTIAL IMPACTS AND PROPOSED MITIGATION

Potential environmental impacts associated with the Embark Structure Plan are discussed in Sections 4.1 to 4.5. Where relevant, comparison of potential impacts has been made against the previous Provence Structure Plans and the areas or impacts addressed in environmental approvals.

4.1 Flora and vegetation

4.1.1 EPA environmental objective

The EPA Objective for this key environmental factor is 'to protect flora and vegetation so that biological diversity and ecological integrity are maintained.'

4.1.2 Potential impacts

Historical land uses have resulted in the clearing and fragmentation of native vegetation at the site. As there is minimal native vegetation remaining on the site, development of the site will not have a significant impact on flora and vegetation values.

No conservation significant flora or vegetation are present within the site.

4.1.3 Mitigation

Remnant vegetation will be retained within POS and road reserves where possible. A comparison of the vegetation retained with the previous Provence Structure Plan with that proposed to be retained within the Embark Structure Plan shows a small increase in the vegetation protected within POS (Table 4). Over 68% of the remnant vegetation within the Embark Structure Plan is proposed for retention within POS.

Of the 15.74 ha of remnant vegetation retained within the Embark Structure Plan, 10.4 ha (72%) is in Good condition. The remnant vegetation proposed to be cleared comprises only 1.4 ha in Good condition.

Table 4: Summary of remnant vegetation retention

Land use	Area (ha)	Percentage of vegetation within the SP (%)	Variance with previous SP (ha)
Previous structure plan			
Remnant vegetation retained within POS	14.31 ha	67.7%	-
Remnant vegetation outside of POS	6.84 ha	32.3%	-
Embark Structure Plan			
Remnant vegetation retained within POS	14.41 ha	68.48%	An additional 0.1 ha retained within POS.
Remnant vegetation retained outside the POS	1.33 ha	6.32%	An additional 1.33 ha of vegetation retained within other areas of the structure plan.
Remnant vegetation impacted	5.3 ha	25.19%	A reduction in vegetation cleared by 1.54 ha

Revegetation within POS areas and the landscape habitat buffers will be undertaken with local native species where possible, as outlined in the Landscape Concept Plan (Appendix E).

Access to remnant vegetation retained in POS areas will be managed through fencing and signage to prevent unauthorised access.

4.2 Terrestrial environmental quality

4.2.1 EPA environmental objective

The EPA Objective for this key environmental factor is 'to maintain the quality of land and soils so that environmental values are protected'.

4.2.2 Potential impacts

4.2.2.1 Acid sulfate soils

Acid sulfate soil risk mapping and previous investigations identified potential ASS within the site. Consequently, ground disturbing activities or dewatering has potential to result in the acidification and release of heavy metals from ASS into the terrestrial environment, underlying groundwater and surrounding freshwater environments.

4.2.2.2 Potential contamination

The site has historically been used for meat works, mineral sands mining and agriculture. There is potential that these land uses have introduced contaminants to soil and groundwater at the site.

4.2.3 Mitigation

4.2.3.1 Acid sulfate soils

An Acid Sulfate Soil Dewatering Management Plan (ASSDMP) (RPS 2022a) has been prepared for the site. ASS will be managed in accordance with this ASSDMP, which outlines soil and dewatering effluent treatment measures, environmental monitoring requirements and contingency measures to minimise any environmental impacts to the satisfaction of DWER.

4.2.3.2 Potential contamination

Contamination assessments were undertaken at the Busselton Meats Facility by ATA Environmental (2004). The assessment identified zinc and copper in soil above Ecological Investigation Levels (EILs) and arsenic and nutrients in groundwater above ANZECC Freshwater and Australian Drinking Water Guidelines. As a result of the soil and groundwater impacts, DWER classified the site under the *Contaminated Sites Act 2003* as "Possibly Contaminated – Investigation Required".

The initial phase of remediation works at the historical Busselton Meats Facility site have been undertaken and comprised soil 'hot spot' removal and asbestos remediation. Further remediation is currently being undertaken to ensure the site is suitable for residential purposes and includes on-site asbestos remediation works.

4.3 Terrestrial fauna

4.3.1 EPA environmental objective

The EPA Objective for this key environmental factor is 'to protect terrestrial fauna so that biological diversity and ecological integrity are maintained.'

4.3.2 Potential impacts

Ecosystem Solutions (2016) identified suitable habitat for the western ringtail possum and black cockatoos at the site, potential impacts to these species are discussed in the sections below.

Other conservation significant fauna were not detected during the field survey and are unlikely to be impacted by the development of the site.

4.3.2.1 Western ringtail possum

Ecosystem Solutions (2016) identified three key areas of western ringtail possum habitat within the site. The Embark Structure Plan will result in loss of 1.2 ha (10.3%) of 11.65 ha of western ringtail possum habitat (Table 5).

Table 5 provides a summary of the extent of western ringtail possum habitat provided by the previous structure plan, compared to the Embark Structure Plan and shows a small increase (0.13 ha) in the western ringtail possum habitat retained within POS.

4.3.2.2 Black cockatoos

During the Flora, Vegetation and Fauna Assessment (Ecosystem Solutions, 2016), 81 potential breeding trees (with a diameter at breast height greater than 500 mm) were identified within the survey area. None of these trees were being used by black cockatoo species when the habitat assessment was undertaken (Ecosystem Solutions, 2016). Of these habitat trees, 77 are located within the site, with seven (9.1%) proposed to be cleared.

Minimal foraging habitat was identified by Ecosystem Solutions (2016); therefore development of the Embark Structure Plan will not have a significant impact on black cockatoo foraging habitat.

Table 5 provides a summary of the extent of potential black cockatoo habitat protected within the previous structure plan compared to the Embark Structure Plan. The Embark Structure Plan will result in a reduced impact on black cockatoo habitat. The areas provided in Table 5 do not include the non-native vegetation proposed to be retained within the Structure Plan, as being non-native it provides little habitat value.

Table 5: Summary of key fauna habitat retention

Land use	Area (ha)	Percentage of habitat within the SP (%)	Variance with previous SP (ha)
Previous structure plan			
Western ringtail possum habitat within POS	10.32 ha	88.5%	-
Western ringtail possum habitat outside of POS	1.34 ha	11.5%	-
Potential black cockatoo habitat trees within POS	67 trees	87%	-
Potential black cockatoo habitat trees outside of POS	10 trees	13%	-
Embark Structure Plan			
Western ringtail possum habitat retained within POS	10.45 ha	89.7%	An increase of 0.13 ha within the POS
Western ringtail possum habitat impacted outside of POS	1.2 ha	10.3%	Area of habitat impacted within the development is decreased by 0.13 ha
Potential black cockatoo habitat trees retained within POS	70 trees	90.9%	An additional three trees within POS.
Potential black cockatoo habitat trees impacted outside of POS	Seven trees	9.1%	Three less trees impacted within the development.

4.3.2.3 Western grey kangaroos

The western grey kangaroo is not listed as protected under state or Commonwealth legislation. However, conditions for subdivision for Provence provided by the WAPC in June 2006 included the requirement to implement a Western Grey Kangaroo Management and Relocation Strategy.

Coffey Environments developed the Western Grey Kangaroo Management and Relocation Strategy in 2008. In June 2015, the Western Grey Kangaroo Management and Relocation Strategy was reviewed and updated by Ecosystem Solutions. This strategy will be implemented during development of the site.

4.3.3 Mitigation

4.3.3.1 Protection of fauna during construction

A Construction Environmental Management Plan (CEMP) will be prepared by the contractor and implemented during development of the site, management measures to reduce impacts to native fauna during vegetation clearing works will include:

- Fencing will be installed between the construction area and retained vegetation with the POS. Fencing should be of a type to allow fauna to escape the site towards conservation bushland without becoming trapped on the site.
- Vegetation clearing operations will be undertaken in a fauna-friendly manner. Clearing works will be conducted at a slow pace and machine operators should bump or shake any tall trees to be cleared prior to removal to allow remaining fauna an opportunity to relocate.
- If native fauna is encountered during clearing works it should, initially, be allowed to make its own way from the works area. However, if this is not possible or practicable, a qualified wildlife handler will be contacted to relocate it.

4.3.3.2 Western ringtail possum

The Embark Structure Plan has resulted in a small increase (0.13 ha) in western ringtail possum habitat retention within POS and road reserves, when compared to the previous structure plan.

A Western Ringtail Possum (*Pseudocheirus occidentalis*) Management Plan (WRPMP) has been prepared for the site and includes such measures as:

- Enhancement of western ringtail possum habitat through rehabilitation of POS areas and landscape buffers
- Creation of ecological linkages through:
  - Planting street trees
  - Rehabilitation of 30 m landscape buffers along the northern and southern boundary
- Protection of the western ringtail possum and its habitat during construction
- Access management.

Where applicable, these measures will be implemented during and after construction of the site to ensure development of the site does not have significant impacts on the western ringtail possum and is in accordance with relevant EPBC conditions.

4.3.3.3 Black cockatoos

Seventy habitat trees (over 90% of those present within the site) will be retained in the Embark Structure Plan. As outlined in Table 5, this is an increase of three potential black cockatoo habitat trees, when compared to the previous structure plan design.

As Ecosystem Solutions did not identify any significant foraging habitat within the site and most of the potential black cockatoo habitat trees within the site are being retained, impacts to black cockatoo species are unlikely to be significant.

4.3.3.4 Western grey kangaroos

A Western Grey Kangaroo Management and Relocation Strategy was prepared in 2008 by Coffey and reviewed and updated in 2015 by Ecosystem Solutions. The Western Grey Kangaroo (*Macropus fuliginosus*) Survey and Management Plan is considered appropriate to support the Embark Structure Plan (Appendix D).

4.3.3.5 Existing EPBC Act approval

In conditionally approving the proposed action (EPBC 2004 / 1878) in April 2006 and variation in July 2008, the DEH (now DCCEEW) has regulated the environmental impacts to Matters of National Environmental Significance (MNES), including western ringtail possums and black cockatoos, at the site to date.

The Embark Structure Plan is in compliance with all EPBC conditions relating to fauna as discussed in Table 6.

Table 6: EPBC 2004/1878 conditions relevant to this EAR

Condition	Description	Compliance with condition
2	The person taking the action must ensure a minimum of 6.5 ha of remnant peppermint (*Agonis flexuosa*) is placed under conservation covenant. The covenant must include all the areas listed as Public Open Space (POS) on the site plan provided in Annexure 2. The covenant must ensure that the *Agonis flexuosa* is protected and maintained as long-term foraging and breeding habitat for the western ringtail possum.	The approved Western Ringtail Possum Management Plan (WRPMP) (Coffey 2009) states which areas are to be placed under a Conservation Covenant / Management Order to address this condition. The Embark Structure Plan has been designed to retain the same areas of remnant *Agonis flexuosa* identified in the 2009 WRPMP for protection under a conservation covenant. However, 7.31 ha is proposed for protection under conservation covenant in the Embark Structure Plan. This is a 0.81 ha increase in habitat placed under a conservation covenant, when compared to the previous structure plan. The location of habitat protected within the POS and conservation covenant is shown in Figure 13.
3	The person taking the action must prepare and submit for the Minister's approval, a Western Ringtail Possum (*Pseudocheirus occidentalis*) Management Plan (the Plan). The Plan must address the objective of the long-term preservation of the western ringtail possum and connectivity of its habitat on-site. The Plan must address the matters listed below and clearly state the performance criteria, monitoring and reporting actions, responsibility and timing of each. The Plan must include: a. Maps of the construction zone showing the areas to be cleared and the location of temporary fencing required to protect the remaining native vegetation during construction activities. b. Clearly identified existing western ringtail possum habitat and proposed additional habitat. c. Planting of *Agonis flexuosa* to improve western ringtail possum habitat corridors across the site. d. Arrangements for the long-term management of conservation areas on-site. e. Conservation management measures to manage: – Rehabilitation – Habitat protection – Predator management – Fire management. f. Maps of the areas for preservation of existing habitat in any Public Open Space areas (not included in the conservation areas identified at Annexure 2) and designated building envelopes. g. Measures to mitigate impacts on the western ringtail possum during vegetation clearing. h. A strategy prepared in consultation with a suitably qualified arborist to protect trees used by the western ringtail possums from impacts associated with infilling works throughout the site. i. Environmental awareness training for all staff, contractors and other personnel working on the development site. j. Interpretation and education strategies. k. Monitoring and review of the Plan.	A WRPMP was prepared by ATA Environmental in 2006 and approved by the (then) DEH in May 2006. ATA Environmental became Coffey Environments (Coffey) in 2009. Coffey updated the approved WRPM (ATA Environmental) in 2009. The only amendments to the 2006 WRPMP were: • Document formatting • Correction of minor editorial errors • Amendments to the introduction. Where applicable, the management measures outlined in the WRPMP will be implemented during and after construction of the site to ensure development of the site does not have significant impacts on the western ringtail possum and is in accordance with relevant EPBC conditions.

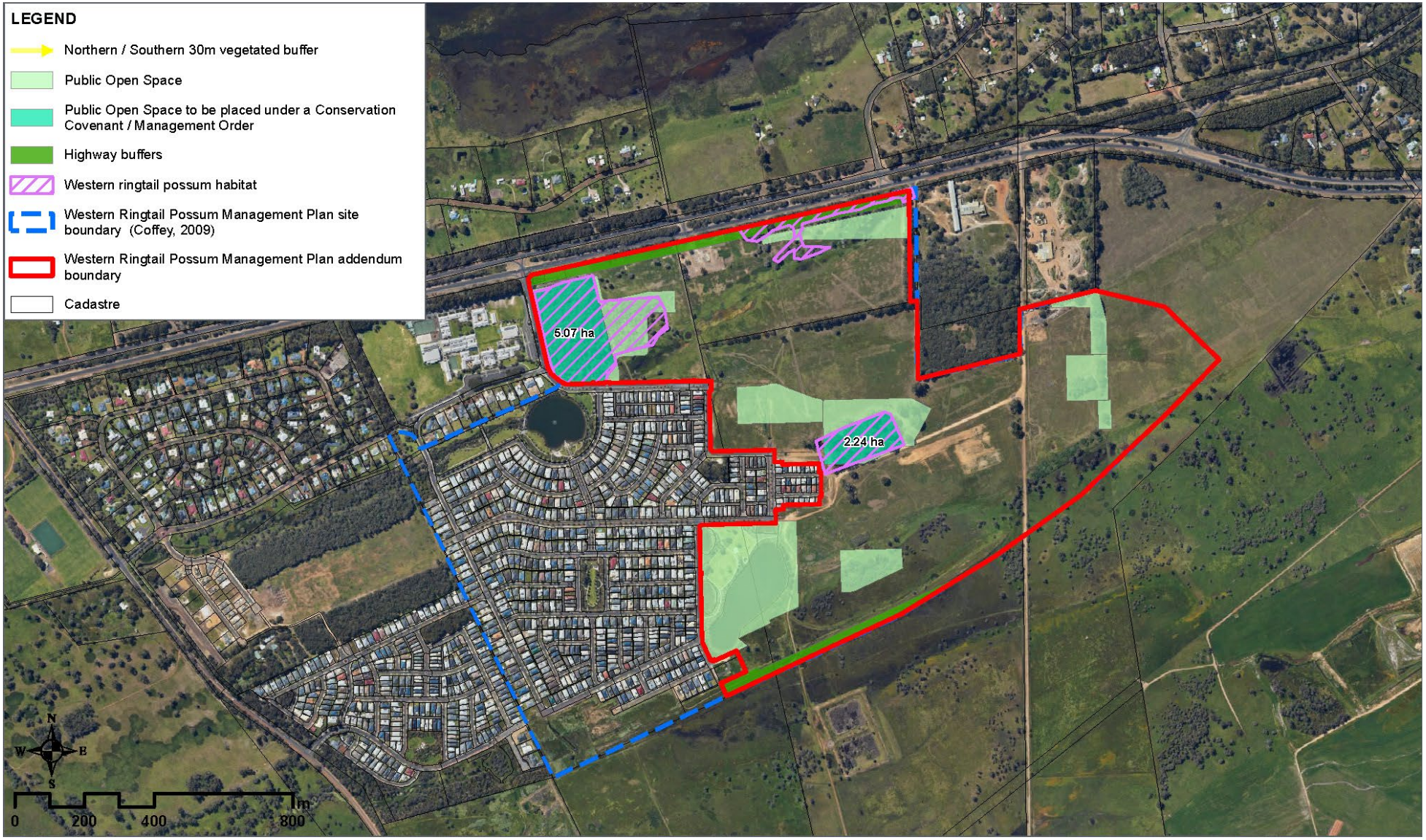


Figure 13: Public Open Space and conservation covenanted areas

4.4 Inland waters

4.4.1 EPA environmental objective

The EPA Objective for this key environmental factor is 'to maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected'.

4.4.2 Potential impacts

Potential impacts to surface water and groundwater because of development includes:

- Changes the hydrological regimes resulting from modified landforms that may alter water flow and levels
- Reduced groundwater or surface water quality caused by discharge of stormwater.

4.4.3 Mitigation

The EPBC approval conditions require a Water Management Strategy to be prepared and implemented during development of the site (Appendix A). A Water Management Strategy was approved by DEWHA (now DCCEEW) in 2008. Stormwater and drainage will be managed in accordance with this Water Management Strategy.

To comply with the provisions contained in Better Urban Water Management (WAPC 2008), Urban Water Management Plans (UWMPs) will be prepared at subdivision stage and approved by the City of Busselton to ensure development of the site does not significantly impact surface water or groundwater.

4.5 Social surroundings

4.5.1 EPA environmental objective

The EPA Objective for this key environmental factor is "to protect social surroundings from significant harm".

4.5.2 Potential impacts

4.5.2.1 Aboriginal heritage

There are no known Registered Aboriginal heritage sites recorded on the site, with the closest known site mapped over 500 m from the site boundary. Consequently, impacts to known Aboriginal heritage sites are unlikely. However, there is potential for excavation and construction activities to unearth and/or damage previously unknown artefacts or other items of Aboriginal cultural significance.

4.5.2.2 Noise

Bussell Highway runs along the site's northern boundary and the proposed Outer Bussell Highway lies directly to the south of the site. Noise associated with current and future road traffic has the potential to impact the amenity of future residents within the site.

The Busselton-Margaret River Airport is located to the south of the site. However, a review of the Busselton-Margaret River Regional Airport Noise Modelling Technical Report (Aviation Consultants, 2019) indicates that the site is not located within the ANEC 20 contours or greater of the airport. AS2021 specifies that buildings or residences which fall within ANEC 20 contours are permissible, therefore as the site is not located within an ANEC 20 contour or greater, noise impacts to the site are unlikely and no mitigation or management measures are likely to be required at the site.

4.5.2.3 Mosquitoes

The site is low-lying and includes wetlands and areas susceptible to high groundwater levels that can be conducive to mosquito breeding. Mosquitoes are known to present health risks and cause considerable nuisance to residents and visitors to the City of Busselton (ATA Environmental 2007).

4.5.2.4 Bushfire risk

A search of the DFES Bush Fire Prone Areas Map identified that all the site, except for a small portion of Lot 9034 adjacent to the lake, is mapped as bushfire prone (Figure 12).

4.5.3 Mitigation

4.5.3.1 Aboriginal heritage and culture

A Construction Environmental Management Plan will be prepared and implemented by the construction contractor and will include an unexpected finds protocol. Should any Aboriginal objects be identified or unearthed then construction will be stopped, and the findings will be reported to the Department of Planning Lands and Heritage.

4.5.3.2 Noise

As part of previous structure plans, impacts from noise has historically been assessed at the subdivision stage, with previous stages subject to WAPC conditions (e.g., conditions 19 and 20 of WAPC application No. 151654) that require preparation of acoustic noise traffic reports and implementation of noise management plans for areas adjacent to major road and freight infrastructure.

Subdivision specific Traffic Noise Assessments have been undertaken in accordance with SPP 5.4. It is anticipated that acoustic assessments will be undertaken to support the Embark Structure Plan at the subdivision stage, with noise mitigation measures to be incorporated into the subdivision design and the constructed development.

4.5.3.3 Mosquitoes

To mitigate potential health risks and nuisance considerations to future residents within the site a Mosquito Management Plan was prepared by ATA Environmental in 2007. The key objectives of the Mosquito Management Plan were:

- To effectively utilise the principles of integrated mosquito control
- To enable the of City of Busselton's Mosquito Control Minimisation Strategy to be efficiently implemented
- To ensure that mosquito control is conducted in an environmentally responsible manner
- That as far as practicable no new mosquito breeding sites will be created during construction.

To ensure that these objectives were achieved, ATA Environmental (2007) identified the following mosquito management measures:

- Physical – physical modification or removal of source to prevent breeding
- Chemical – larvicides, including both ground and aerial applications and adulticides, including fogging and residual surface adulticides
- Biological – introduction of appropriate mosquito predators
- Cultural – encouragement of public to implement personal preventative measures.

Health and nuisance risks associated with mosquitoes at the site will be managed in accordance with the endorsed Mosquito Management Plan, Provence Estate, Busselton (ATA Environmental 2007).

4.5.3.4 Bushfire risk

A Bushfire Management Plan (BMP) is being prepared to support the Embark Structure Plan. The BMP will demonstrate that all fire protection requirements for issues including fire suppression response, development design, access, water supply, building locations and other relevant performance criteria can be achieved.

5 RECOMMENDATIONS AND CONCLUSIONS

Table 7 details the proposed mitigation measures to manage potential environmental impacts to the following key environmental factors:

- Flora and vegetation
- Terrestrial environmental quality
- Terrestrial fauna
- Inland waters
- Social surroundings.

The Embark Structure Plan recognises the importance of the key environmental and landscape attributes of the site, and surrounding areas, and incorporates these in an urban forum that creates an environmental responsive urban development that meets the EPA's environmental objectives.

The key environmental outcomes achieved in the structure plan are:

- Protection of 10.45 ha of western ringtail possum habitat within POS areas. This is an increase (0.13 ha) in the area of western ringtail possum habitat protected within the Embark Structure Plan POS reservations when compared to the previous structure plan
- Protection of 70 potential black cockatoo habitat trees within POS areas. This is three more trees protected within the Embark Structure Plan POS reservations when compared to the previous structure plan
- Undertaking revegetation within the northern and southern habitat corridors to improve the availability of western ringtail possum habitat and to provide a northern and southern "ecological linkage"
- Implementation of the Western Ringtail Possum Management Plan (Coffey 2009) to protect western ringtail possums and their habitat within the site and ensure compliance with relevant EPBC approval conditions
- Implementation of best practice water sensitive urban design and stormwater drainage management in accordance with the Water Management Strategy and future UWMPs
- Implementation of management measures outlined in acoustic assessments undertaken at the subdivision stage will reduce potential noise and fire impacts on future residences
- Implementation of management measures outlined in the Embark Structure Plan Bushfire Management Plan, which is being prepared to support the proposed development to reduce potential fire impacts on future residences.

This EAR concludes that, through the implementation of the proposed mitigation measures the subdivision and development of the site will meet the EPA's environmental objectives for the assessed environmental factors.

Table 7: Potential impacts and proposed mitigation measures

Flora and vegetation		
EPA objective	To protect flora and vegetation so that biological diversity and ecological integrity are maintained	
Policy and guidance	• *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Flora and Vegetation (EPA 2016a) • Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment (EPA 2016b)	
Potential impacts	The site's historical land uses have resulted in the clearing and fragmentation of vegetation and reduction of native vegetation cover to minimal areas. Consequently, it is anticipated that the Embark Structure Plan would have very little impact on flora and vegetation values.	
Mitigation	• 14.4 ha (68.5% of the overall vegetation within the structure plan) of remnant vegetation has been retained within the Embark Structure Plan. This is a small increase (0.1 ha) in native vegetation retention to the previous structure plan. • Remnant trees will be retained where practicable, within POS reservations and road reserves. • Access management will be undertaken using fencing and signage to prevent unauthorised access to native vegetation retained within POS reservations. • Revegetation with local native species will be undertaken where possible.	
Terrestrial environmental quality		
EPA objective	To maintain the quality of land and soils so that environmental values are protected	
Policy and guidance	Acid sulfate soils	• Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016c) • Treatment and Management of Soils and Water in Acid Sulfate Soil Landscapes (DER 2015a) • Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes (DER 2015b)
	Potential contamination	• *Contaminated Sites Act 2003* • Environmental Factor Guideline: Terrestrial Environmental Quality (EPA 2016c) • Assessment and Management of Contaminated Sites (DER 2014)
Potential impacts	Acid sulfate soils	Acid sulfate soil (ASS) mapping and investigations indicate that potential ASS are present at the site. Excavations and dewatering activities during construction has the potential to result in acidification and release of heavy metals from these ASS into the terrestrial environment, underlying groundwater and surrounding freshwater environments.
	Potential contamination	The site has been historically used for a meat works, mineral sands mining and agriculture. Potentially, parts of these land uses may have introduced contaminants to the site's soil and groundwater.
Mitigation	Acid sulfate soils	• ASS will be managed in accordance with the Acid Sulfate Soil Dewatering Management Plan (ASSDMP) (RPS 2022). The ASSMP outlines soil and dewatering effluent treatment measures, environmental monitoring requirements and contingency measures to minimise any environmental impacts to the satisfaction of DWER.
	Potential contamination	• An initial phase of remediation works comprising soil 'hotspot' removal and asbestos remediation has been undertaken. Further remediation will be undertaken to ensure the site is suitable for residential land use.
Terrestrial fauna		
EPA objective	To protect terrestrial fauna so that biological diversity and ecological integrity are protected	
Policy and guidance	• *Environment Protection and Biodiversity Conservation Act 1999* • *Biodiversity Conservation Act 2016* • Environmental Factor Guideline: Terrestrial Fauna (EPA 2016d) • Technical Guidance: Sampling Methods for Terrestrial Vertebrate Fauna (EPA 2016e) • Technical Guidance: Terrestrial Fauna Surveys (EPA 2016f)	
Potential impacts	Ecosystem Solutions identified habitat for the Western ringtail possum and black cockatoos at the site, potential impacts to these species are summarised below: • Clearing two potential western ringtail possum habitat trees • Permanent loss of up to 1.2 ha of western ringtail possum habitat • Clearing up to seven potential black cockatoo habitat trees. There is also potential for fauna to be impacted during construction activities, these impacts include: • Injury and/or mortality during clearing activities • Disturbance during construction (clearing activities and noise) may affect the local abundance of fauna populations due to interruption to fauna behaviour.	
Mitigation	• The Embark Structure Plan has retained 10.45 ha (89.7% of the overall habitat within the site) of western ringtail possum habitat within POS. Of this, 7.31 ha will be protected under conservation covenant in accordance with EPBC conditions that require the protection of 6.5 ha with conservation covenant. • Thirty-metre buffers along the northern and southern boundaries will be revegetated using species known to be of habitat value for western ringtail possums to create ecological linkages. • Seventy potential black cockatoo habitat trees have been retained within the structure plan; this is three more than the previous version of the structure plan. • Implementation of the Western Ringtail Possum (*Pseudocheirus occidentalis*) Management Plan (Coffey 2009) and Western Grey Kangaroo (*Macropus fuliginosus*) Survey and Management Plan (Ecosystem Solutions 2015) will ensure impacts to fauna at the site are minimised. • A CEMP will be prepared and implemented by the contractor to management actions will be implemented during vegetation clearing works to reduce impacts to native fauna species including: – Construction area will be appropriately fenced along the interface of the site with retained vegetation. Prior to and during clearing works, adequate sections of fencing should be of a type to allow fauna to escape the site towards conservation bushland without becoming trapped on the site. – Vegetation clearing operations will be undertaken in a fauna-friendly manner. Clearing works will be conducted at a slow pace and machine operators should bump or shake any tall trees to be cleared prior to removal to allow remaining fauna an opportunity to relocate. – If native fauna is encountered during clearing works it should initially, be allowed to make its own way from the works area, however if this is not possible or practicable a qualified wildlife handler will be contacted to relocate it.	

Flora and vegetation		
Inland waters		
EPA objective	To maintain the hydrological regimes and quality of groundwater and surface water so that environmental values are protected	
Policy and guidance	• Environmental Factor Guideline: Inland Waters (EPA 2018a) • Better Urban Water Management (WAPC 2008)	
Potential impacts	• Changes the hydrological regime resulting from modified landforms that may alter water flow and levels • Reduced groundwater or surface water quality caused by discharge of stormwater	
Mitigation	• Stormwater and drainage will be managed in accordance with the updated Water Management Strategy. • Urban Water Management Plan(s) will be completed at subdivision stage to the satisfaction of the City of Busselton, on advice from the DWER	
Social surroundings		
EPA objective	To protect social surroundings from significant harm	
Policy and guidance	Aboriginal heritage and culture	• *Aboriginal Heritage Act 1972* • Environmental Factor Guideline: Social Surroundings (EPA 2016g) • Guidance Statement No 41: Assessment of Aboriginal Heritage (EPA 2004c)
	Noise	• Environment Protection (Noise) Regulations 1997 • Environmental Factor Guideline: Social Surroundings (EPA 2016g) • SPP 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning
	Mosquitoes	• *Health Act 1911* • Environmental Factor Guideline: Social Surroundings (EPA 2016g)
	Fire	• *Fire and Emergency Services Act 1998* • Environmental Factor Guideline: Social Surroundings (EPA 2016g) • SPP 3.7: Planning in Bushfire Prone Areas • Guidelines for Planning in Bushfire Prone Areas, Version 1.3 (DPLH, DFES and WAPC 2017)
Potential impacts	Aboriginal heritage and culture	• No known registered Aboriginal heritage sites are likely to be impacted by the Embark Structure Plan. • Excavation and construction activities may unearth and/or damage previously unidentified artefacts or other items of Aboriginal cultural significance.
	Noise	• Noise associated with current and future road traffic has the potential to impact the amenity of future residents. • The Busselton-Margaret River Regional Airport is located to the south of the site; noise from the airport has potential to impact the amenity of future residents.
	Mosquitoes	• Wetlands and low-lying areas susceptible to high groundwater levels can support mosquito breeding. Mosquitoes may cause nuisance and serious health risks residents.
	Fire	• The site is located within a bushfire prone area. Bushfires may result in damage to property and infrastructure, and death and/or injury of people/fauna.
Mitigation	Aboriginal heritage and culture	• The CEMP prepared and implemented by the contractor will include an unexpected finds protocol. Should any Aboriginal objects be identified or unearthed then construction will be stopped, and the findings will be reported to the Department of Planning Lands and Heritage.
	Noise	Acoustic assessments will be undertaken to support the Embark Structure Plan at the subdivision stage, with noise mitigation measures to be incorporated into the subdivision design and the constructed development.
	Mosquitoes	Health and nuisance risks associated with mosquitoes will be managed in accordance with the Mosquito Management Plan Provence Estate, Busselton (ATA Environmental 2007).
	Fire	A Bushfire Management Plan (BMP) is being prepared to support the Embark Structure Plan. The BMP will demonstrate that all fire protection requirements for issues including fire suppression response, development design, access, water supply, building locations and other relevant performance criteria can be achieved.

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Appendix A
EPBC approvals

COMMONWEALTH OF AUSTRALIA

ENVIRONMENT PROTECTION AND BIODIVERSITY CONSERVATION ACT 1999

DECISION TO APPROVE THE TAKING OF AN ACTION

Pursuant to section 133 of the *Environment Protection and Biodiversity Conservation Act 1999*, I, IAN GORDON CAMPBELL, Minister for the Environment and Heritage, approve the taking of the following action:

> The proposed action to develop the East Busselton Estate, on Lots 2, 9003 and 202 Bussell Highway and Vasse Highway, Western Australia, and associated infrastructure and activities (EPBC 2004/1878).

by the Satterley Property Group subject to the conditions set out in ANNEXURE 1.

This approval has effect for:

> Sections 16 and 17B (Wetlands of international importance);
> Sections 18 and 18A (Listed threatened species and communities); and
> Sections 20 and 20A (Listed migratory species) of the *Environment Protection and Biodiversity Conservation Act 1999*

This approval has effect until 31 December 2021.

Dated this 3RD day of APRIL 2006.

.....

IAN GORDON CAMPBELL

ANNEXURE 1

1. The person taking the action must construct the residential development on Lots 2, 9003 and 202, in accordance with the site plan provided in Annexure 2.

2. The person taking the action must ensure a minimum of 6.5ha of remnant Peppermint (*Agonis flexuosa*) is placed under a conservation covenant. The covenant must include all the areas listed as public open space on the site plan provided in Annexure 2. The covenant must ensure that the *Agonis flexuosa* is protected and maintained as long-term foraging and breeding habitat for the Western Ringtail Possum (*Pseudocheirus occidentalis*).

3. The person taking the action must prepare and submit for the Minister's approval, a Western Ringtail Possum (*Pseudocheirus occidentalis*) Management Plan (the Plan). The plan must address the objective of long-term preservation of the Western Ringtail Possum and connectivity of its habitat on site. The plan must address the matters listed below and clearly state the performance criteria, monitoring and reporting actions, responsibility and timing of each. The plan must include:

   (a) maps of the construction zone showing the areas to be cleared and the location of temporary fencing required to protect the remaining native vegetation during construction activities;

   (b) clearly identified existing Western Ringtail Possum habitat and proposed additional habitat;

   (c) planting of *Agonis flexuosa* to improve Western Ringtail Possum habitat corridors across the site;
   (d) arrangements for the long-term management of conservation areas on site;
   (e) conservation management measures to manage;
      i. rehabilitation;
      ii. habitat protection;
      iii. predator management;
      iv. fire management;
   (f) maps of the areas for preservation of existing habitat in any public open space areas (not included in the conservation areas identified at Annexure 2) and designated building envelopes;
   (g) measures to mitigate impacts on the Western Ringtail Possum during vegetation clearing;
   (h) a strategy prepared in consultation with a suitably qualified arborist to protect trees utilised by Western Ringtail Possums from impacts associated with infilling works throughout the site;
   (i) environmental aw areness training for all staff, contractors and other personnel working on the development site;
   (j) interpretation and education strategies; and
   (k) monitoring and review of the plan.

   Works must not commence on the site before the above plan is approved.
   The approved plan must be implemented.

5. The person taking the action must design and implement a Water Management Strategy which implements documented industry best practice water sensitive design principles and practices, including:
   - a review of environmental values and water quality objectives for the Vasse Wonnerup wetland;
   - replicating natural surface and groundwater flows and water quality;
   - protecting the environmental values of receiving waters, including through attainment of water quality objectives (in this instance for the Vasse-Wonnerup wetland system) consistent with Figure 2.1.1 of the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000*; and
   - water quality objectives employed in the Water Management Strategy must be sought from the Western Australian Environment Protection Authority and the South West Catchments Council. Where water quality objectives are not available from these authorities, the water quality trigger values published in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000* must be employed.

6. The Water Management Strategy is to include the following elements:
   - the water treatment management practices and management practice treatment trains that will be used to achieve environmental performance targets;
   - how attainment of water quality objectives for these receiving waters will be supported by the action;
   - the environmental performance targets for the action, including rates of pollutant export off-site; and
   - how monitoring activities that will be undertaken to track environmental performance of the action as well as continuously improve the modelling efforts. Groundwater and surface water monitoring must be undertaken pre, during and post development (subdivision and construction) for the purpose of performance monitoring and continuous improvement of the Model for Urban Stormwater Improvement Conceptualisation (MUSIC). This is to include a period of five years following completion of construction and during operation of the subdivision.

7. Preparation of the Water Management Strategy will employ the MUSIC, where that model is calibrated for local hydrogeological conditions and attainment of environmental performance targets. Those environmental performance targets are to be for the following pollutants:
   - total suspended solids (TSS);
   - total nitrogen (TN);
   - dissolved inorganic nitrogen (DIN);
   - total phosphorus (TP); and
   - dissolved inorganic phosphorus (DIP).

8. If water quality measurements exceed the environmental performance targets set under the Water Management Strategy then works must stop immediately and the Department of Environment and Heritage must be advised immediately. Failure to stop works and notify this Department will be considered a breach of approval conditions.

   Works must not commence on the site before the above strategy is designed and implemented.

9. If, at any time after 5 years from the date of this approval, the Minister notifies the person taking the action in writing that the Minister is not satisfied that there has been substantial commencement of the residential development on Lots 2, 9003 and 202, the residential development on Lots 2, 9003 and 202 must not thereafter be commenced.

Definitions

Conservation covenant - an agreement between a landholder and a Covenant Scheme Provider (this may be a covenant organisation, a local council or a government agency) that provides for the long-term conservation of vegetation subject to the covenant. The covenant is registered on the title of the land and binds all future owners.

ANNEXURE 2



Australian Government

Department of the Environment, Water, Heritage and the Arts

Notification of VARIATION TO APPROVAL DECISION

East Busselton 'Provence' Estate Development, Busselton, WA (EPBC 2004/1878)

This variation is made under Section 143 of the *Environment Protection and Biodiversity Conservation Act 1999*.

Proposed action

person to whom the approval is granted	Satterley Property Group
proposed action	To develop the East Busselton Estate, on Lots 2, 9003 and 202 Bussell Highway and Vasse Highway, Western Australia, and associated infrastructure and activities.

Variation to approval decision

Variation of conditions	The variation is: - Delete the map at Annexure 2 and substitute with the attached map; and - Delete conditions 5, 6, 7 and 8 of the approval dated 3 April 2006 and substitute with conditions 4, 5 and 6 specified below.
expiry date of approval	This approval has effect until 31 December 2021.

Person authorised to make decision

name and position	Michelle Wicks Acting Assistant Secretary Environment Assessment Branch
signature	Wicks
date of decision	22/7/2008

Conditions attached to the approval

4. The person taking the action must design and implement a Water Management Strategy (the Strategy) which implements water sensitive urban design principles and practices, including:
   - a review of the environmental values, water quality objectives[1] and pollutant load targets[2] for the Vasse Wonnerup wetlands, and demonstrate how those values, objectives and targets have informed the environmental performance targets developed in the Strategy;

[1] Environmental values (EVs) and water quality objectives (WQOs) are to be described consistent with the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000*. EVs and WQOs must be sought from the Department of Water.

[2] Pollutant load targets are to be derived from, in priority order and as they become available (a) the Vasse-Geographe Water Quality Improvement Plan (VGWQIP), (b) draft load targets prepared by the Department of Water for the purpose of developing a draft VGWQIP, and (c) interim values prepared by the proponent and subject to suitably qualified third party audit and review.

- environmental performance targets in order for the activity to, as a minimum, contribute to attainment of those water quality objectives and load targets. Environmental performance targets are to be defined as concentrations[3] and total annual loadings;
- application of a computer model (eg the Model for Urban Stormwater Improvement Conceptualisation (MUSIC), calibrated by the Western Australian Department of Water for local hydrogeological conditions, for identifying water sensitive urban design practices in the area to which the action applies;
- a commitment to supply surface and groundwater data, derived from implementation of the Strategy, to the Western Australian Department of Water for the purpose of continuous improvement of the computer model;
- the nature, location and maintenance schedules for structural and non-structural water sensitive urban design practices, including as they relate to a treatment train approach to achieving performance targets. The assumptions relating to pollutant removal efficiencies of those practices must be clearly documented for future verification and calibration using the computer model;
- annual reporting to the Department, which describes the status of the project, the results from monitoring and predictive modelling activities, assesses those results against attainment of environmental performance targets, and describes management interventions taken in response to any failure or anticipated failure to achieve the environmental performance targets; and
- the Strategy is to be approved by the Department prior to its commencement and implementation.

5. The Strategy is to include a Contingency Management Plan (CMP) which describes:
   - surface and groundwater monitoring pre, during and post development (for subdivision and construction) in order to track attainment of environmental performance targets for total suspended solids, and total and dissolved inorganic nitrogen and phosphorus. Monitoring regimes (including the nature, timing and frequency of monitoring activities, the relationship between monitoring activities and hydrologic conditions) are to be described;
   - activities to increase the certainty associated with the effectiveness and practicability of water sensitive urban design practices and treatment trains; and
   - management measures that will be taken by the proponent, and options for adjusting existing and proposed practices and treatment trains over the duration of the project, in response to measured or predicted failure to meet environmental performance targets during the period of the CMP. This is to include a description of circumstances where a stop work order will be issued by the proponent during construction due to failure to meet environmental performance targets.

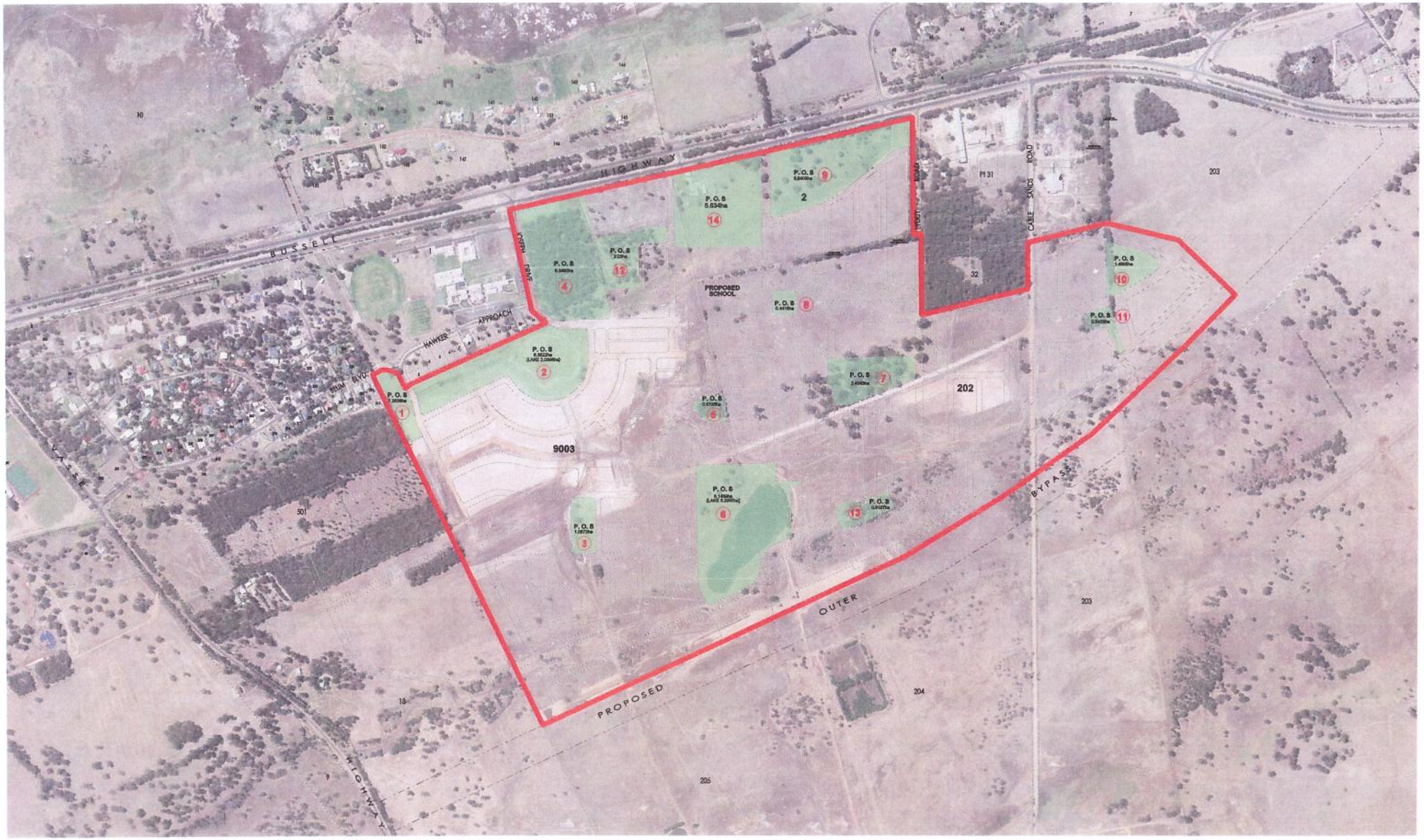
   The CMP is to be effective for the duration of the project, and for a period of five years following transfer of responsibility for the project to a land management authority. The proponent will provide funds to that land management authority to implement the CMP for the first two years of that five year period.

6. If, through direct measurements or from predictive modelling, environmental performance targets are exceeded or predicted to be exceeded, the person taking the action must:
   - within 72 hours of becoming aware of the exceedence or predicted exceedence, notify the Department of this and of the measures the person will take to mitigate or prevent that exceedence; and
   - within 14 days of notifying the Department of the exceedence or predicted exceedence, notify the Department that (a) the measures that have been taken to mitigate or prevent that exceedence, and the effectiveness of those measures, and (b) of the measures the person will take to prevent and/or minimise the likelihood of similar future exceedences.

   Works must not commence on the site before the above strategy is designed and implemented.

[3] The environmental performance targets may be based on 'trigger' values published in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000.*

Annexure 2



0 50 100 200 300 400 500m

PUBLIC OPEN SPACE PLAN (LOTS 2, 9003 & 202) - PROVENCE ESTATE DEVELOPMENT, YALYALUP

LEGEND

SUBJECT LOT BOUNDARY (PROVENCE ESTATE DEVELOPMENT)

PUBLIC OPEN SPACE

Revision	Date	Item
b	8/7/2008	Remove notation, highlight boundary, adjust title
a	30/4/2008	Initial issue

NOTES

SATTERLEY PROPERTY GROUP : CLIENT
A1 @ 5,000 : SCALE
8 JULY 2008 : DATE
10971-5-021 : PLAN No
b : REVISION
G.A : PLANNER
B.I. : DRAWN

RPS koltasz smith
TOWN PLANNING PROJECT MANAGEMENT URBAN DESIGN DEVELOPMENT CONSULTING
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Appendix B
EPA advice

Environmental Protection Authority
Westralia Square,
141 St Georges Terrace, Perth, Western Australia 6000.
Telephone: (08) 9222 7000. Facsimile: (08) 9222 7155.
Postal Address: PO Box K822,
Perth, Western Australia 6842.
Website: www.epa.wa.gov.au

SHIRE OF BUSSELTON
FILE
Off
Copy

Chief Executive Officer
Shire of Busselton
Locked Bag 1
BUSSELTON WA 6280

Your Ref PSC46&17909AMD
Our Ref CRN210724
Enquiries Mark Jefferies

ATTENTION: Tim Shingles

Dear Sir/Madam

SCHEME/AMENDMENT TITLE:	**Shire of Busselton TPS 20 Amendment 83 - Rezone from Agriculture, Residential & Rural Residential to Special Purpose with Special Provisions for Busselton Airport Structure Plan**
SCHEME/AMENDMENT LOCATION:	**Various lots in Bussell/Vasse Highways**
LOCALITY:	**Yalyalup**
RESPONSIBLE AUTHORITY:	**Shire of Busselton**
LEVEL OF ASSESSMENT:	**Scheme Not Assessed - Advice Given (no appeals)**

Thank you for your letter of 28 October 2004 referring the above scheme amendment.

After consideration of the likely environmental factors related to the above scheme amendment and based on the information provided by you, the EPA decided that the overall environmental impact of its implementation would not be severe enough to warrant assessment under Part IV of the Environmental Protection Act, the preparation of an Environmental Review and the subsequent setting of formal conditions by the Minister for the Environment. Please note that there are no appeal rights on the level of assessment set for scheme amendments.

Although there is to be no formal assessment of the scheme amendment, the following advice is provided to you on the key environmental factors. A copy of this advice will also be sent to the relevant decision-making authorities and will be publicly available on request. The information provided is advice only and is not legally binding.

ADVICE

(a) Key Environmental Factors

- **Contamination**
- **EPP wetland**
- **Nutrient export and drainage**
- **Noise**

Deferred factors
- **Contamination**
- **EPP wetland**

(b) Relevant advice

Contamination – former abattoir
Prior to ground disturbing activities, investigations to determine the nature and extent of contamination and requirements for remediation are to be undertaken on the former abattoir site (and adjacent as appropriate), in accordance with Department of Environment guidelines.

EPP wetland
The Environmental Protection Policy (EPP) wetland on site is to be protected by a buffer of at least 50m.

Nutrient export and drainage
An Urban Water Management Plan should be prepared as a condition of any subdivision approval in accordance with DoE requirements.

Noise
It is noted that the nearby airport is subject to Ministerial conditions and a Noise Management Plan is in development with the DoE. The key impacts on use of this airport are likely to be caused by increases in training activities for commercial training rather than standard airport traffic.

If a decision is made to develop this area, this will place further constraints on the airport activities.

Under the provisions of Section 48A(a) of the Environmental Protection Act the above scheme amendment is now deemed assessed by the EPA.

Yours faithfully

C J Murray
A/Director
Environmental Impact Assessment

1 August 2005

cc: Department for Planning & Infrastructure

Appendix C
Flora, vegetation and fauna reports

Report

Provence Estate



Flora, Vegetation and Fauna Assessment

Prepared by

ECOSYSTEM SOLUTIONS PTY LTD

A.B.N. 19115287593

For

Glen Yeatman

Manager – Infrastructure & Regional Development

Environment – Land and Infrastructure

RPS Australia Asia Pacific

&

Satterley Property Group

14th January 2016

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Limitations Statement

This report has been solely prepared for RPS Australia Asia Pacific and Satterley Property Group.

No express or implied warranties are made by Ecosystem Solutions Pty Ltd regarding the findings and data contained in this report. No new research or field studies were conducted other than those specifically outlined in this report. All of the information details included in this report are based upon the research provided and obtained at the time Ecosystem Solutions Pty Ltd conducted its analysis.

In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Any conclusions drawn or recommendations made in the report are done in good faith and the consultants take no responsibility for how this information and the report are used subsequently by others.

Please note that the contents in this report may not be directly applicable towards another organisation's needs. Ecosystem Solutions Pty Ltd accepts no liability whatsoever for a third party's use of, or reliance upon, this specific report.

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Appendix A: Significant Tree Data 37

1. Introduction

Ecosystem Solutions were contracted by RPS Australia Asia Pacific to survey and document on the presence and distribution of significant flora, vegetation and fauna within the Provence Estate Development site. The fauna elements specifically targeted Western Ringtail Possum (*Pseudocheirus occidentale*) and signs or suitable habitat for Black Cockatoo Species (*Calyptorhynchus baudinii*, *C. latirostris and C. banksii subsp. naso*) as well as any other significant fauna within the Provence Estate Development.

The purpose of this report is to identify any significant flora, vegetation and fauna to support future investigations into development possibilities.

This report outlines the methodology and results of targeted surveys of the study area.

2. Site Details

The site consists of approximately 169 hectares of mixed pasture and bushland areas approximately 4 km east of Busselton, on Bussell Highway, as shown in Map 1 (hereafter referred to as the Study Area).

The Study Area is predominantly flat, being approximately 5 m above sea level (Australian Height Datum – AHD) towards the north western section and rising to approximately 10 m (AHD) to the south west (Map 1).

The Study Area sits to the west of the current residential development of Provence.

Three areas of native vegetation within the Study Area were surveyed in January and February 2015 (these are shown in Map 2). The additional areas were surveyed in December 2015 and January 2016 (Map 2).

3. Flora and Vegetation.

3.1. Landscape, Soils & Vegetation

Soil-Landscape systems are areas with recurring patterns of landforms, soils and vegetation and are used by the Department of Agriculture to maintain a consistent approach to land resource surveys.

The Study Area contains three individual soil-landscape types (Map 3) which are described as:

- Ludlow wet flats Phase (211SpLDw) – Poorly drained flats on sand over coastal limestone in the Swan Coastal Plain. Yellow deep sands and semi wet soils. Principal vegetation is Flooded Gum and Peppermint Woodland.
- Ludlow wet vales Phase (211SpLDvw) – Poorly drained open and closed drainage depressions on sand over coastal limestone in the Swan Coastal Plain. Wet and Semi wet soils and deep brown sands. Principal vegetation is Flooded Gum Woodland.
- Cokelup wet clayey flats Phase (213AbCKw) – Low lying flats and depressions on alluvium overlying coastal limestone in the southern Swan Coastal Plain. Wet and Semi wet soils, Alkaline grey shallow sandy and loamy duplexes and hard cracking clays. Principal vegetation is Paperbark and Flooded Gum woodlands and barley grass flats.
-

The mapping of Havel and Matiske (2000) categorises the remaining larger areas of native vegetation within the Study Area as one vegetation complex (Map 4):

- Ludlow (Lw) – Open woodland of Melaleuca rhaphiophylla and sedgelands of Cyperaceae - Restionaceae species on broad depressions in the subhumid zone.

Comparing the current extent to the pre-European extent and estimated 24% of this vegetation type remains (Webb *et al,* 2009).

3.2. Methods

An extract from the Department of Parks and Wildlife (DPAW) Nature Base Database was obtained to determine if records of any rare or threatened flora are known within the boundary or vicinity of the site. A preliminary reconnaissance survey of the results of the desktop study was conducted, consistent with a Level 1 Flora and Vegetation Survey (EPA, 2004).

The Study Area was surveyed on 17th and 18th December 2015 and 12th January 2016 by Gary McMahon (B.Sc. M. Env Mgmt). The site was walked in a systematic manner to cover all of the area. Zones with consistent vegetation structure and composition were noted and the main species in each of the strata were identified and recorded. The vegetation condition of the vegetation based on Keighery (1994) was also recorded using Global Positioning System (GPS). Vegetation communities and condition maps were prepared.

The Study Area was also inspected for flora species of significance and Threatened

Ecological Communities, based on the DPaW database records.

3.3. Declared Rare and Priority Flora

Species of flora and fauna are defined as Declared Rare or Priority conservation status where their populations are restricted geographically or threatened by local processes. DPAW recognizes these threats of extinction and consequently applies regulations towards population and species protection. Declared Rare Flora species are gazetted under subsection 2 of section 23F of the Wildlife Conservation Act (1950) and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the Wildlife Conservation Act (1950-1980) defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means" (Government of Western Australia, 2010).

Priority List Flora are under consideration for declaration as "rare flora", but are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents the definitions of Declared Rare and the four Priority ratings under the Wildlife Conservation Act (1950) (Department of Environment and Conservation, 2010a).

Table 1 : Rare and Priority Flora Categories

CONSERVATION CODE	CATEGORY
T	"Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.'
P1	"Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey."
P2	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey."
P3	"Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey."
P4	"Taxa which are considered to have been adequately surveyed and which, while being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years."

3.4. Results and Discussion

3.4.1. Native Flora

Twenty-nine threatened or priority flora species are listed as being within 5 kilometres of the Study Area (Table 2).

Table 2: Rare and Priority Flora within 5 km of the site.

SPECIES	STATUS	LIFE FORM	HABITAT
Banksia nivea subsp uliginosa	T	Shrub	Flowers yellow-brown Aug-Sept.Sandy Clay and gravels.
Caladenia procera	T	Herb	Rich clay loam, alluvial loamy flats, jarrah marri peppermint woodland, dense heath and sedge areas
Chamelaucium sp S Coastal Plain	T	Shrub	Swamp margins, winter wet sandy clays.
Diuris purdiei	T	Herb	Grey black sands, moist. Winter wet swamps
Drakea elastic	T	Herb	White or grey sand, low lying situations adjoining winter wet swamps
Grevillea elongata	T	Shrub	Gravelly Clay, sandy caly and sand on road verges, swamps and creek banks.
Lambertia echinata subsp occidentalis	T	Shrub	Shallow soils over sheet ironstone and white sandy soils over laterite. Winter wet rich heathlands.
Lambertia orbifolia subsp Scott River Plain	T	Shrub	Grey brown white gravelly sandy loam over ironstone
Verticordia densiflora var pedunculata	T	Shrub	Light yellow or grey sands in low lying winter wet areas.
Verticordia plumose var anaeotes	T	Shrub/herb	Sandy soils in jarrah woodlands
Verticordia plumose var vassensis	T	Shrub	Variety of sands and swampy clay soils in mostly winter wet flats and depressions.
Gastrolobium sp Yoongarillup	P1	Shrub	White Sand and gravel
Puccinellia vassica	P1	Grass like herb	Saline soils. On the outer margins of coastal saltmarshes
Acacia heteroclite subsp valida	P2	Shrub	
Amperea micrantha	P2	Herb	Sandy Soils
Leucopogon sp Busselton	P2	Shrub	
Synaphea petiolaris subsp simplex	P2	Shrub	Flowers yellow June – Dec. Sandy soils, laterite granites, Swamp edges Sandplains slopes and winter wet sites.
Chorizema carinatum	P3	Shrub	Sand or sandy clays.
Grevillea brachystylis subsp. brachystylis	P3	Shrub	Flowers: red, Aug to Nov. Black sand, sandy clay. Swampy situations.
Grevillea bronwenae	P3	Shrub	Grey sand over laterite, lateritic loams, Hillslopes.
Isopogon formosus subsp. dasylepis	P3	Shrub	Sand, sand clay, gravelly sandy soils over laterite. Often swampy areas
Jacksonia gracillima	P3	Shrub	Sandy soils, Sandplains rises swampy depressions.
Johnsonia inconspicua	P3	Grass like herb	White-grey or black sand. Low dunes, winter-wet flats
Loxocarya magna	P3	Sedge like herb	Sand, loam, clay, ironstone, seasonally inundated or damp habitats.
Synaphea hians	P3	Shrub	Sandy soils and rises
Verticordia attenuata	P3	Shrub	White or grey sand, winter wet depressions
Acacia flagelliformis	P4	Rush like shrub	Sandy Soils and winter wet areas.
Franklandia triaristata	P4	shrub	White or grey sand
Ornduffia submersa	P4	Herb	Freshwater lakes swamps and Claypans.

None of these species were identified during the field surveys within the Study Area. While a spring flora survey was not conducted as part of this survey, none of the vegetation areas surveyed had any herb or ground layer species present apart from annual and perennial grasses. This is evidence of previous grazing practices within the Study Area and it is unlikely that any of the significant species listed in Table 2 would be present.

3.4.2. Vegetation Communities

Finer scale mapping of the broad communities was defined by their broad upper canopy species being named. This is due to a lack of mid and lower strata species within any of the vegetation areas.

The Vegetation communities are best categorised by the dominant species within them which is shown in Map 5.

Utilising the scale of condition developed by Keighery (1994, Table 3), the areas of native vegetation were ranked from Good to Completely Degraded. This is mainly based upon the lack of ecological structure within the remnants that remain due to past grazing practices. While there is some regeneration occurring in the larger sections, the smaller areas are likely to remain as groups of trees over paddocks. Vegetation condition is shown in Map 6.

Table 3: Keighery Condition Scale.

Category	Description
Pristine	Pristine or nearly so, no obvious signs of destruction.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. For example, damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle track.
Very Good	Vegetation structure altered, No obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate to it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.

Category	Description
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration, but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation in no longer intact and the area is completely or almost completely without native species. These areas are often described as "parkland cleared" with the flora composing weed or crop species with isolated native trees or shrubs.

(Keighery. 1994).

4. Fauna

4.1. Objectives

The objective of this survey was to identify significant fauna or signs of significant fauna, including Western Ringtail Possum and Black Cockatoo species, within the Study Area.

4.2. Methodology

A desktop study and analysis of the records of the Department of Parks and Wildlife (DPaW) (Nature Map) and the Australian Government's Department of Environment's Protected Matters Search Tool were made to determine the presence or likely presence of fauna or faunal assemblages within the study area. The analysis primarily targeted terrestrial threatened vertebrate species listed under the Environmental Protection and Biodiversity Conservation Act 1999 (Cwth), (EPBC Act) and the Western Australian Wildlife Conservation Act (WA) 1950 (WC Act).

With these species in mind, a field study of the site was conducted. The approach adopted for this survey was:

- A Satellite Image of the Study Area was aquired.
- A day time visual inspection of the property and adjoining vegetation for any signs of fauna (e.g. scats, diggings, dreys, nests, burrows, feeding signs) was conducted.
- Hollow bearing trees or trees suitable for Black Cockatoos were recorded.
- Direct observations of fauna and signs of fauna were recorded using a Trimble

Global Positioning System (GPS) and ArcPad© (Version 8- ESRI).

- Two, non-consecutive, night time spotlight surveys were conducted to determine fauna activity. A 40 w LightForce handheld spotlight was used with white light. Observations were recorded using GPS and ArcPad©.
- Two predawn and two dusk surveys were conducted to determine Black cockatoo activity.
- Field observations were analysed and mapped with ArcGis (ArcMap V10.3©).

This type of survey has minimal impact on the fauna within the property and provides sufficient data on the presence and relative abundance and distribution of taxa. During the field surveys, the habitat at the site was assessed to determine its potential suitability to host any of the anticipated threatened or rare species. This approach is consistent with a Level 1 survey under the EPA's Guideline No. 56: Terrestrial Fauna Surveys for Environmental Impact Assessment in Western Australia (2004) which specifies a minimum requirement of a background research or desktop study to gather information on the subject site and a reconnaissance survey to verify the accuracy of the background study and delineate fauna and faunal assemblages.

The survey's protocol is also consistent with the requirements outlined in the Development Planning Guidelines for Western Ringtail Possums (CALM 2003, now DPAW).

Guidelines for the three black cockatoo species (Department of Sustainability, Environment, Water, Populations and Communities, 2011) outline requirements for appropriate level of surveys for these species. This survey's intensity and design comply with these guidelines.

4.3. Conservation Significant Fauna

The conservation status of fauna within Western Australia is determined by criteria outlined within two acts of legislation: the Environmental Protection and Biodiversity Conservation Act 1999 (Cwth), (EPBC Act) and the State-based Western Australian Wildlife Conservation Act (WA) 1950 (WC Act).

Under Section 179 of the EPBC Act, fauna may be listed in one of the following categories (in decreasing degree of threat of extinction):

- Extinct;
- Extinct in the wild;
- Critically Endangered;

- Endangered;
- Vulnerable; and
- Conservation Dependant.

These categories are consistent with the International Union for Conservation of Nature (IUCN) classifications and therefore link into a global ranking system for taxa at risk of extinction.

The WC Act also uses these categories, but uses a set of schedules to define extinction risk (Table 4).

Table 4: Conservation Categories in the Wildlife Conservation Act (WA) 1950.

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct.
Schedule 2	S2	Fauna which is presumed extinct.
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Fauna that is otherwise in need of special protection.

The Department of Parks and Wildlife also produce a supplementary list of possible threatened species that do not meet the criteria for listing in the above categories. These species are not considered threatened under the WC Act, but due to a lack of knowledge or where species are poorly represented in conservation reserves, some concern for their long term survival exists. Table 5 shows the priority classifications.

Table 5: Priority Classifications used in WA.

Category	Code	Description
Priority 1	P1	Taxa with a few, poorly known populations on lands not managed for conservation (e.g. agricultural lands, urban areas etc.).
Priority 2	P2	Taxa with few, poorly known populations on conservation lands (e.g. national parks, nature reserves etc.).
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands, but where known threats could affect them.

Category	Code	Description
Priority 4	P4	Rare, near threatened and other species in need of monitoring.
Priority 5	P5	Conservation Dependant species: species that are not threatened, but are subject to a specific conservation project that if stopped, would result in the species becoming extinct within 5 years.

The EPBC Act also requires the compilation of a list of migratory species that are recognised under international treaties including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA), and the Bonn Convention (The Convention on the conservation of Migratory Species of Wild Animals). Species listed under JAMBA are also protected under Schedule 3 of the WC Act.

The conservation status of all vertebrate species listed as occurring within, near or likely to occur within the property, were assessed using the most recent lists of the relevant legislation and DPAW priority lists

4.4. Limitations

Field surveys were confined to five day surveys and four nocturnal spotlight surveys conducted over non-consecutive night. Four predawn and four pre-dusk surveys for black cockatoo activity were also conducted. The night surveys were conducted using experienced ecologists utilising individual head torches and a single hand-held spotlight.

The site was traversed by foot in a systematic way, however it was not possible to examine every tree for evidence of fauna, and therefore the listing of foraging evidence found will only present a subset of the actual evidence that is present for the site.

All large trees of suitable size were examined from the ground for the presence of hollows. Guidelines for the survey techniques for black cockatoo species (Dept., of Sustainability, Environment, Water Populations and Communities, 2011) state that all trees with a DBH of over 500m should be inspected. All of these trees were inspected, however only those with observable hollows or potential for hollows were recorded. It should be noted however, that all of the prerequisites that determine the suitability of

a hollow for use by cockatoos is difficult to assess. In addition to entrance size, the depth, floor and orientation of the hollow are important factors. The presence of suitable hollows, even in breeding areas, does not make them available for breeding as hollows must be spatial, structurally and temporally correct (Johnstone and Johnston, 2004). The listing of potential nesting hollows is therefore likely to be an over estimation of those actually suitable.

4.5. Expected Fauna

A list of fauna expected to occur within a five kilometre radius of the study site was compiled from searches conducted on the WA Museum database and DPaW fauna database (Nature Maps), Commonwealth Environmental Protection and Biodiversity Conservation database and the Birds Australia Atlas project database.

The results of the native fauna database search for species likely to still be within or utilise the study area include (note marine species were excluded due to the location of the study area):

- *Calyptorhynchus baudinii* (Baudin's White Tailed Black Cockatoo) - Vulnerable (Cwth) & Schedule 1(WA);
- *Calyptorhynchus latirostris* (Carnaby's White Tailed Black Cockatoo - Endangered (Cwth) & Schedule 1(WA);
- *Pseudocheirus occidentalis* (Western Ringtail Possum) (Vulnerable-Cwth) & Schedule 1 (WA);
- *Dasyurus geroffroii* (Chuditch) - Vulnerable (Cwth) & Schedule 1(WA);
- *Phascogale tapoatafa* subsp. *tapoatafa* (Southern Brush-tailed Phascogale, Wambenger) (P3-WA);
- *Isoodon obesulus* subsp. *fusciventer* (Southern Brown Bandicoot, Quenda) (P5-WA).

The following species are protected under international agreement:

- *Actitis hypoleucos (Common Sandpiper)*
- *Ardea ibis (Cattle Egret)*
- *Ardea modesta (Eastern Great Egret)*
- *Calidris acuminata (Sharp-tailed Sandpiper)*
- *Calidris ruficollis (Red-necked Stint)*
- *Calidris subminuta (Long-toed Stint)*
- *Charadrius leschenaultii (Greater Sand Plover)*
- *Haliaeetus leucogaster (White-bellied Sea-Eagle)*

- *Limosa limosa (Black-tailed Godwit)*
- *Merops ornatus (Rainbow Bee-eater)*
- *Plegadis falcinellus (Glossy Ibis)*
- *Pluvialis fulva (Pacific Golden Plover)*
- *Pluvialis squatarola (Grey Plover)*
- *Tringa glareola (Wood Sandpiper)*

The following species are listed as being found within 5km of the Study Area, however these are historical records and the habitat within the site are not considered suitable. There are listed here for completeness and are not expected to be found within the *Study Area:*

- *Bettongia penicillata subsp. ogilbyi (Woylie, Brush-tailed Bettong)*
- *Macrotis lagotis (Bilby, Dalgyte)*
- *Setonix brachyurus (Quokka)*

5. Results

The initial day surveys were conducted on 14th and 17th November 2014 by Gary McMahon (B.Sc, M. Env Mgmt) and Kelly Paterson (B.Sc, Hons) from Ecosystem Solutions. The second phase of day surveys were conducted on the17th and 18th December 2015 and 12th January 2016 by Gary McMahon. The areas of the two survey events are shown in Map 2.

All trees with large hollows were inspected for any signs of use by cockatoos. These include wear around the hollow, chewing, scarring and scratch marks on the trunks or branches. All hollow assessments were conducted from ground level, with the suitability for use by black cockatoo based on the size of the hollows entrance. Hollows that appeared large enough to allow the entry of a cockatoo were recorded as a potential nest site. Hollows with an entrance of less than about 12 cm in diameter were considered unsuitable for cockatoos.

Old or recent evidence of cockatoo's feeding or roosting sites (feathers, droppings etc.) were also searched for.

There were 81 trees with a Diameter at Breast Height (DBH) of over 500 mm with either observable hollows or canopy and formation that potentially could contain or develop hollows within the areas surveyed. Five of these had visible hollows that would be suitable for black cockatoos, however some of the larger Tuart trees are

likely to have hollows but were not detectable from ground observations. Height of these trees was determined using a Nikon Forestry Pro and the Diameter at Breast Height (DBH) and other elements were directly measured and recorded. Aluminium tags were placed on each tree for identification. Appendix A shows the details of these 81 trees, which are also shown in Map 7.

There were no food signs of any Black Cockatoo species found within any of the areas.

The canopy of the vegetation within the Study Area were thoroughly inspected and there were nine dreys observed. Eight areas with recent WRP scats were found within the Study Area. In three areas, small clumps of WRP fur was found. Locations of the fauna observations for the day surveys are shown in Map 8.

The first nocturnal survey was conducted on 17th November 2014 from 6.15 pm to 10.45pm. This was in the first survey area shown in Map 2. This included a pre-dusk and dusk survey for any sign of black cockatoos. Official sunset time was 7.01 pm with dusk (last light) at 7.28 pm.

The site was traversed by foot in a systematic plan to cover the area thoroughly.

No black cockatoos were seen or heard during the dusk observations and three WRP were observed during the spotlighting survey (Map 9).

The second nocturnal survey was conducted 19th November 2014 from 6.15 pm to 9.45 pm. The official sunset time was 7.03 pm with dusk at 7.30 pm. This was in the first survey event area shown in Map 2.

The site was traversed in a systematic fashion to ensure all habitat areas were inspected during these surveys.

No Black Cockatoo species were observed or heard during this survey. Eight WRP were observed during the survey.

The initial pre-dawn survey for Black Cockatoo activity occurred on 18th November 2014 from 4.10 am till 6.25 am. Dawn (first light) was at 4.37 am and Sunrise was at 5.05am.

No cockatoos were seen or heard on or near the property.

The second pre-dawn survey took place on 21st November 2014, between 4.00 am and 6.30am. Dawn was at 4.35 am and Sunrise was at 5.03 am. No Black Cockatoos were seen or heard during wither of these pre-dawn surveys.

The second monitoring event timelines and results were:

First nocturnal survey, including pre dusk Black Cockatoo Survey– 17th December 2015 – from 6.30 pm to 11.55 pm. Official Sunset was 7.26pm with last light at 7.55 pm.

Seven WRP were found during this survey, three in the bushland along the northern boundary and four within the large remnant to the west. Two Brushtail possums were also observed in the western remnant. No cockatoo activity was seen or heard during any of the survey.

Second nocturnal survey, including pre dusk Black Cockatoo survey – 12th January 2016 – from 6.20pm till 11.30 pm. Official sunset was 7.33 pm and last light was 8.01pm.

Eight WRP were found, two in the northern boundary bushland and six in the western remnant. One brush tail possum was found in the western section. No cockatoo activity was seen or heard during the survey.

The results of the nocturnal surveys from both events are shown in Map 9.

The first dawn survey for black cockatoos occurred on 19th December 2015, from 3.55am to 6.10 am. Official sunrise was 5.03am with first light at 4.34am.

No cockatoos were seen or heard during this survey.

The second dawn survey for black cockatoos occurred on 7th January 2016, from 4.05am to 6.20 am. Official sunrise was 5.16am with first light at 4.41 am.

No cockatoos were seen or heard during this survey.

6. Discussion

Eighty-one trees over 500mm were found within the Study Area that either had hollows or had the potential to develop hollows. No black cockatoos were seen or heard during any of the surveys. There were no signs of feeding or feathers within the study areas. This is probably due to the site having minimal Marri trees, which is a preferred food source for the animals. Better quality food and roosting sites exist to the east and south of the site, with the Tuart Forest National Park being 2 m to the east and large areas of state forest 10 kms to the south. All local species of Black cockatoos can forage over extensive areas (up to 15-20 kms from their nesting sites (Saunders, 1980)) and given that there are larger areas of more preferred habitat within their range, it could be assumed that black cockatoo species are not relying on the site for habitat or food source. They would, however, utilise the site opportunistically within their range and may potently utilise some of the hollows within the survey area in the future.

Combining the survey results over the entire Study Area, ten WRP were observed in the first night survey effort and sixteen were seen during the second night of survey effort. All of the observations occurred within three distinct areas of the Study Area: the western Reserve area, the vegetation along the northern boundary and the large remnant within the centre of the survey area. These are marked on Map 10 as Plots A, B and C respectively.

Plot A is to be retained as a reserve in any proposed redesign, and given the 8.1 ha area and WRP observed, the density of 1 animal per 0.6ha allows adequate capacity for the population to grow without over populating the space.

The animals in Plot B are likely to either reside within larger unseen hollows within this section, though there is a continuous connective canopy through this area to the large area of remnant vegetation on the private property adjoining. This remnant was not surveyed as part of this project, however it appears to be very dense with multiple vegetative layers and strata typical of highly suitable WRP habitat.

Plot C also appears to support a small extant population of WRP, however conditions were not ideal for nocturnal spotting or diurnal nest or scat observations. The density of the foliage would also provide excellent refugia for any animals within this area. Any spotlighting survey would only highlight those animals on the periphery of the canopy and any estimation of population would likely be a gross underestimate. Given the quality of the habitat and the density of the canopy within this area, the lack of any direct observation of any WRP should not be used to conclude that the area does not support any WRP.

Eighty one trees over 500mm were found within the Study Area that either had hollows or had the potential to develop hollows. No black cockatoos were seen or heard during any of the surveys. There were no signs of feeding or feathers within the study areas. This is probably due to the site having minimal Marri trees, which is a preferred food source for the animals. Better quality food and roosting sites exist to the east and south of the site, with the Tuart Forest National Park being 2 m to the east and large areas of state forest 10 kms to the south. All local species of Black cockatoos can forage over extensive areas (up to 15-20 kms from their nesting sites (Saunders, 1980)) and given that there is larger areas of more preferred habitat within their range, it could be assumed that black cockatoo species are not relying on the site for habitat

or food source. They would, however, utilise the site opportunistically within their range and may potently utilise some of the hollows within the survey area in the future.

While no other animals of significance were observed, either directly or through signs, this lack of this data should not be taken directly as an indication that those species is absent from the site. No trapping or seasonal sampling was conducted.

No trapping or seasonal sampling was conducted. Table 7 summarises the likely presence based on habitat availability and the potential impact of the development on potential significant species within the subject site.

Table 6: Other Significant Fauna Likelihood and Impact

Species	Potential impact in site
Baudin's White Tailed Black Cockatoo	No nest hollows are being used and minimal foraging habitat is present in the site. No impact is anticipated.
Carnaby's White Tailed Black Cockatoo	No nest hollows are being used and minimal foraging habitat is present in the site. No impact is anticipated.
Western Ringtail Possum	three small populations were found within the Study Area. The development is unlikely to cause significant disturbance to the bulk of the habitat area. Any disturbance planned in the area where WRP were found will be managed to ensure no animals are impacted.
Chuditch	Given large home range required and minimal vegetation on site. It is unlikely that the species frequents the site. No impact is anticipated.
Quenda	Only potential habitat is small dam/wet area in the northern section, but no signs of animals were found in the survey. No impact on the species is anticipated.
Brush Tail Phascogale	No signs of the species found. Habitat is marginal. The proposal is unlikely to impact on any populations of this species due to the minimal proposed disturbance.
Western Brush Wallaby	This species was not observed in the Study Area. Given large home range required and the lack of observation on the site, it is highly unlikely that the species frequents the site. No impact is anticipated.

The bird species protected under international agreements was not seen during the surveys. The nature of the site would result in the area within it as unsuitable habitat for breeding for these species and it is highly unlikely that they would be occasional opportunistic visitors to the site.

7. Significance

Under the EPBC Act, an action that has, will have, or is likely to have, a significant impact on a matter of national environmental significance, requires approval from the Minister. A significant impact is defined as an impact which is important or of consequence, having regard for its context or intensity (Commonwealth of Australia, 2009).

Matters of environmental significance are:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- The Commonwealth marine environment
- World Heritage properties
- National Heritage places
- Great Barrier Reef Marine Park, and
- Nuclear actions.

For this development, there is a potential for impact on threatened species. Significant Impact Guidelines 1.1 (Commonwealth of Australia, 2009) lists significant impact criteria for the assessment for activities which may impact on threatened species. Table 8 describes these criteria as it relates to the subject site and the vulnerable species that may potentially be impacted in the subject site.

Table 7: Significant Impact Criteria for Key Listed Species.

Significant Impact Criterion	Discussion		Meets Criterion
	Black Cockatoo Species	**Western Ringtail Possum**	
Lead to a long-term decrease in the size of an important population[1] of a species	None of the trees are utilised by the regional population of Black Cockatoos.	Three extant population of WRP are believed to be present within the Study Area. The proposal intends minimal impact on the habitat and the overall impact on the population will minimal, if at all.	No
Reduce the area of occupancy of an important population	Will not impact on the area of occupancy of the current population.	Will not reduce the area of occupancy.	No
Fragment an existing important population into two or more populations	Will not fragment current population.	Will not fragment population.	No
Adversely affect habitat critical to the survival of a species	None of the trees are presently being utilised by Black Cockatoos. Will not affect critical habitat	Will not affect critical habitat.	No
Disrupt the breeding cycle of an important population	No breeding sites identified on site.	Small populations within the site, any disturbance in the vegetation for building purposes will be conducted with fauna management protocols and will not impact on the population	No
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The number of trees to be removed will be minimised where possible and it is unlikely that the removal of a small number of these trees will result in the species decline or local population decline.	Potential disturbance or removal of building envelope requirements may reduce some of the available habitat, however this is unlikely to cause a decline in the species within the site.	No

[1] *An 'important population' is a population that is necessary for a species' long-term survival and recovery.*

Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	Any introductions highly unlikely to have any impact on species.	Potential of the introduction of invasive species likely to impact the species are minimal to very low	No
Introduce disease that may cause the species to decline,	Highly unlikely to occur.	Highly unlikely to occur.	No
Interfere substantially with the recovery of the species.	Development will not impact on the recovery of the species.	Development will not impact on the recovery of the species.	No

Using these criteria, the proposed development will not significantly impact on any significant species to a point where a referral is required under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Referral guidelines for three threatened black cockatoo species (Commonwealth of Australia. 2011) uses a decision tree and a set of criteria to determine whether actions significantly impact on black cockatoos. These are set out below based on the details of the development and the data obtained from the surveys. Notes on the flow chart follow.

Question	Answer	High Risk of Significance – Referral Recommended
1. Could the impacts of your action occur within the modelled distribution of the black cockatoos?	Yes – Action occurs within the distribution area of all three species.	• Clearing of any known nesting tree • Clearing of any part or degradation of breeding habitat • Clearing more than 1ha of quality foraging habitat • Creating a gap of greater than 4 km between patches of habitat • Clearing or degradation of known roosting site.
2. Could the impacts of your action affect any black cockatoo habitat or individuals?	Unlikely. No signs of animal utilisation of the site were found.	**Uncertainty – Referral Recommended or contact Department**
3. Have you surveyed for black cockatoos using the recommended methods?	Yes	• Degradation of more than 1 ha of foraging habitat. • Clearing or disturbance in areas surrounding habitat that has the potential to degrade through introduction of threats. • Actions that do not directly affect species but have potential to introduce indirect impacts. • Actions with potential to introduce known plant diseases.
4. Could your actions have an impact on black cockatoos or their habitats?	No. No signs of animal activity was found within the site.	**Low risk of significant impacts – referral may not be required.**
5. Is your impact mitigation best practice so that it may reduce the significance of your impacts on black cockatoos?	No significant impact is anticipated due to lack of evidence of activity on site.	• Actions that do not affect black cockatoo habitat or individuals • Actions whose impact occurs outside modelled distribution.
6. Could your action require a referral to the federal environmental Minister for significant impact on black cockatoos?	No as there are no signs of any of the three species present within or adjoining the Study Area. It is unlikely that the species is dependent on the site.	

The summary of these responses are:

1- The development is within the area of modelled distribution of black cockatoo species.
2- The proposed actions will not impact black cockatoo individuals or habitat.
3- The site has been surveyed using the recommended methods from the guideline.
4- It is unlikely that any actions will impact on any animals or habitat as no evidence of use or visitation by the species were found on site.
5- No evidence on site of utilisation and the unlikely presence of any of the three species of black cockatoos would mean that no mitigation measures are required.
6- Using the flow chart and criteria it is determined that there is a low risk of actions resulting in an impact upon black cockatoos within the subject site.

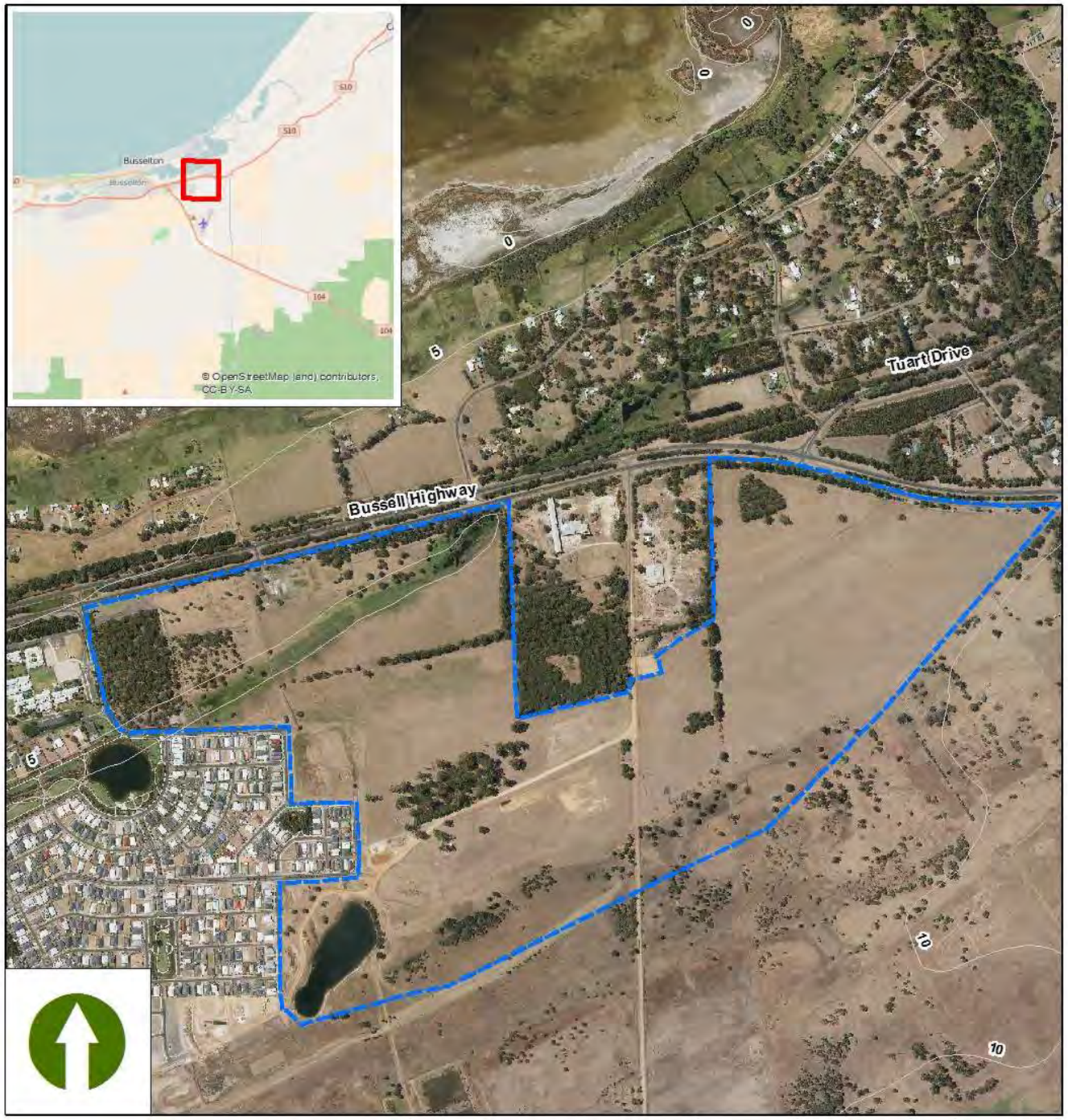
It is recommended that a referral pursuant to the EPBC Act is not required for the components of the development within the subject site, as actions involved do not constitute a significant impact on any of the threatened species present.

8. Summary and Recommendations

Based on the results of the analysis of study area, the following conclusions and recommendations are made.

- There is an extant population of Western Ringtail Possum within Plots A, B and C of the Study Area.
- Should any vegetation be disturbed within any of the 3 sites, this should be done in accordance with an approved WRP management plan and a fauna spotter be in attendance during any clearing or pruning event.
- Eighty one trees with sufficient girth to potential develop future hollows that are potentially suitable for Black Cockatoos were identified, however no signs of nesting or roosting within them were found.
- Black cockatoo species are highly mobile and it is likely they would utilise the site opportunistically as a feeding site within their range but are not presently relying on the site for habitat.
- A referral under the EPBC Act is not considered as required as any proposed actions are unlikely to significantly impact on the species or the local populations

9. Maps



Map 1	Site Location
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1: 10,000

Legend

Study Area Boundary

Metres (AHD)

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

ecosystem solutions



Map 2	Survey Areas
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

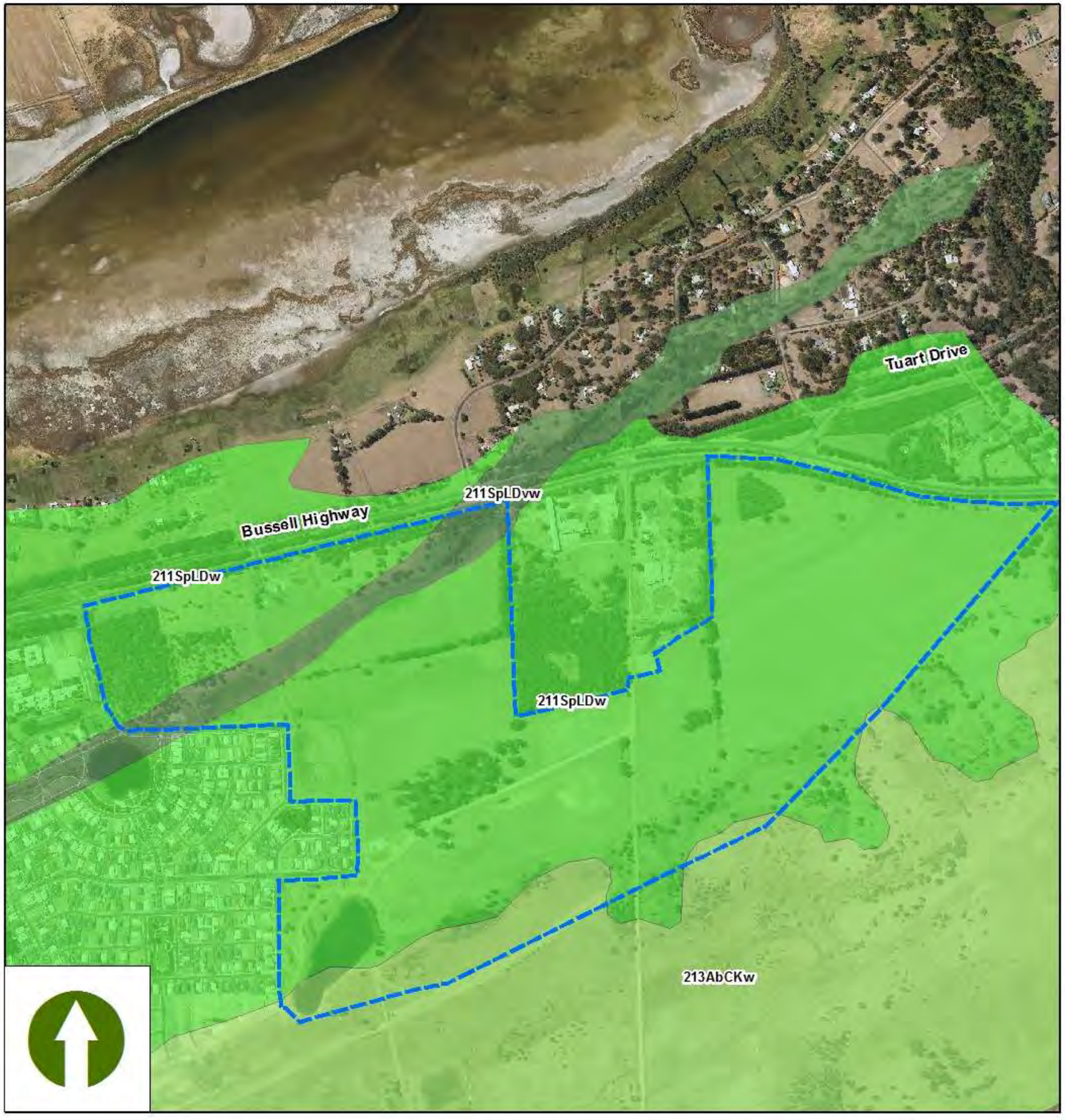
- Study Area Boundary
- Survey Areas (Dec 2015-Jan 2016)
- Survey Areas (Jan-Feb 2015)

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

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Map 3	Soil Landscapes
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Soil Landscape Units

211SpLDvw

211SpLDw

213AbCKw

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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Map 4	RFA Vegetation
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

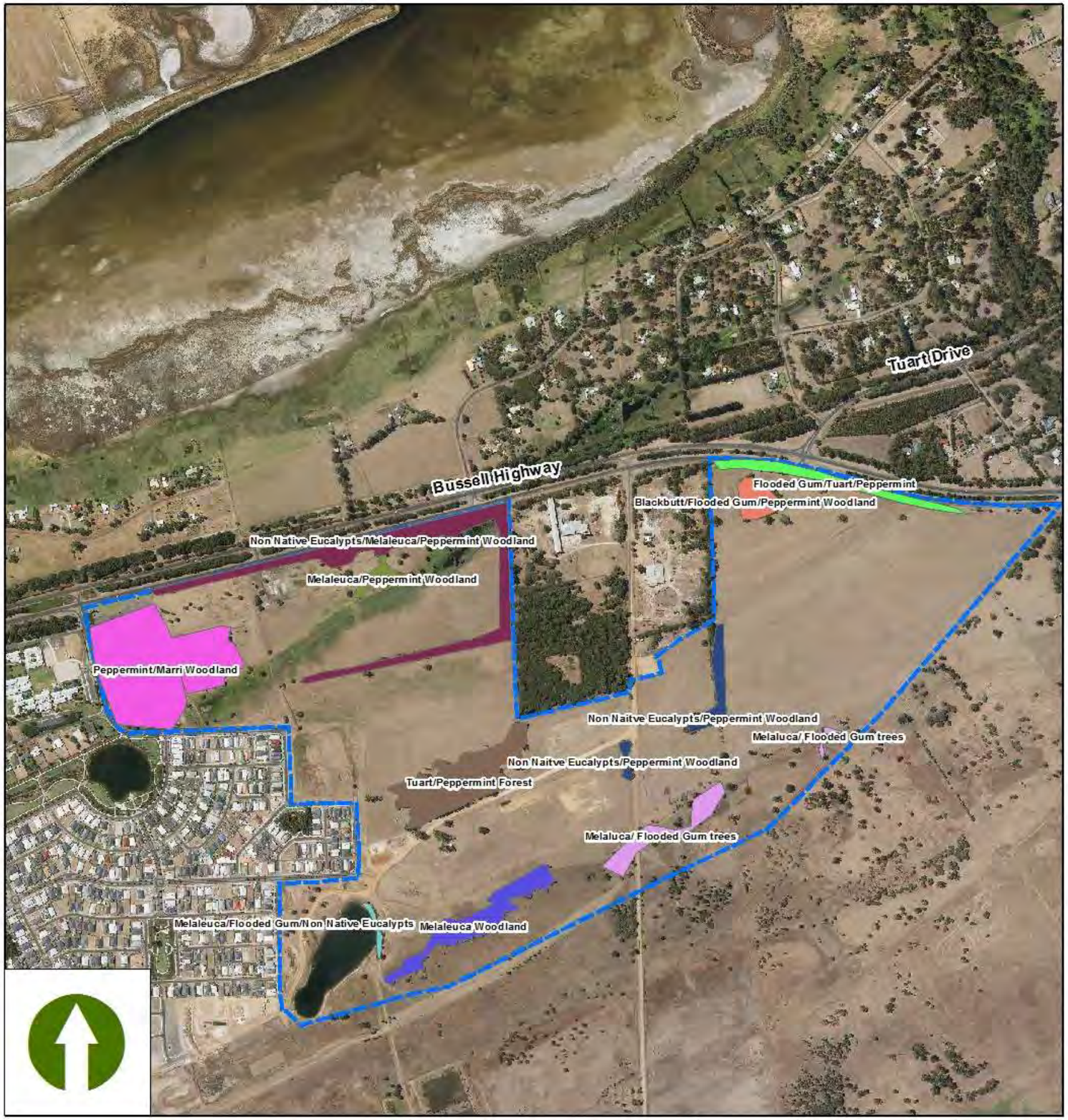
Vegetation (Havel & Mattiske)

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

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Map 5	Vegetation
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Vegetation Types

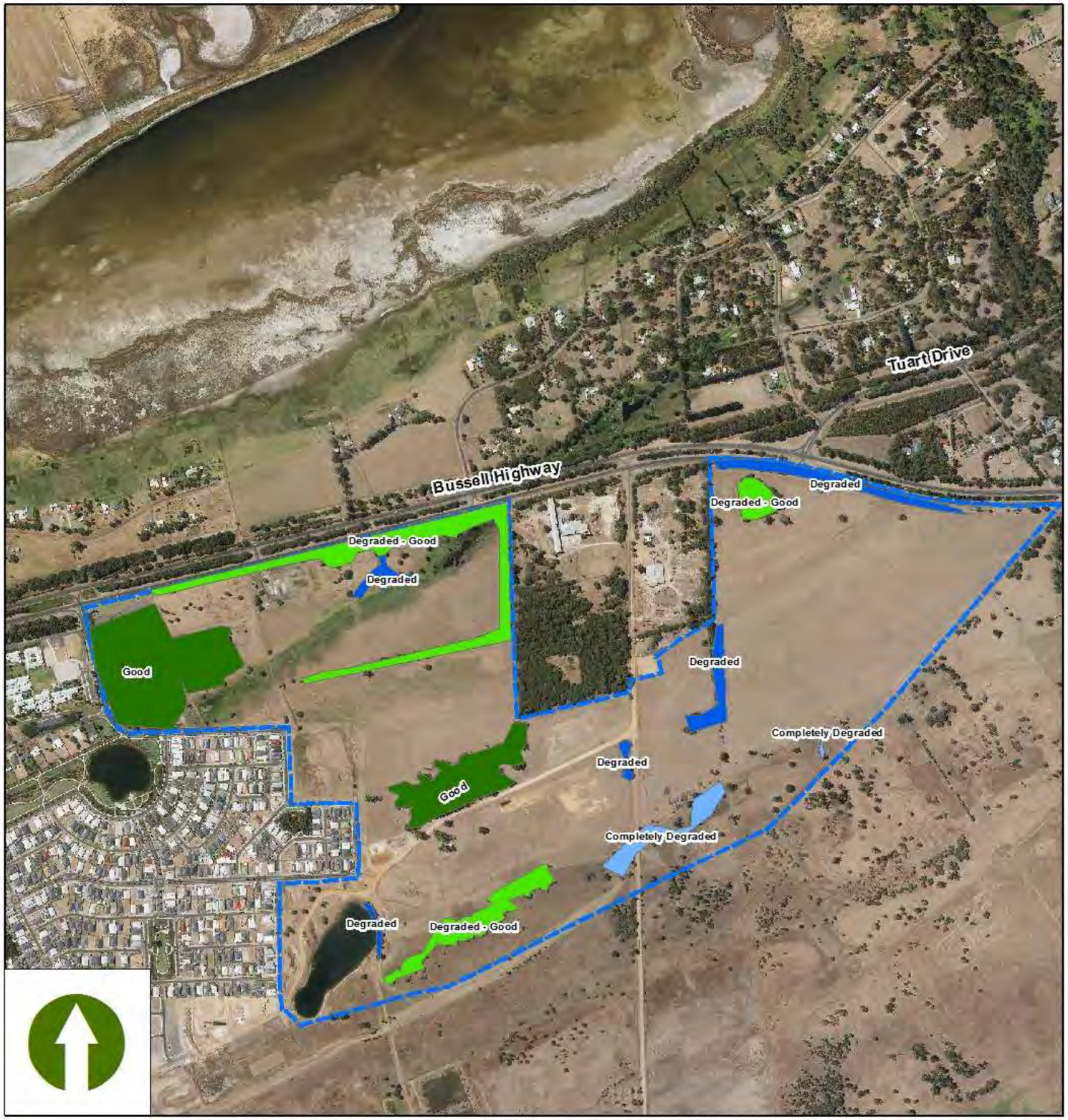
- Blackbutt/Flooded Gum/Peppermint Woodland
- Flooded Gum/Tuart/Peppermint
- Melaleuca Woodland
- Melaleuca/Flooded Gum/Non Native Eucalypts
- Melaleuca/Peppermint Woodland
- Melaluca/ Flooded Gum trees
- Non Naitve Eucalypts/Peppermint Woodland
- Non Native Eucalypts/Melaleuca/Peppermint Woodland
- Peppermint/Marri Woodland
- Tuart/Peppermint Forest

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

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Map 6	Vegetation Condition
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Condition

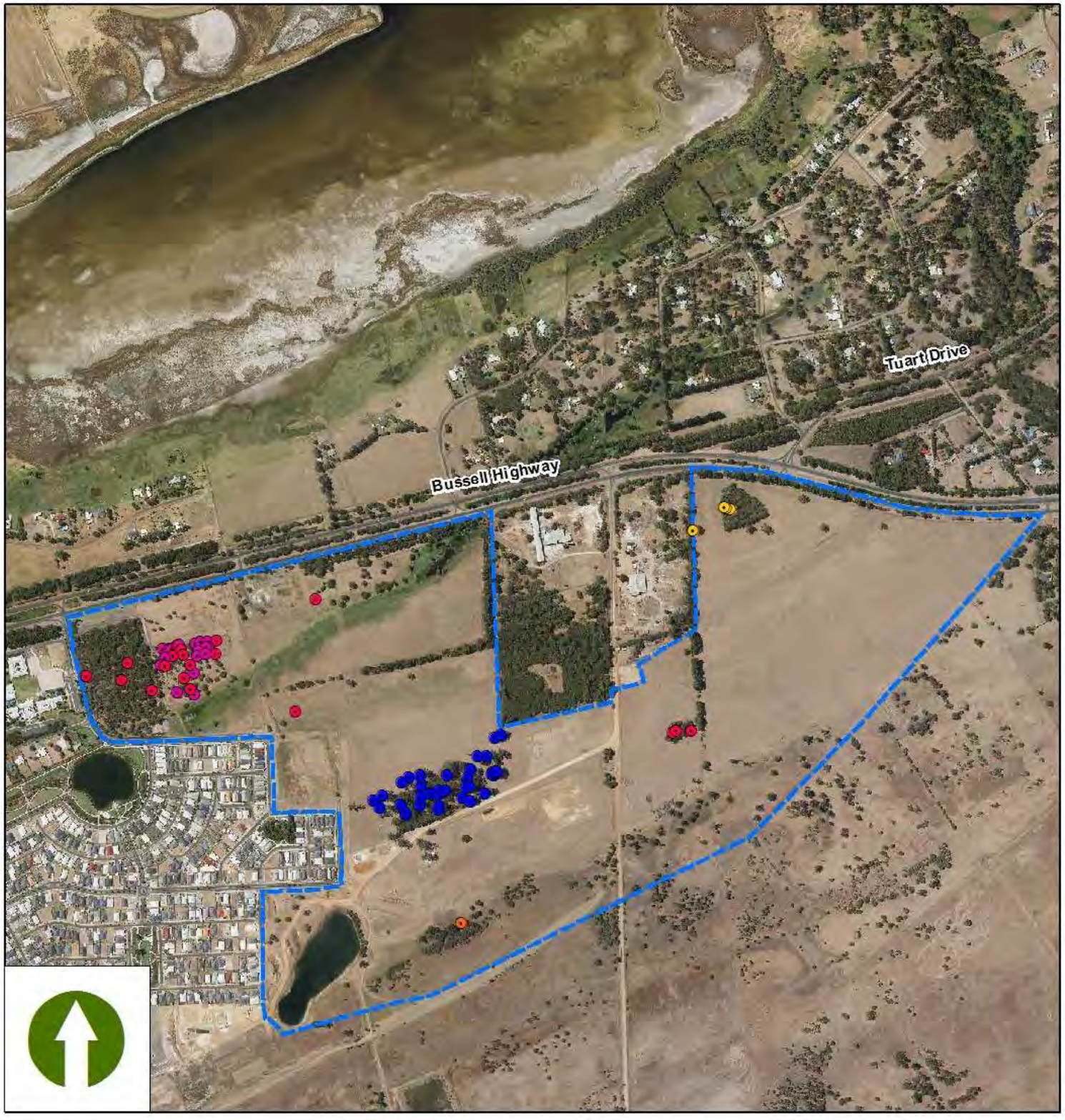
- Good
- Degraded - Good
- Degraded
- Completely Degraded

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

ecosystem solutions



Map 7	Trees Observed
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

SPECIES

- Blackbutt
- Flooded Gum
- Marri
- Peppermint
- Tuart

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.

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Map 8	Day Fauna Observations
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Fauna Signs

Drey

Fur

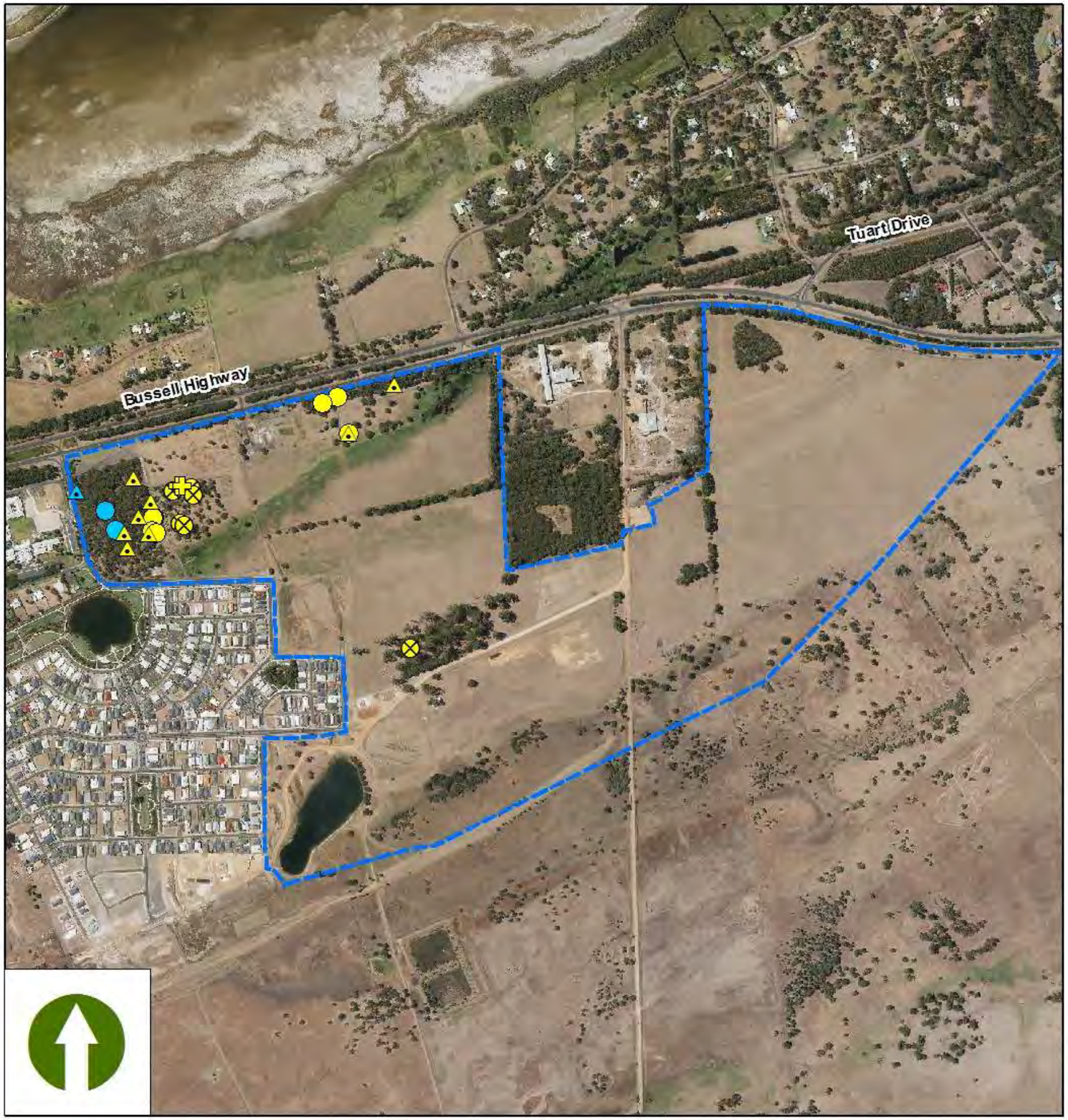
Scat

0 170 340 680 1,020

Metres

Prepared by Gary McMahon
Ecosystem Solutions
January 2016
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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Map 9	Nocturnal Fauna Observations
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Night Survey 1 (Nov 2014)

WRP

Night Survey 2 (Nov 2014)

WRP

Night Survey 1 (Dec 2015)

WRP

Brushtail P

Night Survey 2 (Jan 2016)

WRP

Brushtail P

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Metres

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Map 10	Key WRP Areas
Site	Provence Estate
Project	Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:8,000

Legend

Study Area Boundary

Key WRP Areas

Plot A

Plot B

Plot C

0 137.5 275 550 825

Metres

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Projection - MGA50
Datum - GDA94
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Appendix A: Significant Tree Data

TREE No	SPECIES	DBH (mm)	HEIGHT (m)	HEALTH	X coordinate	Y coordinate
1	Peppermint	550	9	Healthy	350420	6274422
2	Marri	940	13	Healthy	350429	6274410
3	Peppermint	580	14	Healthy	350439	6274423
4	Peppermint	580	15	Healthy	350445	6274422
5	Marri	680	19	Healthy	350448	6274405
6	Marri	530	16	Dead	350457	6274430
7	Peppermint	560	15	Healthy	350464	6274433
8	Peppermint	530	10	Healthy	350469	6274419
9	Marri	530	13	Healthy	350468	6274419
10	Peppermint	630	11	Healthy	350505	6274437
11	Peppermint	640	13	Healthy	350520	6274440
12	Peppermint	600	13	Healthy	350536	6274440
13	Marri	770	8	Dead	350562	6274443
14	Peppermint	520	12	Healthy	350541	6274428
15	Peppermint	910	23	Healthy	350534	6274428
16	Peppermint	1030	22	Healthy	350514	6274417
17	Marri	730	30	Healthy	350473	6274407
18	Peppermint	790	17	Healthy	350428	6274398
19	Peppermint	870	21	Healthy	350415	6274380
20	Marri	840	22	Healthy	350427	6274378
21	Marri	770	12	Healthy	350476	6274347
21	Peppermint	1430	8	Healthy	350459	6274308
23	Peppermint	1730	11	Healthy	350504	6274302
24	Marri	1040	32	Healthy	350491	6274316
25	Peppermint	1190	12	Healthy	350502	6274358
26	Marri	800	22	Dead	350493	6274380
27	Peppermint	1040	13	Healthy	350511	6274404
28	Peppermint	780	14	Healthy	350531	6274410
29	Marri	1370	13	Dead	350558	6274409
40	Tuart	1280	70	Healthy	351206	6274033
41	Tuart	2040	30	Healthy	351224	6274024
42	Tuart	1820	52	Healthy	351262	6274045
44	Tuart	560	50	Healthy	351285	6274093
45	Tuart	1080	50	Healthy	351286	6274097
46	Tuart	750	50	Healthy	351283	6274099
47	Tuart	990	50	Healthy	351282	6274096
48	Tuart	800	50	Healthy	351293	6274103
49	Tuart	950	50	Healthy	351291	6274103
50	Tuart	1060	50	Healthy	351294	6274099

TREE No	SPECIES	DBH (mm)	HEIGHT (m)	HEALTH	X coordinate	Y coordinate
53	Tuart	1370	40	Healthy	351289	6274191
54	Tuart	1110	40	Healthy	351304	6274198
58	Tuart	1700	50	Healthy	351267	6274143
59	Tuart	1330	40	Healthy	351244	6274143
63	Tuart	1660	45	Healthy	351226	6274108
64	Tuart	2370	53	Healthy	351217	6274085
65	Tuart	1520	35	Healthy	351224	6274064
66	Tuart	2470	35	Healthy	351215	6274059
67	Tuart	1100	40	Healthy	351165	6274092
70	Tuart	1150	45	Healthy	351096	6274070
71	Tuart	1260	45	Healthy	351096	6274058
73	Tuart	2020	50	Healthy	351093	6274093
74	Tuart	1580	33	Dead	351063	6274088
75	Tuart	1850	55	Healthy	351046	6274073
76	Tuart	1790	50	Healthy	350996	6274040
77	Tuart	2100	50	Healthy	350973	6274025
78	Tuart	1390	30	Healthy	350986	6274006
82	Tuart	1910	50	Healthy	351056	6273989
83	Tuart	2750	50	Healthy	351057	6273993
84	Tuart	1760	45	Healthy	351044	6274016
85	Tuart	1980	54	Healthy	351093	6274011
86	Tuart	2360	60	Healthy	351095	6274033
87	Tuart	1520	50	Healthy	351122	6274045
88	Tuart	1330	50	Healthy	351142	6274042
89	Tuart	1830	50	Healthy	351144	6274052
90	Tuart	1740	54	Healthy	351159	6274053
91	Tuart	2240	50	Healthy	351144	6274012
92	Tuart	840	38	Healthy	351141	6274001
95	Flooded Gum	1600	30	Healthy	351201	6273706
101	Blackbutt	907	20	Healthy	351907	6274787
102	Blackbutt	890	14	Healthy	351896	6274791
103	Blackbutt	860	20	Healthy	351891	6274794
104	Blackbutt	1050	16	Healthy	351808	6274733
105	Marri	860	18	Healthy	351755	6274202
106	Marri	940	17	Healthy	351763	6274208
107	Marri	1260	15	Dead	351802	6274210
108	Marri	1070	18	Dead	350822	6274554
109	Marri	1190	17	Dead	350769	6274258
110	Marri	850	17	Dead	350329	6274386
111	Marri	790	17	Dead	350221	6274353

TREE No	SPECIES	DBH (mm)	HEIGHT (m)	HEALTH	X coordinate	Y coordinate
112	Marri	880	11	Dead	350313	6274340
113	Marri	1170	0	Dead	350393	6274315

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Report

Addendum to Provence Estate Development Significance Assessment



Flora, Vegetation and Fauna

Prepared by

ECOSYSTEM SOLUTIONS PTY LTD

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For

Glen Yeatman

Principal Scientist /Team Leader

Infrastructure & Regional Development

Environment – Land and Infrastructure

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Satterley Property Group

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Limitations Statement

This report has been solely prepared for RPS Australia Asia Pacific and Satterley Property Group.

No express or implied warranties are made by Ecosystem Solutions Pty Ltd regarding the findings and data contained in this report. No new research or field studies were conducted other than those specifically outlined in this report. All of the information details included in this report are based upon the research provided and obtained at the time Ecosystem Solutions Pty Ltd conducted its analysis.

In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Any conclusions drawn or recommendations made in the report are done in good faith and the consultants take no responsibility for how this information and the report are used subsequently by others.

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1. Introduction

Ecosystem Solutions were contracted by RPS Australia Asia Pacific to ammend the Provence Estate Development Significance Assessment v2.0, 28 January 2016 with an updated Provence Structure Plan Design (Figure 1).

This Addendum summarises the changes to the Study Boundary and associated data collected in 2015 and 2016. There was no new data collected as a result of this Addendum.

For all other information relating to the Provence Estate Development Significance Assessment, refer to the v2.0, 28 January 2016, report.

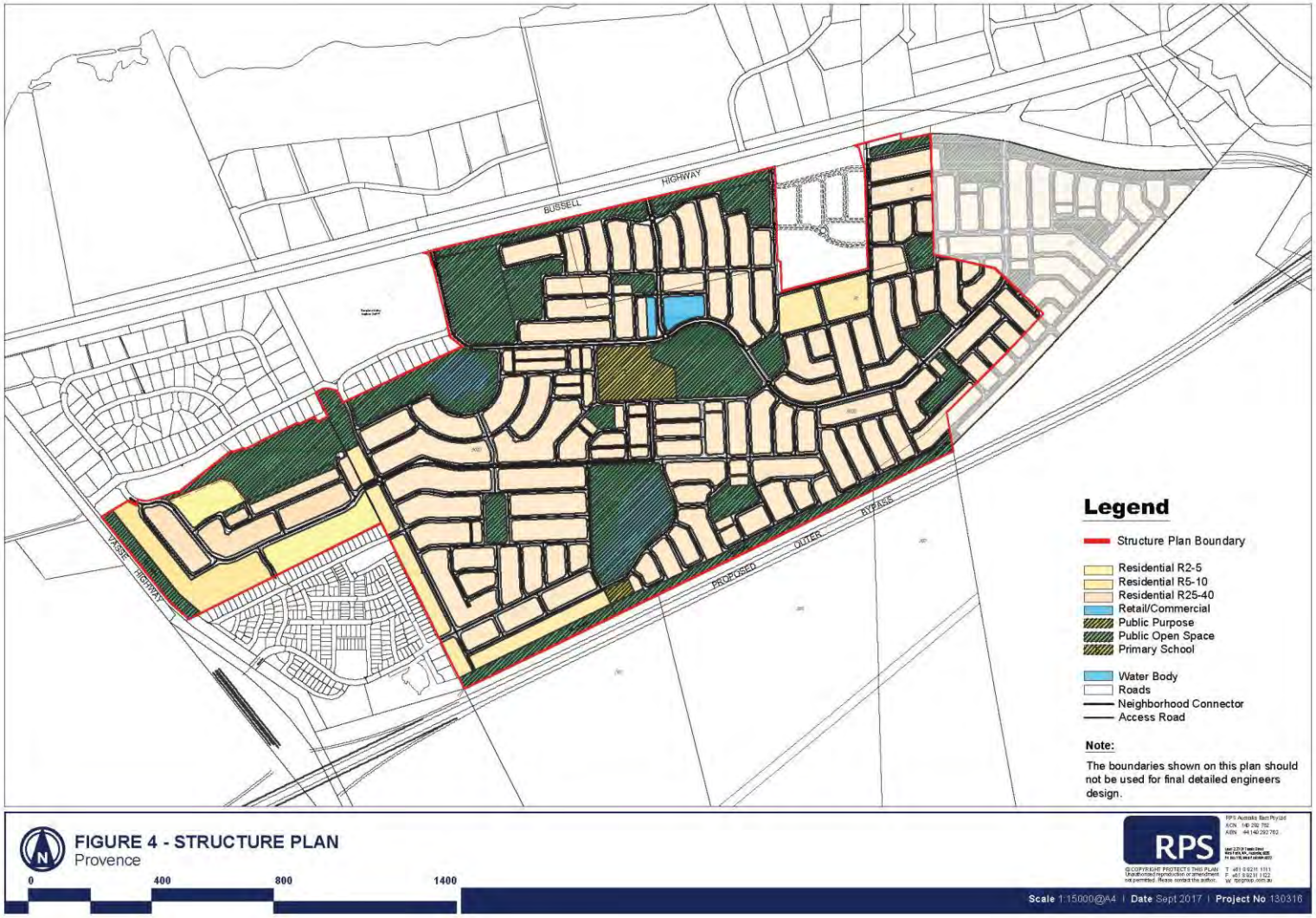


Figure 1 Provence Estate Structure Plan Design Revised 2018

2. Site Details

The amended site boundary consists of approximately 133 hectares of mixed pasture and bushland areas approximately 4 km east of Busselton, on Bussell Highway, as shown in Map 1 (hereafter referred to as the Study Area).

The Study Area has been amended to the new Provence Estate Structure Plan Design with the eastern portion removed. The new Provence Estate Structure Plan Design includes an area to the west of the Study Area which has not been surveyed and therefore is not included in the Study Area depicted in Map 1.

The amended Study Area removes three areas from the December 2015 to January 2016 survey (Map 2).

3. Flora and Vegetation

3.1. Landscape, Soils & Vegetation

The revised Study Area contains three individual soil-landscape types with the the eastern portion of Ludlow wet vales Phase (211 SpLDvw) removed. The areas of Ludlow wet flats Phase (211 SPLDw) and Cokeluup wet clayey flats Phase (213 AbCKw) remains the same, as depicted in Map 3.

The mapping of Havel and Mattiske (2000) categorises the remaining larger areas of native vegetation within and adjacent to the Study Area as one vegetation complex (Map 4):

- Ludlow (Lw) – Open woodland of Melaleuca rhaphiophylla and sedgelands of Cyperaceae - Restionaceae species on broad depressions in the subhumid zone.

Comparing the current extent to the pre-European extent it is estimated 24% of this vegetation type remains (Webb *et al,* 2009).

3.2. Method

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

3.3. Declared Rare and Priority Flora

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

3.4. Results and Discussion

3.4.1. Native Flora

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

3.4.2. Vegetation Communities

The Vegetation communities are categorised by the dominant species within them and the upper canopy. Vegetation condition was ranked from Good to Completely Degraded due to a lack of mid and lower strata species within any of the vegetation areas. As a result of the changed Study Area, two Vegetation communities were removed from Map 5 and Map 6.

4. Fauna

4.1. Objectives

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

4.2. Methodology

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

4.3. Conservation Significant Fauna

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

4.4. Limitations

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

4.5. Expected Fauna

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

5. Results

There were 77 trees with a Diameter at Breast Height (DBH) of over 500 mm with either observable hollows or canopy and formation that potentially could contain or develop hollows within the revised Study Area. The tree species removed with the revised Study Area did not have any visible hollows or dead stags suitable for Black Cockatoos. Appendix A and Map 7 shows the revised tree list and details of these 77.

Map 8, Map 9 and Map 10 have been updated with the new Study Area. There are no changes to the Western Ringtail Possum (WRP) observations for the day and nocturnal surveys or the key habitat areas. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016, for the results of these surveys.

6. Discussion

Seventy seven trees over 500mm were found within the new Study Area that either had hollows or had the potential to develop hollows. No black cockatoos were seen or heard during any of the surveys. There were no signs of feeding or feathers within the Study Area. This is probably due to the site having minimal Marri trees, which is a preferred food source for the animals. Better quality food and roosting sites exist to the east and south of the site, with the Tuart Forest National Park being 2 m to the east and large areas of state forest 10 kms to the south. All local species of Black cockatoos can forage over extensive areas (up to 15-20 kms from their nesting sites (Saunders, 1980)) and given that there is larger areas of more preferred habitat within their range, it could be assumed that black cockatoo species are not relying on the site for habitat or food source. They would, however, utilise the site opportunistically within their range and may potently utilise some of the hollows within the survey area in the future.

Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016, for the discussion on the remaining results.

7. Significance

It was recommended in 2016 that a referral pursuant to the EPBC Act was not required for the components of the development at that stage. No new information has been provided regarding any additional potential impacts.

Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016, for further evidence on the recommendation that a referral pursuant to the EPBC Act is not required.

8. Summary and Recommendations

Based on the results of the analysis of the new Study Area, the following conclusions and recommendations have been amended:

- Seventy seven trees with sufficient girth to potential develop future hollows that are potentially suitable for Black Cockatoos were identified, however no signs of nesting or roosting within them were found.

As per Provence Estate Significance Assessment Report v2.0, 28 January 2016, a referral under the EPBC Act is not recommended as any proposed actions are unlikely to significantly impact on the species or the local populations

Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016, for further summary and recommendations.

9. Maps



Map 1	Site Location
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1: 10,000

Legend

Metres (AHD)

Study Area Boundary

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 2	Survey Areas
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

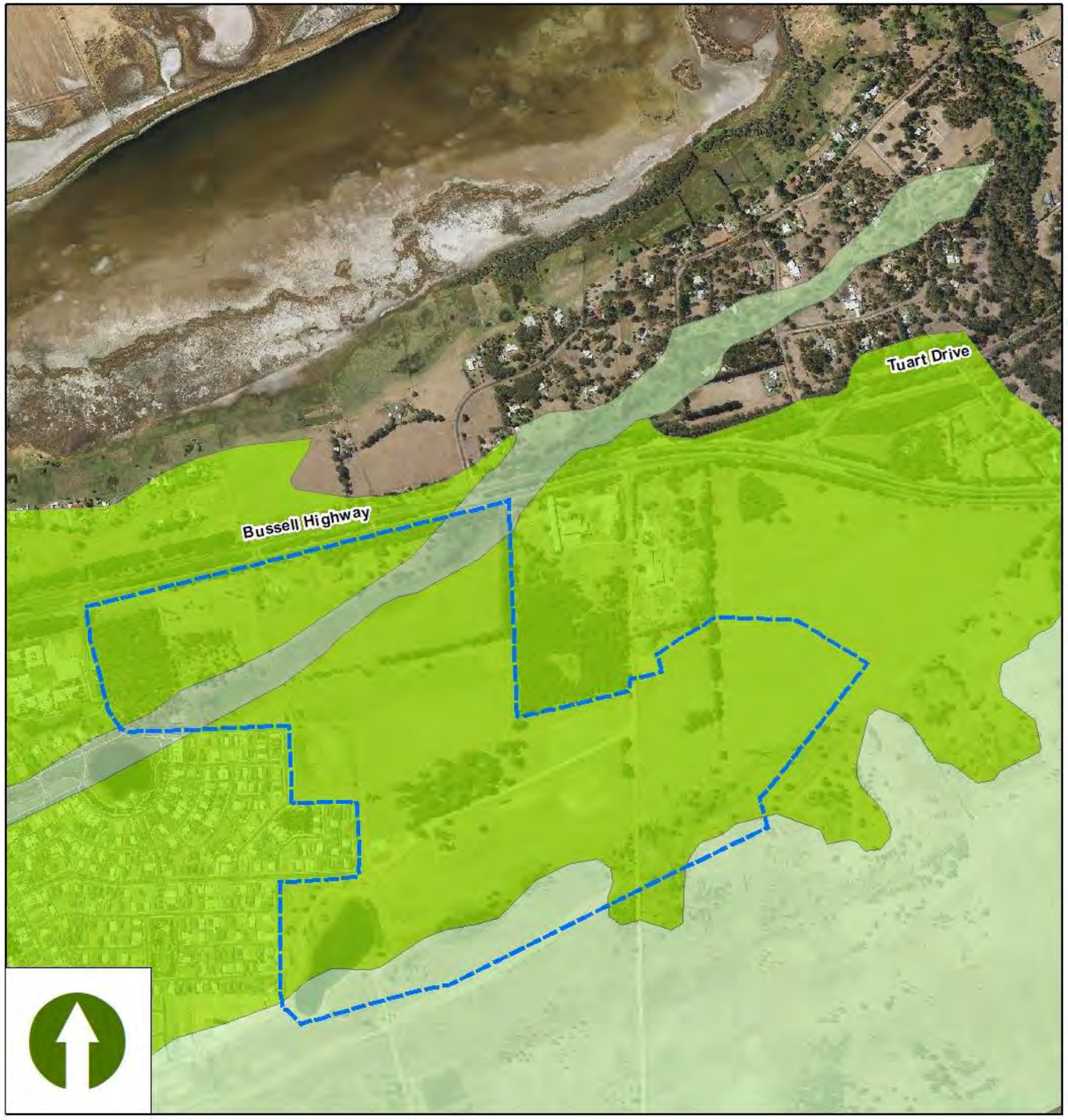
Legend

- Study Area Boundary
- Survey Areas (Jan-Feb 2015)
- Survey Areas (Dec 2015-Jan 2016)

0 230 460 920 1,380

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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Map 3	Soil Landscapes
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Soil Landscape Units

211 SpLDvw

211 SpLDw

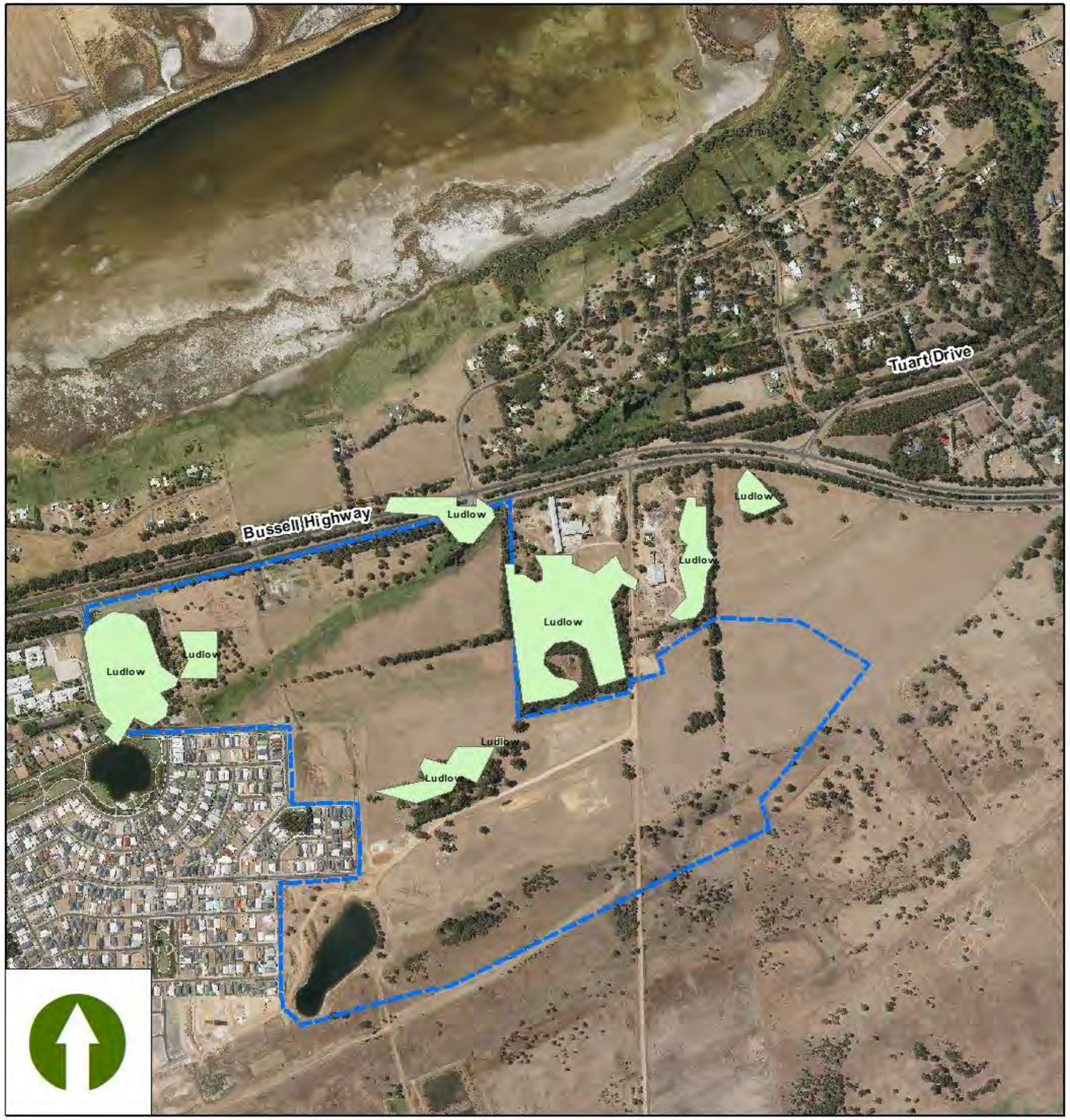
213 AbCKw

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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Map 4	RFA Vegetation
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

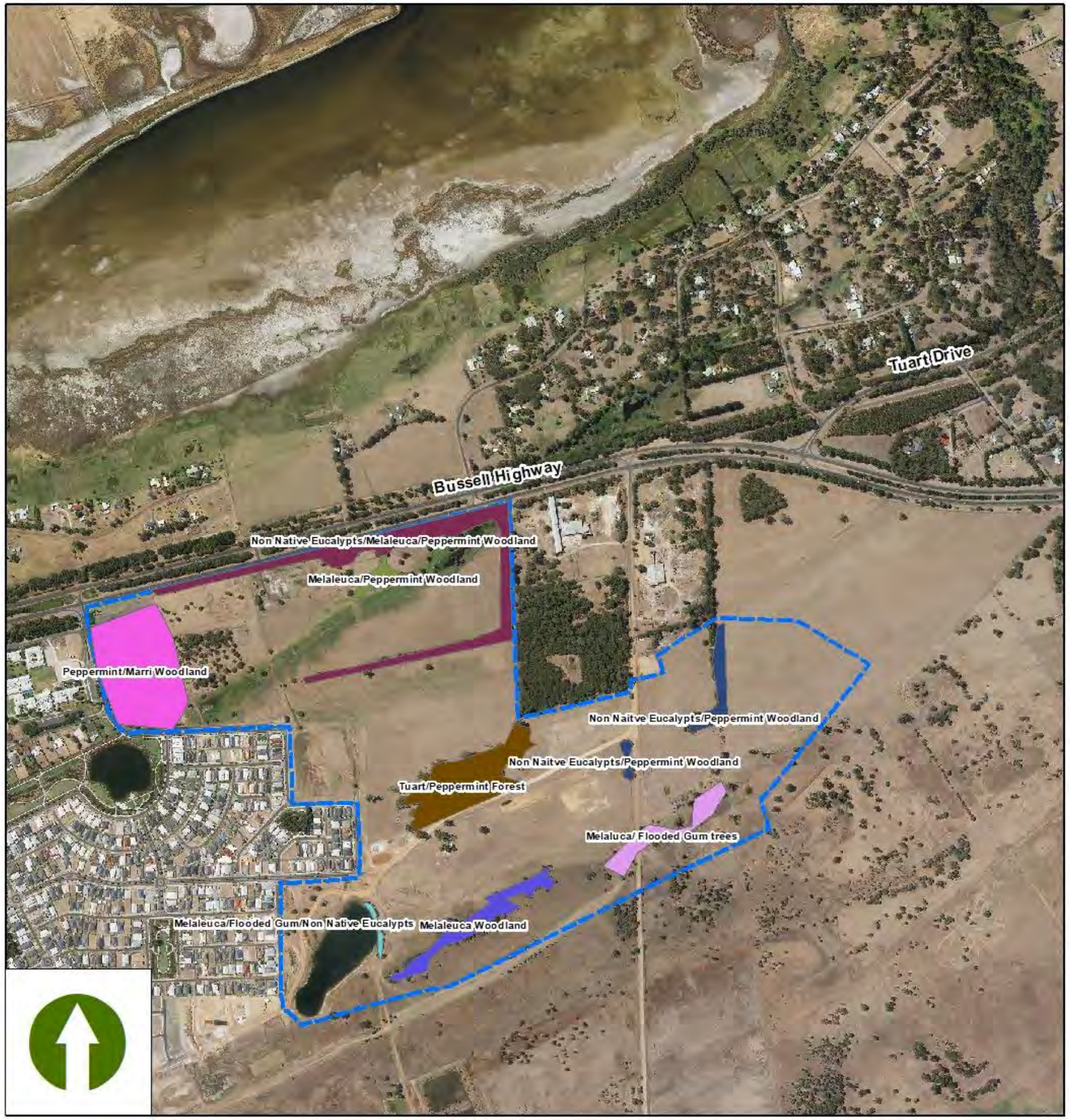
Study Area Boundary

Vegetation (Havel & Mattiske)

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 5	Vegetation
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

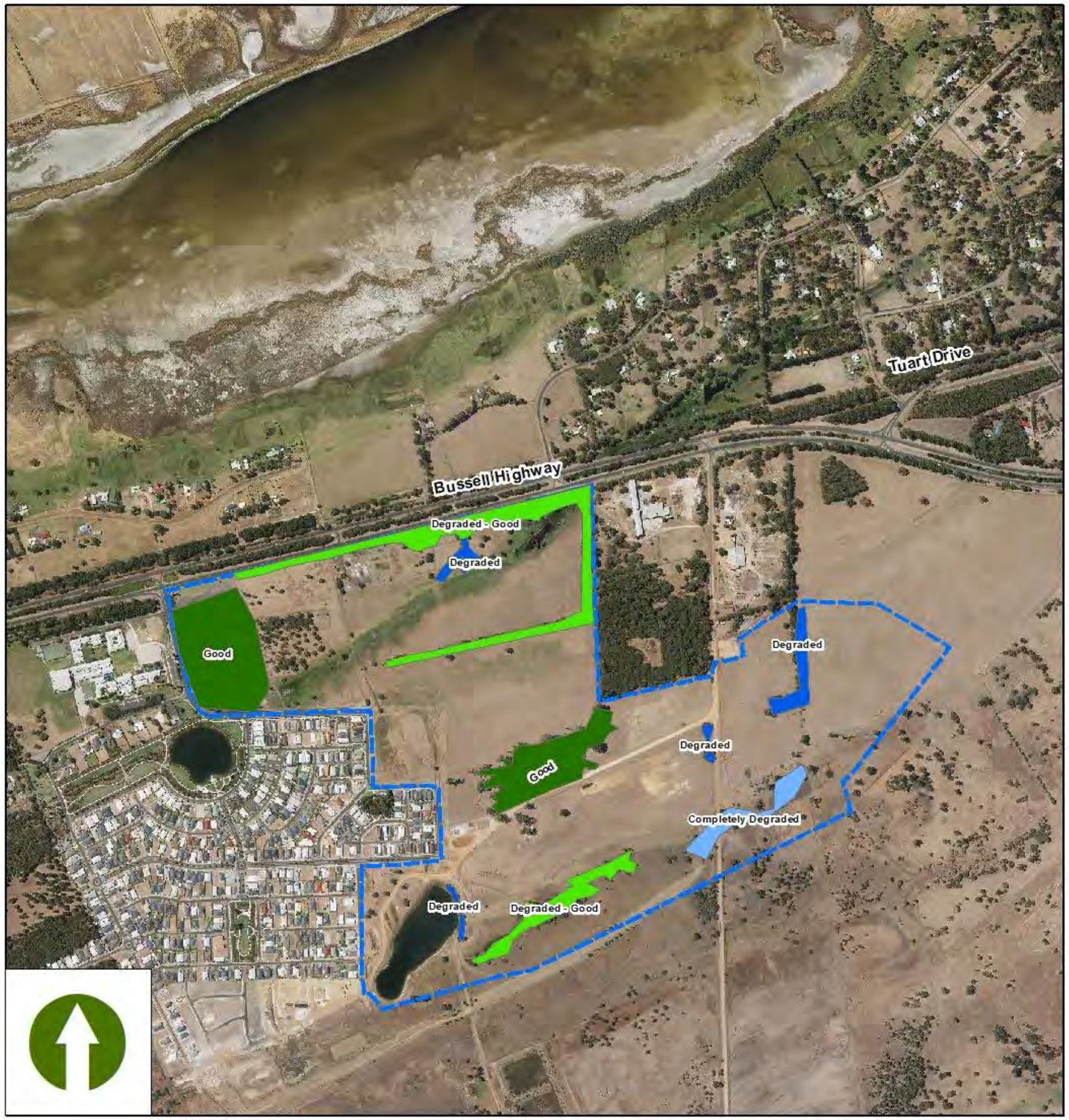
Vegetation Types

- Melaleuca Woodland
- Melaleuca/Flooded Gum/Non Native Eucalypts
- Melaleuca/Peppermint Woodland
- Melaluca/ Flooded Gum trees
- Non Naitve Eucalypts/Peppermint Woodland
- Non Native Eucalypts/Melaleuca/Peppermint Woodland
- Peppermint/Marri Woodland
- Tuart/Peppermint Forest

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 6	Vegetation Condition
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

- Study Area Boundary

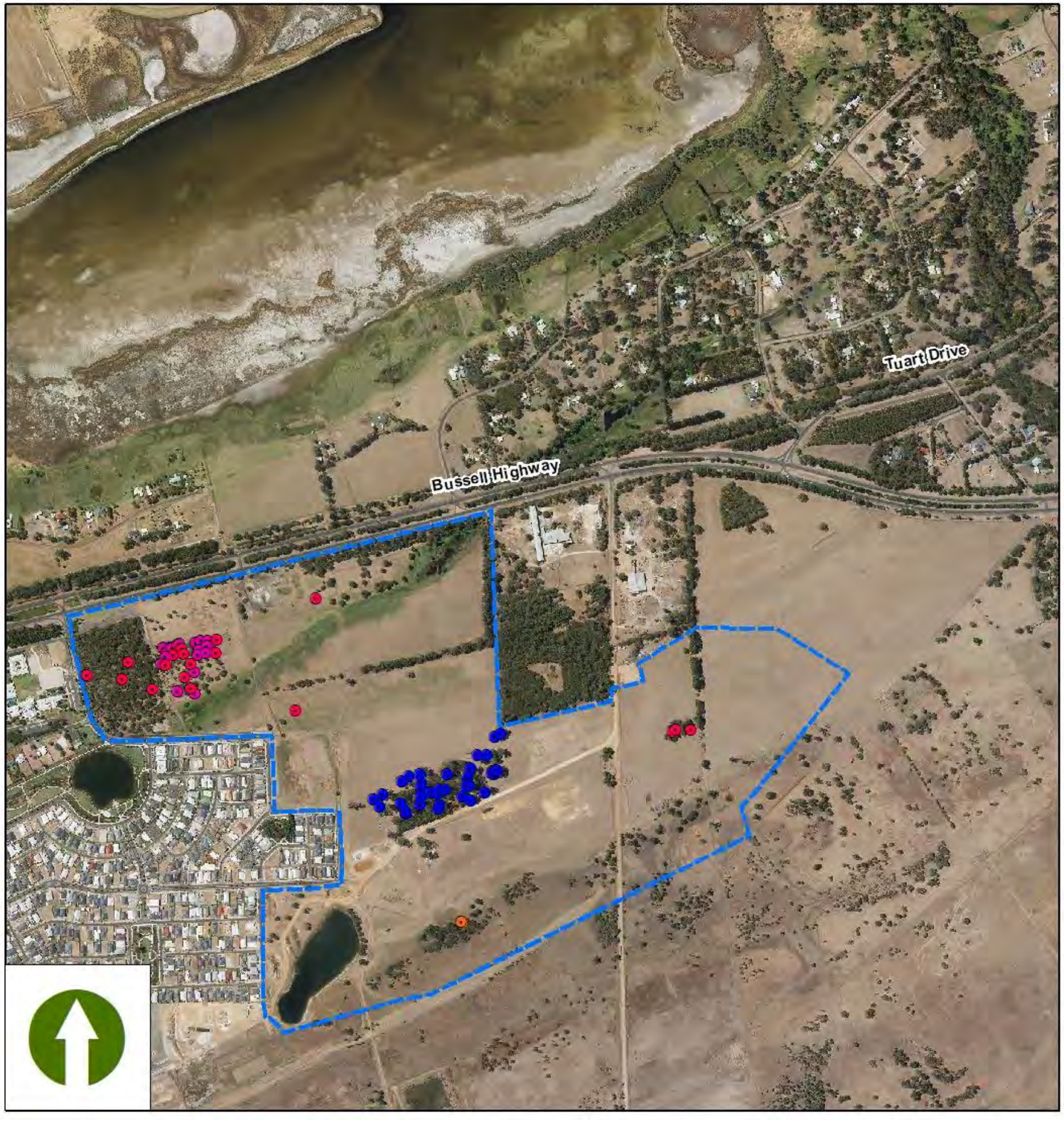
Condition

- Good
- Degraded - Good
- Degraded
- Completely Degraded

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 7	Trees Observed
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

SPECIES

- Flooded Gum
- Marri
- Peppermint
- Tuart

0 170 340 680 1,020

Metres

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Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 8	Day Fauna Observations
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Fauna Signs

Drey

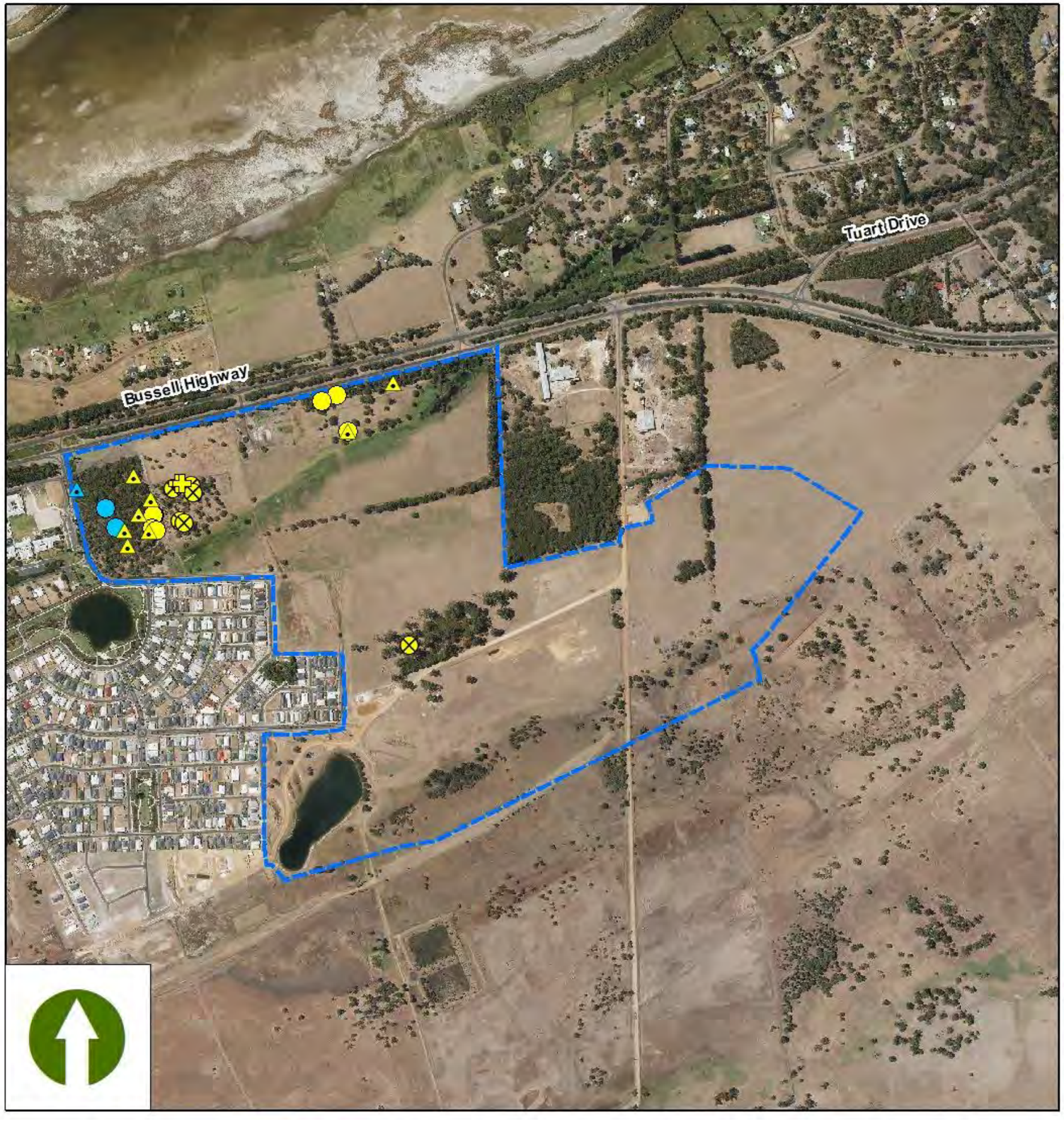
Fur

Scat

0 170 340 680 1,020

Metres

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May 2018
Projection - MGA50
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Map 9	Nocturnal Fauna Observations
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

Study Area Boundary

Night Survey 1 (Nov 2014)

WRP

Night Survey 2 (Nov 2014)

WRP

Night Survey 1 (Dec 2015)

WRP

Brushtail P

Night Survey 2 (Jan 2016)

WRP

Brushtail P

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 10	Key WRP Areas
Site	Provence Estate
Project	Addendum to Provence Signficance Assessment
Client	Satterley Property Group
Scale	1:10,000

Legend

- Study Area Boundary

Key WRP Areas

- Plot A
- Plot B
- Plot C

0 170 340 680 1,020

Metres

Prepared by Danae Plowman
Ecosystem Solutions
May 2018
Projection - MGA50
Datum - GDA94
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10. References (not all cited)

There has been no change to this section. Refer to Provence Estate Significance Assessment Report v2.0, 28 January 2016.

Appendix A: Significant Tree Data

TREE No	SPECIES	DBH (mm)	HEIGHT (m)	HEALTH	X coordinate	Y coordinate
1	Peppermint	550	9	Healthy	350420	6274422
2	Marri	940	13	Healthy	350429	6274410
3	Peppermint	580	14	Healthy	350439	6274423
4	Peppermint	580	15	Healthy	350445	6274422
5	Marri	680	19	Healthy	350448	6274405
6	Marri	530	16	Dead	350457	6274430
7	Peppermint	560	15	Healthy	350464	6274433
8	Peppermint	530	10	Healthy	350469	6274419
9	Marri	530	13	Healthy	350468	6274419
10	Peppermint	630	11	Healthy	350505	6274437
11	Peppermint	640	13	Healthy	350520	6274440
12	Peppermint	600	13	Healthy	350536	6274440
13	Marri	770	8	Dead	350562	6274443
14	Peppermint	520	12	Healthy	350541	6274428
15	Peppermint	910	23	Healthy	350534	6274428
16	Peppermint	1030	22	Healthy	350514	6274417
17	Marri	730	30	Healthy	350473	6274407
18	Peppermint	790	17	Healthy	350428	6274398
19	Peppermint	870	21	Healthy	350415	6274380
20	Marri	840	22	Healthy	350427	6274378
21	Marri	770	12	Healthy	350476	6274347
21	Peppermint	1430	8	Healthy	350459	6274308
23	Peppermint	1730	11	Healthy	350504	6274302
24	Marri	1040	32	Healthy	350491	6274316
25	Peppermint	1190	12	Healthy	350502	6274358
26	Marri	800	22	Dead	350493	6274380
27	Peppermint	1040	13	Healthy	350511	6274404
28	Peppermint	780	14	Healthy	350531	6274410
29	Marri	1370	13	Dead	350558	6274409
40	Tuart	1280	70	Healthy	351206	6274033
41	Tuart	2040	30	Healthy	351224	6274024
42	Tuart	1820	52	Healthy	351262	6274045
44	Tuart	560	50	Healthy	351285	6274093
45	Tuart	1080	50	Healthy	351286	6274097
46	Tuart	750	50	Healthy	351283	6274099
47	Tuart	990	50	Healthy	351282	6274096
48	Tuart	800	50	Healthy	351293	6274103
49	Tuart	950	50	Healthy	351291	6274103
50	Tuart	1060	50	Healthy	351294	6274099

TREE No	SPECIES	DBH (mm)	HEIGHT (m)	HEALTH	X coordinate	Y coordinate
53	Tuart	1370	40	Healthy	351289	6274191
54	Tuart	1110	40	Healthy	351304	6274198
58	Tuart	1700	50	Healthy	351267	6274143
59	Tuart	1330	40	Healthy	351244	6274143
63	Tuart	1660	45	Healthy	351226	6274108
64	Tuart	2370	53	Healthy	351217	6274085
65	Tuart	1520	35	Healthy	351224	6274064
66	Tuart	2470	35	Healthy	351215	6274059
67	Tuart	1100	40	Healthy	351165	6274092
70	Tuart	1150	45	Healthy	351096	6274070
71	Tuart	1260	45	Healthy	351096	6274058
73	Tuart	2020	50	Healthy	351093	6274093
74	Tuart	1580	33	Dead	351063	6274088
75	Tuart	1850	55	Healthy	351046	6274073
76	Tuart	1790	50	Healthy	350996	6274040
77	Tuart	2100	50	Healthy	350973	6274025
78	Tuart	1390	30	Healthy	350986	6274006
82	Tuart	1910	50	Healthy	351056	6273989
83	Tuart	2750	50	Healthy	351057	6273993
84	Tuart	1760	45	Healthy	351044	6274016
85	Tuart	1980	54	Healthy	351093	6274011
86	Tuart	2360	60	Healthy	351095	6274033
87	Tuart	1520	50	Healthy	351122	6274045
88	Tuart	1330	50	Healthy	351142	6274042
89	Tuart	1830	50	Healthy	351144	6274052
90	Tuart	1740	54	Healthy	351159	6274053
91	Tuart	2240	50	Healthy	351144	6274012
92	Tuart	840	38	Healthy	351141	6274001
95	Flooded Gum	1600	30	Healthy	351201	6273706
105	Marri	860	18	Healthy	351755	6274202
106	Marri	940	17	Healthy	351763	6274208
107	Marri	1260	15	Dead	351802	6274210
108	Marri	1070	18	Dead	350822	6274554
109	Marri	1190	17	Dead	350769	6274258
110	Marri	850	17	Dead	350329	6274386
111	Marri	790	17	Dead	350221	6274353
112	Marri	880	11	Dead	350313	6274340
113	Marri	1170	0	Dead	350393	6274315

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Appendix D
Western Grey Kangaroo (*Macropus fuliginosus*) Survey and Management Plan

Report

Provence Estate Yalyallup
City of Busselton



Western Grey Kangaroo
(*Macropus fuliginosus*)
Survey and Management Plan

Prepared by

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30th September 2015

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Limitations Statement

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In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Any conclusions drawn or recommendations made in the report are done in good faith and the consultants take no responsibility for how this information and the report are used subsequently by others.

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1. Introduction

1.1. Background11

Satterley Property Group are the developers of the Provence Estate at Yalyallup in the City of Busselton.

The Western Australian Planning Commission (WAPC) granted approval for the original development in June 2006 (WAPC Reference 129999). One of the conditions was that a Western Grey Kangaroo Management Plan (WGKMP) be prepared and implemented. This was developed by Coffey Environments (2008) and been implemented since then.

The development in now ready to expand to the eastern section of the development and the Department of Parks and Wildlife have requested an update of the kangaroo numbers in the remaining areas of the development boundary, and compared to those in the original WGKMP (Coffey Environments, 2008).

This report outlines the methodology and results of the surveys and the management plan and recommendations to ensure that Western Grey Kangaroos (WGK) within the project site are managed in an appropriate and humane manner.

1.2. Location Details

The development is located approximately 5 kms south east of Busselton (Map 1). The site is bounded by Bussell Highway to the north and agricultural lands to the south and east. Since the previous WGKMP, DAP 1 and parts of DAP have been developed and this area no longer supports paddocks and suitable kangaroo habitat.

2. Existing Environment

2.1. Climate

The project area is situated within the zone classified as a Mediterranean type climate. It is characterised by hot dry summers and cool wet winters, during which most of the rainfall occurs.

The mean annual maximum temperature is 22°C, which ranges from approximately 16°C in July to 28°C in January (BOM, 2014). The annual average rainfall is 804mm, with 80% of the rainfall occurring between May and September (BOM, 2014).

2.2. Surrounding Land Use

The current developed areas of the site have been completed and is now urban housing lots, with interspaced public open areas. To the north, south and east of the site are agricultural farming lands of mixed paddocks and remnant areas of vegetation. The area to the west of the site has a rural residential development, sporting complexes and agricultural lands (Map 1).

2.3. Landforms, Soils and Vegetation

The site is flat with very gentle slopes throughout. The site is situated at approximately 5m above sea level Australian Height Datum (AHD).

Soil-Landscape systems are areas with recurring patterns of landforms, soils and vegetation and are used by the Department of Agriculture to maintain a consistent approach to land resource surveys.

The Study Area is within two Soil-Landscapes areas, the Spearwood System (211Sp) and the Abba System (213Ab) (Tille and Lantzke, 1990). There are three individual soil-landscape sub-systems within the remaining are of the development (Map 2). These are:

- 211SpLDvw - Ludlow wet vales – Poorly drained open and closed drainage depressions on sand over coastal limestone in the Swan Coastal Plain between Capel and Busselton, Wet and semi wet souls and brown deep sands. Primary vegetation is Flooded gum woodlands;
- 211SpLDw – Ludlow Wet Flats – Poorly drained open and closed drainage depressions on sand over coastal limestone in the Swan Coastal Plain between Capel and Busselton, Yellow deep sands an semi-wet soils supporting Flooded gum and Peppermint woodlands; and
- 213AbCKw – Cokelup wet clayey flats – Low lying flats and depressions on alluvium overlying coastal limestone in the southern Swan Coastal Plain between the Capel River and Dunsborough. Wet and semi wet soils of grey shallow sandy and loamy duplex soils. Primary vegetation are Flooded gum and Melaleuca woodlands.

The vegetation mapping of Havel and Matiske (2000) categorises the remaining native vegetation remnants as being part of the same vegetation complex of the Swan Coastal Plan (Map 3):

- Ludlow (Lw) – Open woodlands of Melaleuca rhaphiophylla and sedgelands of Cyperaceae and Restionaceae spp on broad depressions in the sub humid zone.

3. The Western Grey Kangaroo

3.1. Biology and Ecology

The Western Grey Kangaroo (*Macropus fuliginosus)* (WGK) is a grazing herbivore, which feeds on grasses and herbs as well as improved pastures and crops. In forest and woodland habitats, they rely on browse from native shrubs (DEC, 2009). Their colouring is variable, ranging from greyish-brown to darker chocolate brown. WGKs differ from other larger kangaroos in having a hairy muzzle, with fine hairs in the area between the nostrils and upper lip (Kirsch, et al, 1972).

Adult WGK can range in height from 97cm to 223cm and typically weigh between 30 – 70 kg (Pople and Grigg, 1999, DEC, 2009). Females are smaller than the males, weighing up to 34 kg. The females have been recorded to live for more than 20 years and become sexually active at 18-20 months of age (Pople and Grigg, 1999).

Breeding occurs seasonally from late November to early February each year. Unlike other kangaroos, WGK respond to drought by ceasing breeding until conditions improve. They do not retain embryos in a dormant state in the uterus and in very dry conditions, they do not come into oestrus (DEC, 2009)

Western Grey Kangaroos have a social organisation and many of their home rages overlap (Southwell, 1984, DEC, 2009). Food availability seems to play a larger role in the distribution of females, while males have home rages that are usually larger than, and overlap those of females (Jarman and Southwell, 1986).

After resting in the shade during the day, they move out into the open to graze from late afternoon to early morning. The home range has been measured at 30-200 hectares, but in larger pastoral areas this may be much larger (DEC, 2009).

3.2. Habitat and Distribution

WGKs occur in open forest, coastal heathland, mallee scrubland and woodlands where rainfall exceeds 250mm. The principle strongholds of the species are the State Forest and timber reserves in the Jarrah and Karri areas in the SW of the state.

Seasonal or winter rainfall appears to be the major element that effects the distribution of WGK (Caughley, et al, 1987). The species is distributed throughout the southern areas of Australia, from the forest and scrub areas of Western Australia, the southern South Australia, Western New South Wales, Southern Queensland and Western Victoria. The species prefers dense areas of cover to open grasslands.

3.3. Conservation Status

The WGK is one four large kangaroo and wallaroo species that occur in WA. Changes to the natural environment since European settlement, such as urban and agricultural development, have significantly changed both the distribution and abundance of many macropod species in WA. Six species of macropod are listed as "rare or likely to become extinct" under the WA *Wildlife Conservation Act, 1950*, and four species are listed as "presumed extinct".

The Western Grey Kangaroo is considered common and abundant in WA and is not listed as threatened under either State or Commonwealth legislation.

Larger bodied kangaroos have generally been advantaged by European settlement, whereas smaller wallabies and bettongs have been negatively impacted. Table 1 show that there have been wide variations in the overall population of WGK in Western Australia over the past nine years.

Table 1: Population estimates of Western Grey Kangaroos in Western Australia (2005-2013)

Year	Population Estimate
2013	1,336,939
2012	749,709
2011	1,177,534
2010	1,407,376
2009	1,653,464
2008	1,264,929
2007	1,893,295
2006	1,412,700
2005	1,476,500

Source: DE, 2014.

A reduction in predation following the establishment of dingo baiting programmes, within the sheep rangelands areas, the construction of dingo-proof fences and the provision of additional areas of pasture and water sources are the most likely causes of population increases (Pople and Grigg, 1999). Short and Grigg (1982) have concluded that the WGK while being advantaged by pastoralism, is disadvantaged by more intensive agricultural activities (such as those found in the SW of Western Australia).

Kangaroos, however, are naturally prolific breeders, capable of increasing their population fourfold in five years, under good conditions (i.e. with plentiful food, habitat areas and water) (ADFAT, 1996).

While some kangaroo species have increases their distribution ranges, the WGK is confined to the southern areas of Western Australia and has not extended this range since European settlement (Caughley, *et al*, 1984).

3.4. Current Management in WA

The Western Grey Kangaroo is protected under the WA *Wildlife Conservation Act, 1950*, which is administered by the Department of Parks and Wildlife (DPaW)

The species is also a declared pest of agriculture under the provisions of the *Agriculture and Related Resources Protection Act, 1976*, administered by the WA Department of Agriculture and Food.

A management program for WGK is administered by DPaW and was introduced to the State in 1971. The plan meets the requirements of the Commonwealth's

Environmental Protection and Biodiversity Conservation Act, 1999 and *Regulations* as well as State legislation.

The aim of the Western Australian WGK Management Plan is to prevent unacceptable damage to agriculture, whilst ensuring the long-term viability of kangaroo populations, including those at the local community level. It also aims, where possible, to manage kangaroos as a renewable resource without compromising the conservation of the species. The plans also look at measures to contain the deleterious effects of WGK on other land management values such as biodiversity and conservation assets.

Commercial harvesting quotas for WGK are determined annually by reviewing population trends, past seasonal conditions and land use trends. Yearly aerial surveys are conducted to determine the species abundance and distributions (Table 1).

4. Methodology

4.1. Survey Zones

The previous WGKMP (Coffey, 2008) subdivided the site into seven zones for survey purposes. Zones 3 and 4 from this plan have been mostly developed, while Zones 1, 2, 5, 6 and 7 are still primarily paddocks with some areas of native vegetation. Map 4 shows the location of the survey zones which apart from some changes on the eastern boundaries of Zone 7, are the same as the previous plan's zones to enable comparison.

In order to enable a comparison with the previous plan (as requested by DPaW) these zones have been used in this latest survey.

Zone 1 is the easternmost area, and is delineated by farm fencing apart from the western boundary where Cable Sands Road is the boundary. Zone 2 is the southern zone and is separated from the northern zones by a gravel road used by the developers for machinery and vehicle movement. Zones 5, 6 and 7 are the northern most areas and are delineated by paddock fences.

As part of the previous management plans recommendations, kangaroo exclusion fencing was placed around the areas of development to try to inhibit the movement of kangaroos into the construction area. While the boundaries of this fence has moved to enable the development to progress, a 1.5m ring-lock fence has been

maintained and has been re-established as part of the current development phases (Figure 1). The location of the fencing is shown in Map 4. This fence, as at June 2015, is continuous along the southern boundary of Zone 5, the eastern boundaries of the current Zone 7 and 2. It is along the southern boundary of Zone 2 and segregates Zone 1 from the rest of the survey areas. Within Zones 5, 6 and 7 standard post and wire fencing exists and as such free movement of kangaroos within these areas can occur. The western and southern boundary of Zone 5 has a post and rail fence with cyclone mesh lower to prevent movement of kangaroos into the school or urban areas (Figure 2)

4.2. Kangaroo Pellet/Scat Counts

Arnold *et al* (1992) developed a survey technique based on counting the scats (droppings) of kangaroos and relating this to the abundance of animals. Pellet count data were recorded in 100m long by 1m wide transects, physically delineated by fence droppers and tape. Mean pellet densities per $100m^2$ along each transect were calculated. The mean pellet counts were used to determine the mean kangaroo density along the transect using the relationship of 100 pellets per 100 m^2 being equivalent to a kangaroo density of 0.1 kangaroos per hectare (as described in Arnold *et al,* 1992 and Bamford Consulting Ecologists, 2006). The mean value was then multiplied by the total area within that zone to provide an estimate of the resident kangaroo population.

Two transects were established in each zone and each transect was counted by at least two individual consultants. The location of each of the pellet transects are shown in Map 4.

4.3. Transect Surveys

Direct counts, via a walked transect, were conducted on six occasions between 12th May and 12th June 2015. These were conducted by at least two surveyors between 5pm and 6.45pm on the survey evenings. After a number of trial surveys, pre-dusk surveys were found to be the most efficient as the animals were easier to count using binoculars in the larger open paddocks. Spotlight transect searches resulted in the disturbance and scattering of the populations, which meant that duplicate counting could not be effectively eliminated and this information was ultimately disregarded.

The surveys involved traversing a pre-determined transect that allowed the direct observation and counting of animals in each zone within the site. The surveys were

walked in a manner to try to prevent startling the animals, particularly within Zones 5, 6 and 7, where free movement between the zones was able to occur. The two operator's tallies were averaged to determine the population within that survey zone. The same route was followed for each of the survey events.

The time spent during the surveys was considered sufficient to adequately survey the site.

4.4. Analysis

Pellet counts were analysed as the number of pellets per 100m of transect, with the results being categorised into four densities (Table 2: Bamford Consulting Ecologists, 2006). The densities of pellets were then used to estimate WGK density based on the density per ha figures described in Table 2. These are shown in Table 2.

Table 2: Pellet Count Density Classifications

Classification	Pellets per 100m	Density per ha
Low	0-99	0 - 0.09
Medium	100-155	0.1 – 0.155
High	156-299	0.156 – 0.299
Very High	300 ≥	>0.299

Source: Bamford Consulting Ecologists, 2006

Direct survey counts for WGK per zone were determined during the transect surveys. This was then converted into a density of kangaroo per hectare for each of the survey zones.

To determine whether the observed density of WGK within the project site was higher than that of a sustainable population, the observed data were compared with the natural population densities discussed by Short and Grigg (1982) and Short, *et al,* (1983)) (Table 3). These discussed population densities are based upon habitat type, primarily Eucalypt Woodland and Agricultural. The area of each of these habitat types for each zone was calculated and a suggested sustainable population of WGK within each zone determined by multiplying the available habitat type area by the suggested mean density of a sustainable population.

Table 3: Natural Population Densities of WGK within different habitats

Habitat Type	Mean density (per ha)	Reference
Eucalypt Woodland	0.0124	Short, *et al* (1983).
Agricultural	0.4357	Short & Grigg (1982)

4.5. Limitations

The development site has progressed significantly since the previous survey. The bulk of the western area is now urban development, with significant vehicle movements and people. This would have changed some aspects of kangaroo behaviour and movement within the remainder of the development site. This would also impact on the availability of resources for kangaroos on the site.

The progress of the development means that some of the previous zones for survey are not exactly the same, however the survey was designed to enable a suitable basis for comparison.

The location of the exclusion fencing has changed since the previous surveys and report. Combining this with the urban expansion on the site would have resulted in a smaller area available for the resident kangaroo population.

Water was plentiful during the survey and with the number of water source within the development area. This is the case throughout the year.

Food sources within the remainder of the development site were abundant, with pasture grasses as well as herbage within the bushland areas providing adequate food resources for the resident population.

The population within the project area is considered to be an "open" population that can move into, and out of, the project area and neighbouring properties. While there are exclusion fences in place as well as electronic fences, farming post and wire as well as post and rail cyclone fencing, there are still some breaches in all of the fence that would enable animals to move thorough the landscape, albeit at only particular points. It is acknowledged that the kangaroos can move between zones and that the zones delineated are only an arbitrary separation for management purposes. As kangaroos can freely move between zones, particularly within Zones 5, 6 and 7, some

may have been counted twice during the surveys, however the survey design was changed to minimise this.

There is a large area of remnant vegetation on the north eastern corner of the development site. Flushing of kangaroos out of the vegetation areas on this section was not possible and it is likely that additional numbers of animals were not grazing in the paddocks at the time of survey. The post dusk time period was used to try to minimise this likelihood. In the other bushland areas, surveyors walked through these to flush out any kangaroos before the walked transects were conducted.

Even with the above limitations, it is generally acknowledged that direct counts of kangaroos generally only account for 30-40% of the total population, therefore the actual population is likely to be significantly larger that reported in these results.

5. Results & Analysis

5.1. Pellet Counts

Table 4 shows the pellet counts and the resulting mean density and mean number of kangaroos in each zone, based on this approach.

Table 4: WGK Pellet counts within the survey area

Zone	Mean number of pellets/100m (Range)	Area (ha)	Mean density of kangaroos per ha (range)	Mean number of kangaroos (range)
Zone 1	118 (110-127)	23.5	0.12(0.11-0.13)	2.82 (2.59-3.06)
Zone 2	334 (316-344)	33.4	0.34 (0.32-0.35)	11.36 (10.69-11.69)
Zone 5	585 (565-617)	17.1	0.59 (0.57-0.62)	10.09 (9.75-10.61)
Zone 6	807 (749-854)	22.2	0.81 (0.75-0.86)	17.99 (16.65-19.1)
Zone 7	517 (501-532)	24.0	0.52 (0.5-0.53)	12.48 (12-12.72)

Using the categories of Bamford (2006), Zone 1 would be classified as Medium Density and all the other Zones would be classified as Very High.

Note that there is uncertainty and debate on the relationship between kangaroo and scat density in different environments (Bamford, 2006, Bamford, 2014) and the figure should be used as a relative measure of kangaroo density within the site rather than absolute. This is discussed in more details below in Section 6.

5.2. Direct Count Transects

Table 5 shows the results from the direct count walked transects.

Table 5: Numbers of WGK In Project Area From Direct Counts

Zone	Mean number of kangaroos (Range)	Area (ha)	Mean density of kangaroos per ha (range)
Zone 1	2.8 (0-11)	23.5	0.12 (0-0.47)
Zone 2	22.4 (14-34)	33.4	0.67 (0.42-1.02)
Zone 5	16.8 (7-30)	17.1	0.99 (0.41-1.76)
Zone 6	76.2 (63-97)	22.2	3.44 (2.84-4.37)
Zone 7	84.6 (57-107)	24.0	3.53 (2.38-4.46)
TOTAL	202.8 (141-279)		

The numbers of WGK ranged from 0 to 11 kangaroos in Zone 1, 14-34 kangaroos in Zone 2, 7 to 30 animals in Zone 5, 60-97 animals in Zone 6 and between 57 to 107 kangaroos in Zone 7. Note that animals are free to move between Zones 6 and 7, however care was taken to minimise movement between the two paddocks at the time of survey. These zones also directly adjoin a large remnant bushland area on the neighbouring property and it was not possible to flush animals out of this area at the time of the survey.

Most of the kangaroos were consistently found in the cleared paddock areas of Zones 6 and 7 and the lowest abundance area were in the Zone 1. The animals in Zone 1 are free to move to the east and south of the site. Also there were livestock in Zone 1 during each survey, which may have influenced kangaroo numbers.

The population densities were similarly highest in Zones 6 and 7 (Table 5). The overall observed kangaroo population throughout the site ranged from 141-279, with a mean of 203 animals.

Natural populations densities discussed by Short and Grigg (1982) and Short *et al*, (1983) were compared with the survey results. The natural population densities for the habitat types within the project area are shown in Table 3 and the estimated sustainable populations for each zone, based on these data are summarised in Table 6.

Table 6: Estimate of Sustainable Populations within Zones Based on Literature Review

Zone	Vegetated Area (ha)	Pasture Area (ha)	Estimated kangaroo capacity of vegetation	Estimated kangaroo capacity of pasture	Total estimated sustainable capacity of Zone
Zone 1	1.1	22.4	0.02	9.76	~9-10
Zone 2	1.1	32.3	0.02	14.08	~14-15
Zone 5	6.8	10.3	0.09	4.49	~4-5
Zone 6	1.98	20.2	0.03	8.81	~8-9
Zone 7	3.6	20.4	0.05	8.89	~8-9
TOTAL					~43 - 48

6. Discussion

Overall, the pellet counts gave a much lower estimate of kangaroos densities compared to the direct counts, apart from Zone 1, which has a comparable estimate of density to the direct count.

Bamford Consulting Ecologists (2006) found that pellet counts significantly underestimated the number of kangaroos with Whiteman Park during their 2005 surveys. It is generally considered that direct counts are a more reliable estimate of kangaroo density (Southwell, 1994), as pellet counts can be affected by a number of different factors such as the choice of transect location and the amount of ground cover making pellets more difficult to see. Therefore, the conclusions and recommendations within the Management Plan are based on the densities recorded from the direct counts.

The reduced number of kangaroos observed in Zone1 is likely to be due to the presence of livestock in the paddock and the probability that animals have moved to other areas to the east and south as they have open availability to move to these areas.

The bulk of the animals are based in Zones 6 and Z as they have free movement between the two zones, as there is only a post and wire fence separating them.

Western Grey Kangaroos prefer ecotones where substantial areas of forest provide cover and there are nearby open grassy feeding grounds (Short and Grigg, 1982). The areas in Zones 6 and 7 meet this preferred habitat type.

The WGKs do not appear to be limited by the availability of fresh water, as this is freely available throughout the property. The paddocks are also providing adequate food resources as the bulk of kangaroos around Zone 6 and 7 were observed resting in the paddocks around 10 am in the morning (Figures 3 4), indicating that they have had adequate food resources and do not need to continue grazing through the day.

Table 7 shows the density from the previous surveys conducted by Coffey Environments and the current population counts. Note that the previously constructed exclusion fence separated zones in 2008 surveys. For ease of comparison, the numbers from the previous surveys have been combined and averaged to allow for some form of comparative analysis.

Table 7: comparison of 2008 and 2015 data

	2008 Report Data			May/June 2015 Data
Zone	**12/12/2006**	**13/12/2006**	**14/12/2006**	**Average observations**
Zone 1	0	0	0	3
Zone 2	7	8	1	22
Zone 5	9	4	4	17
Zone 6	3	2	4	76
Zone 7	7	12	0	85

From this analysis, the numbers of kangaroos has increased substantially in Zones 2, 5, 6 and 7. The highest rate of increase has occurred in Zones 6 and 7 likely due to the location of the remnant vegetation nearby to provide shelter as needed.

The population density estimated gained during the survey indicate that the population densities within Zone 1 is within those recorded in natural, sustainable populations (Table 6). Estimates reveal that the capacity of Zone 1 would be 9-10 animals. The direct counts indicate an average number of 3 animals varying between 0 and 11.

Based on the density of naturally sustainable populations (Table 6), Zone 2 could support around 14-15 animals. The observed density of animals in these zones is higher than this figure, with the lowest number recorded being 14.

Zone 5 could support a natural population of 4 – 5 animals and this is exceeded with observations averaging 17, with numbers of up to 30 having been recorded.

Zones 6 and 7 could support approximately 8-9 kangaroos with a sustainable natural population. In both these zones the numbers of kangaroos significantly exceed these levels by 8 to 9 times.

Appropriate management measures are therefore necessary to control the population of WGK within Zones 2, 5, 6 and 7 within the project area. This pressure on the kangaroo population is likely to increase as the development expands and the area available to the kangaroos will reduce which could significantly change their behaviours. Consequently this will place additional pressures on an already unsustainable local population.

7. Western Grey Kangaroo Management Plan

7.1. Management Objectives

The developer is committed to preparing and implementing a Western Grey Kangaroo Management Plan.

The objectives of this management plan are to:

- Protect Western Grey Kangaroos during all construction activities associated with the proposed development; and
- Provide short-term and long-term strategies to control the Western Grey Kangaroo population within the project site, in order to reduce the impacts on remnant vegetation and to minimise the potential health and safety risks for both the public and the long term Western Grey Kangaroo populations within the development.

7.2. Management Targets and Indicators

Targets and indicators for this Management Plan are designed to monitor the progress of the plan and to confirm that an appropriate level of performance has been maintained during the implementation of the plan. The performance indicators of this management Plan are:

- Adherence to all statutory requirements relating to the protection of wildlife;
- No reported injuries or deaths to kangaroos within the construction areas of the site;
- Kangaroo numbers will be maintained at sustainable populations levels based on densities published in the literature (Table 3).

7.3. Management Strategies

To ensure that these objectives are achieved, a number of management strategies are proposed.

- Protection of Western Grey Kangaroos during construction activities;
- Control of current and future Western Grey Kangaroo populations density; and
- Review of the Management Plan.

7.4. Protection of Western Grey Kangaroos during the construction activities.

All staff on site will be required to be briefed on measures to minimise the impact to WGKs during construction. This will include details on the location of sensitive habitat areas to be avoided and actions to be taken if any fauna is encountered. If any native fauna, including WGKs, are encountered, they should be allowed to make their own way from the works area. If this is not possible, an appropriately qualified person (such as a zoologist, ecologist, or veterinarian) will be required to remove the animal to a safe area. If any injured or dead fauna are encountered, the Contractor, should notify the proponent and the DPaW (Busselton Office – 9752 5555, an after hour contact number will be provided on this number, should it be required).

STRATEGIES

A. *All staff, contractors and other personnel working on the development site will be educated and briefed on the values and management of native fauna within the site.*

B. *A ring lock exclusion fence approximately 1.5m high, should be temporarily installed around construction areas, on a stage by stage manner, to prevent kangaroos from entering those areas during construction.*

C. *Construction vehicles should be retained within the footprint of proposed earthworks or on designated access routes. Vehicle speeds will be kept to a maximum of 40km/hr.*

D. *No pets or traps will be brought onto site by construction staff.*

E. *The work area will be maintained in a clean and tidy manner to ensure that feral or other animals are not attracted to the site.*

F. *If native fauna are encountered during construction, it will be allowed to make its own way from the works area. If this is not possible, a relevant specialist will be contacted to remove it.*

G. *If any injured fauna are encountered, the Contractor will contact DPaW Wild care 24hr hotline on (08) 9474 9055, DPaW Busselton Office on (08) 9752 555 or a local vet. If dead fauna are encountered this will be recorded along with the species and sex (if known) and reported to DPaW and the site project manager.*

7.5. Kangaroo Population Management Strategy

It is generally considered that long term maintenance of WGK populations associated with remnant bushland areas within residential subdivision are likely to create further issues of unsustainable numbers of kangaroos. Unsustainable kangaroo numbers are likely to result in increased grazing pressures on vegetation, and greater potential for kangaroo and human conflicts.

The numbers of kangaroos currently present within the development site are above published sustainable population's densities and it is doubtful if these densities can be sustained without significant impact to the animals themselves, the remnant vegetation, the residential development and people within it.

Options for reducing the impact of WGK can include the limiting of food and water areas, utilising fencing and gates and noise generating devices (DEC, 2009). None of these options are considered feasible within the project area given the open nature of the populations, the surrounding land use and the residential areas within the site. Therefore control of the existing population is considered to be necessary as a management strategy for the proposed development.

Two possible strategies to control WGK numbers are:

- Relocation of kangaroos; and
- Commercial harvesting.

Relocation of kangaroo is one measure that has been implemented in the past to control WGK number. However, the relocation of kangaroos through darting and cartage for this development is not considered viable due to the large costs involved, lack of proven success and the lack of areas available to relocate the kangaroos.

Given that the estimated population densities within Zones 2, 5, 6 and 7 are higher than are sustainable, and that the proposed development is likely to increase the pressures on the populations, commercial harvesting of kangaroos as a management strategy to control population numbers should be considered.

Based on the data within Tables 3 and 6, Zone 1 could sustain up to 10 kangaroos. From the transect survey data, these zones appear to contain numbers under this and are therefore considered to be within a sustainable natural population level. Future monitoring of these zones will be required to determine any changes in this population size during the development process.

Table 8 shows the numbers observed within each zone, the estimated sustainable natural population level and the recommended reduction in numbers to achieve a sustainable population within each zone.

Table 8: Recommended Numbers of Kangaroos to be removed.

Zone	Current Population estimate	Sustainable Population estimate	Range of animals to be removed to reach sustainable population	Recommended Reduction in population
2	22.4 (14-34)	15	0-19	10
5	16.8 (7-30)	5	2-25	12
6	76.2 (63-97)	9	54-88	72
7	84.6 (57-107)	9	48-98	73
TOTAL			**104-230**	**167**

Based on the minimum and maximum numbers recorded in these zones during the transect surveys, between 104 and 230 kangaroos would need to be culled to reach sustainable numbers. A conservative population reduction of 167 based on the results in Table 8 is recommended initially. This number can then be revised after the first annual WGK monitoring survey.

Culling needs to be undertaken in consultation with the DPaW and conducted by a licensed shooting contractor, and after liaison with the current residents within the development site.

It is recommended that the animals are removed progressively, over three sessions between September and November 2015, with approximately 20-40 animals removed each session.

On the conclusion of the final session, the site will be resurveyed over a minimum of 3 nights to determine new animal densities and population distributions over the site. This information will be forwarded to DPaW for assessment to determine if any additional animals are required to be removed.

It is considered that on-going culling may be required to maintain the WGK population

at a sustainable level based on population densities from the published literature and as discussed with DPaW. The pressure on populations will also increase as the area of suitable kangaroo habitat is reduced as the development progresses. It is recommended that WGK surveys should be conducted annually as part of the review process for this management plan (See 7.6). Any further recommended culls are to be calculated annually from this ongoing survey effort and based on the remaining available habitat areas.

STRATEGIES

H. *Establish a culling programme, in consultation with the DPaW and licensed shooters to cull up to 167 kangaroos based on natural population estimates calculated by Short and Grigg (1982) and Short et al (1983). This culling programme will conducted over three sessions from September to November 2015 by the property manager. This will be conducted in a staged manner to allow animals dispersed from a shooting event to reinhabit the pasture areas the animals. It would be estimated that 20-40 animals will be removed per shooting event, however this many be increased if circumstances allow. The main area of focus will be Zones 6 and 7, however other zones may be targeted if opportunities exist.*

I. *After the third and final shooting session, the site will be resurveyed and the animal densities and populations will be reviewed. The results of this analysis will be provided to the Department of Parks and Wildlife for assessment.*

J. *Conduct an annual WGK survey programme as part of the management plan review process to monitor population levels up to three years post construction.*

7.6. Review of the Management Plan

The management strategies prescribed in this management plan are intended to be dynamic and flexible to allow for them to respond to changes in the environment, habitat and community values and behaviour.

The proponent will track the implementation of the management strategies to enable:

- Revision of the management strategies, as needed;
- Identification of management issues and trends; and
- Review and update of the management plan, if necessary.

This review strategy will ensure that the objectives of the management plan will be achieved thought an adaptive management process that allows for re-evaluation of outcomes based on circumstantial changes and new management techniques and strategies.

The proponent will review the management plan every 12 months and the finding of this review will be provided to the DPaW.

STRATEGIES

K. *A review of the management plan will be conducted every 12 months until 3 years post construction and the finding of this review will be provided to the DPaW.*

TABLE 9a: MANAGEMENT STRATEGIES REQUIRED TO SATISFY THE OBJECTIVES OF THE MANAGEMENT PLAN

Objective 1			
• **Protect Western Grey Kangaroos during any construction activities associated with the proposed development**			
Targets			
• **100% Compliance** • **No reported injuries or deaths of kangaroos within the construction site**			
Performance Indicators			
• **Compliance with the WA *Wildlife Conservation Act 1950* and other relevant legislation** • **Number of reported injuries and deaths to kangaroos**			
Actions	**Responsibility**	**Priority**	**Timing**
A. ***All staff, contractors and other personnel working on the development site will be educated and briefed on the values and management of native fauna within the site.***	Developer	HIGH	Prior and during construction
B. ***A ring lock exclusion fence approximately 1.5m high, should be temporarily installed around construction areas, on a stage by stage manner, to prevent kangaroos from entering those areas during construction.***	Earthwork Contractor	HIGH	During construction
C. ***Construction vehicles should be retained within the footprint of proposed earthworks or on designated access routes. Vehicle speeds will be kept to a maximum of 40km/hr.***	Earthwork Contractor	HIGH	During construction
D. ***No pets or traps will be brought onto site by construction staff.***	Earthwork Contractor	MEDIUM	During construction
E. ***The work area will be maintained in a clean and tidy manner to ensure that feral or other animals are not attracted to the site.***	Earthwork Contractor	MEDIUM	During construction
F. ***If native fauna are encountered during construction, it will be allowed to make its own way from the works area. If this is not possible, a relevant specialist will be contacted to remove it.***	Earthwork Contractor	HIGH	During construction
G. ***If any injured fauna are encountered, the Contractor will contact DPaW's Wild Care 24hr hotline on (08) 9474 9055, DPaW Busselton Office on (08) 9752 555 or a local vet. If dead fauna are encountered this will be recorded along with the species and location, and reported to DEC and the site project manager.***	Earthwork Contractor	HIGH	During construction

TABLE 10b: MANAGEMENT STRATEGIES REQUIRED TO SATISFY THE OBJECTIVES OF THE MANAGEMENT PLAN

Objective 2			
• **Provide short-term and long-term strategies to control the Western Grey Kangaroo population within the project site in order to reduce the potential health and safety risks for both the public and the long term Western Grey Kangaroo populations and to decrease the impacts on remnant vegetation within the development.**			
Targets			
• **Kangaroo numbers will be maintained at sustainable population levels based on densities published in the literature**			
Performance Indicators			
• **Number of kangaroos within the development**			
Actions	**Responsibility**	**Priority**	**Timing**
H. ***Establish a culling programme, in consultation with the DEC and licensed shooters to cull up to 167 kangaroos based on natural population estimates calculated by Short and Grigg (1982) and Short et al (1983)). This culling programme will conducted over three sessions from September to November 2015 by the property manager. This will be conducted in a staged manner to allow animals dispersed from a shooting event to reinhabit the pasture areas the animals. It would be estimated that 20-40 animals will be removed per shooting event, however this many be increased if circumstances allow. The main area of focus will be Zones 6 and 7, however other zones may be targeted if opportunities exist.***	Developer	HIGH	Prior to completion of construction.
I. ***After the third and final shooting session, the site will be resurveyed and the animal densities and populations will be reviewed. The results of this analysis will be provided to the Department of Parks and Wildlife for assessment.***	Developer	HIGH	After third culling event.
J. ***Conduct an annual WGK survey as part of the management plan review process to monitor population levels up to three years post construction.***	Developer	MEDIUM	Annually for management period of three years after construction.
K. ***A review of the management plan will be conducted every 12 months until 3 years post construction and the finding of this review will be provided to the DPaW***	Developer	MEDIUM	12 months after acceptance of Management Plan.

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9. Figures



Figure 1: 1.5m Ringlock Exclusion Fencing



Figure 2: Post and Rail and wire fence to the east and south of Zone 5

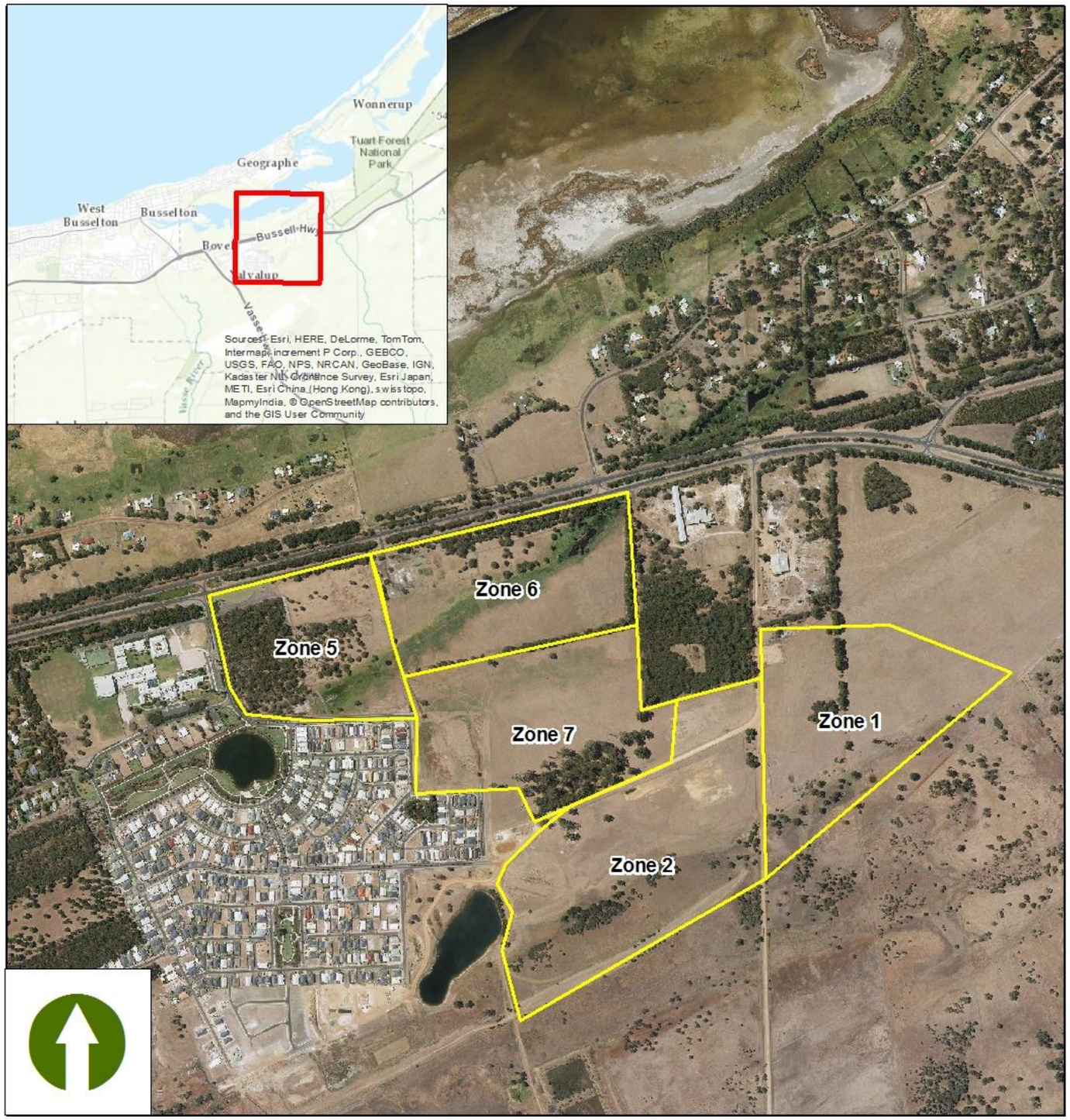


Figure 3: Kangaroos feeding/resting in Zone 6/7



Figure 4: Kangaroos in Zone 6

10. Maps



Map 1	Site Location
Site	Provence Estate
Project	Kangaroo Management Plan
Client	Satterley Property Group
Scale	1: 10,000

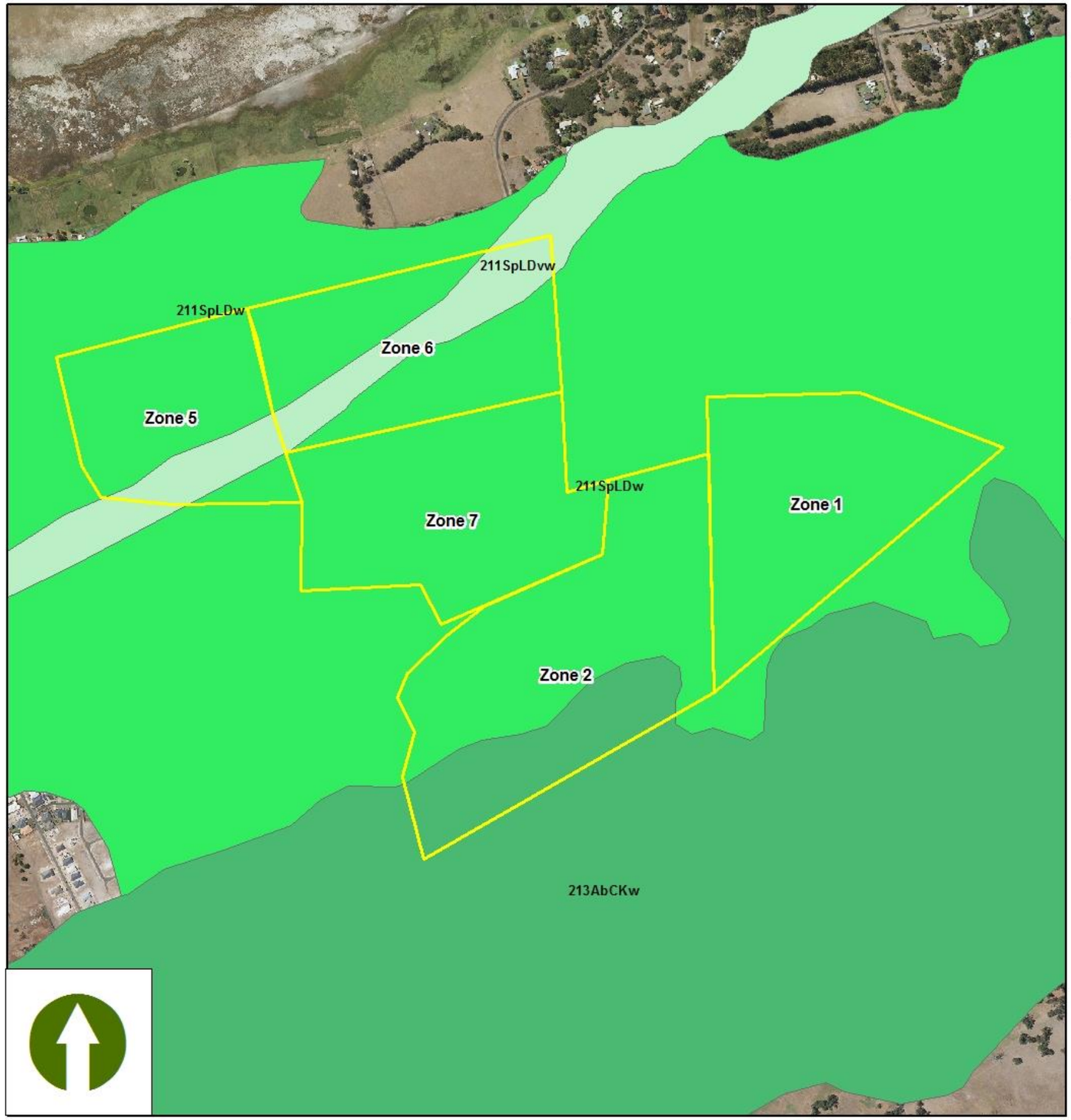
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Survey Areas within Development

0 135 270 540 810

Metres

Prepared by Gary McMahon
Ecosystem Solutions
June 2015
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
This map is for planning/discussion purposes only.



Map 2	Soil Landscapes
Site	Provence Estate
Project	Kangaroo Management Plan
Client	Satterley Property Group
Scale	1: 8,000

Legend

Survey Areas within Development

Soil Landscape Units

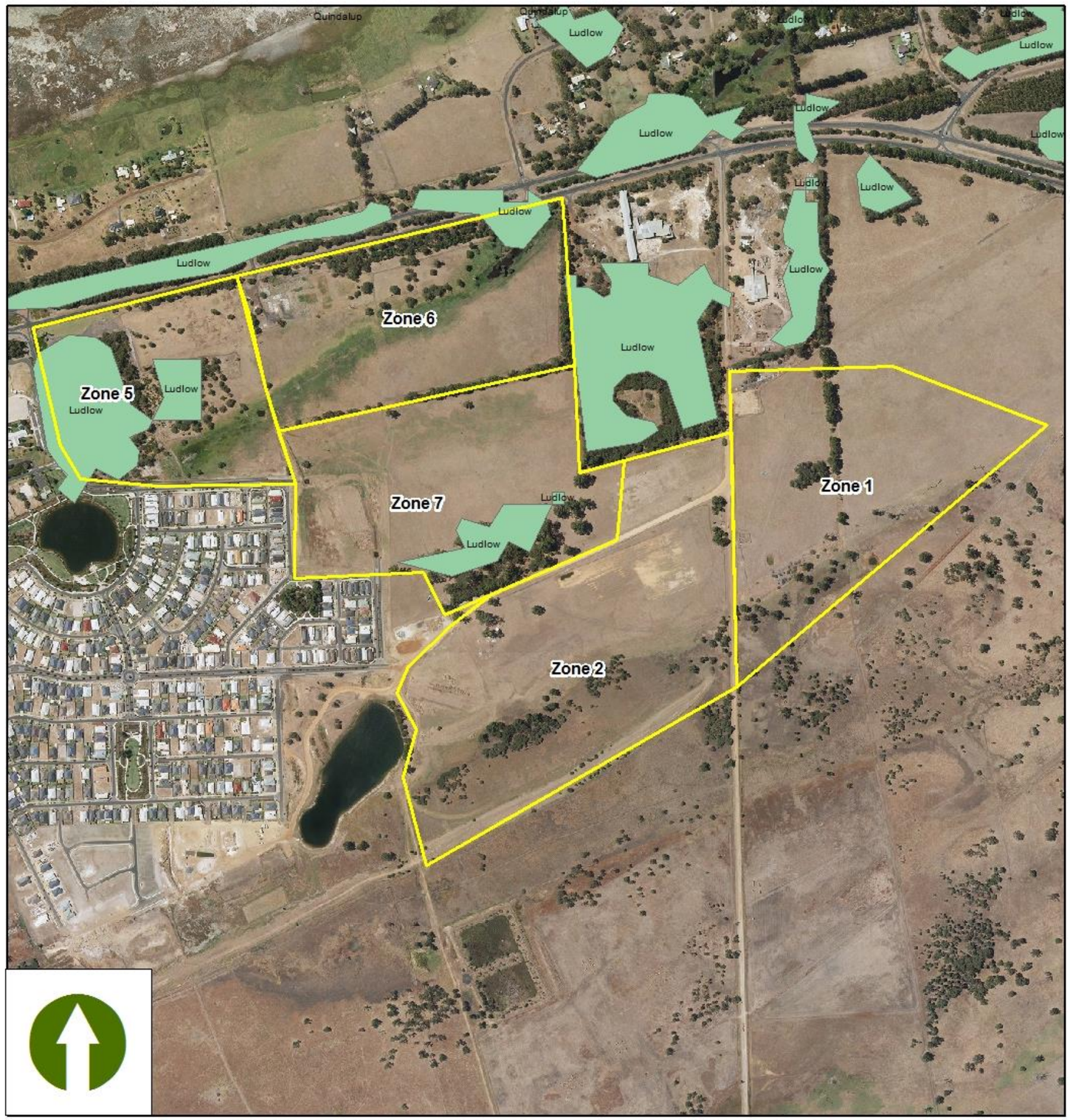
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- 211SpLDw
- 213AbCKw

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Metres

Prepared by Gary McMahon
Ecosystem Solutions
June 2015
Projection - MGA50
Datum - GDA94
The details on this map have not been surveyed.
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Map 3	Vegetation Complexes (RFA)
Site	Provence Estate
Project	Kangaroo Management Plan
Client	Satterley Property Group
Scale	1: 8,000

Legend

Survey Areas within Development

Vegetation Complex

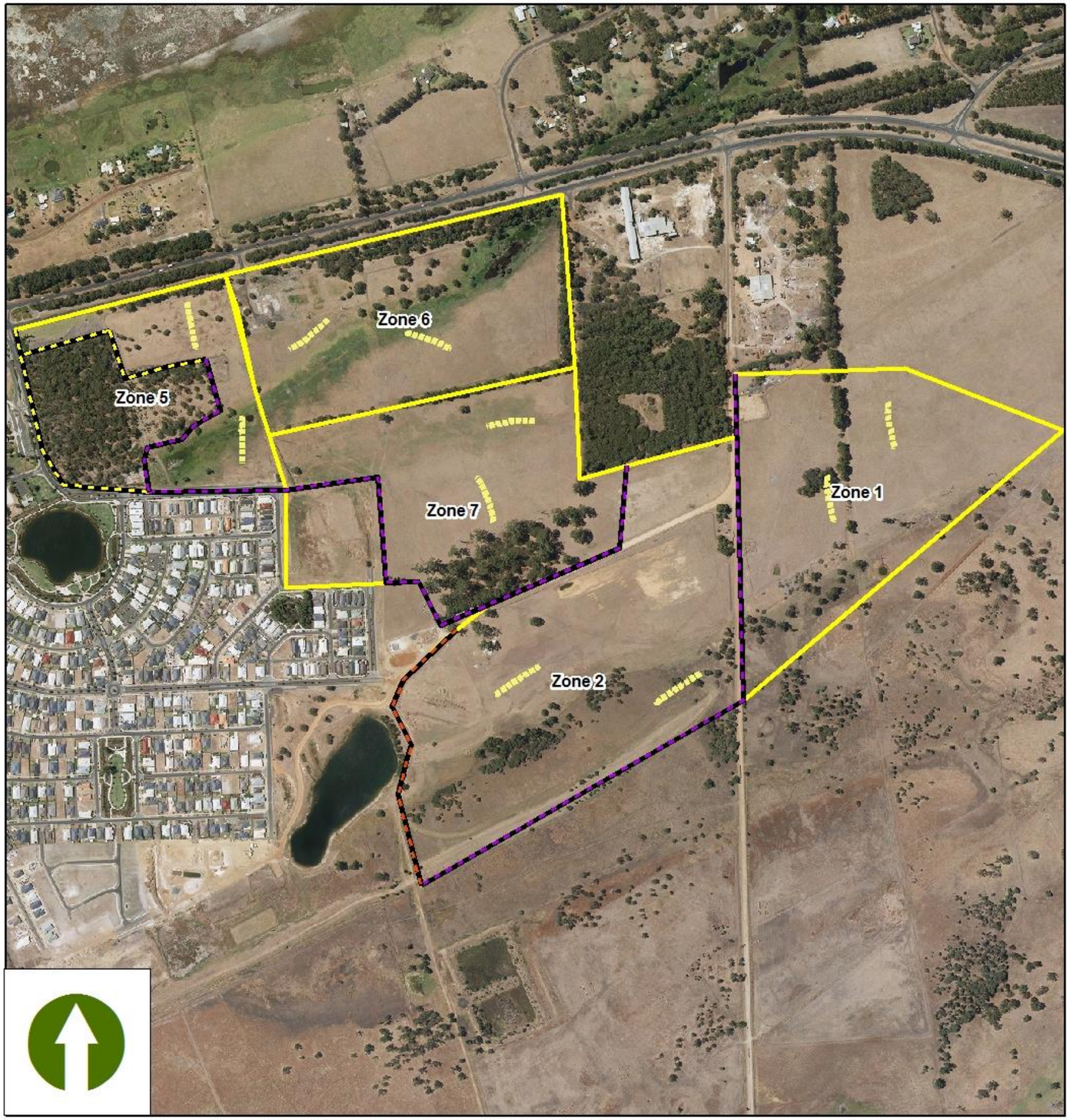
Ludlow (Lw)

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Metres

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Projection - MGA50
Datum - GDA94
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Map 4	Zones, Transects and Fencing
Site	Provence Estate
Project	Kangaroo Management Plan
Client	Satterley Property Group
Scale	1: 8,000

Legend

Survey Areas within Development

Scat Transects

Fencing

Electric Fence 1.2m

Exclusion Fence

Post/Rail Fence

0 100 200 400 600

Metres

Prepared by Gary McMahon
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Projection - MGA50
Datum - GDA94
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Appendix E
Landscape concept plan



PHASE 0. **LANDSCAPE STRATEGY**

LD TOTAL

FOR YOLK PROPERTY GROUP

JANUARY 2023

Project	EMBARK
Report Title	EMBARK Phase 0 - Landscape Strategy
Author(s)	LD Total - Landscape Architectural Department
Review By	Sheldon Day - Strategic Planning & Development Manager
For Client	Yolk Property Group Level 2 Atwell Arcade, 3 Cantonment St, Fremantle WA 6160
Issue Date	16.12.2022
File Location	U:\0PROJECTS\Embark (All Projects)\10.7096 Provence Estate - Phase 0\ 4 Tech work area\4.6 Embark_Phase0

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Document to be printed at A3 landscape double sided with binding to short side.

ISSUED FOR	REVISION	DATE
Issue A	DRAFT - For Review	2.12.2022
Issue B	DRAFT - For Review	16.12.2022

STRATEGY 0. **INTRODUCTION**
Framework + Objectives

STRATEGY 1. **BACKGROUND**
Local Context
Existing Site Character

STRATEGY 2. **LANDSCAPE VISION + MASTER PLAN**
Vision: Landscape Objectives + Place Drivers
Master Plan
Site Diagrams: Analysis + Strategies
CoB POS Hierarchy + Assets
Stormwater + Drainage

STRATEGY 3. **POS PRELIMINARY CONCEPTS**
POS 1-17 - High Level Concept Plan (for each POS)
Softscape Palette

STRATEGY 4. **STREETSCAPE**
Street Tree Master Plan
Streetscape Sections

STRATEGY 5. **IRRIGATION SCHEDULE**
Bore and Mainline Strategy
Overall Irrigation Schedule



The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.

Marcel Proust







Embark is an established estate located approx. 4km from Busselton, and 175km south from Perth Metropolitan Area.

The X hectare site, is one of the region's strategic urban infill site with impressive lake views, extension of existing Provence Estate, established and expanding new amenities for growing communities.

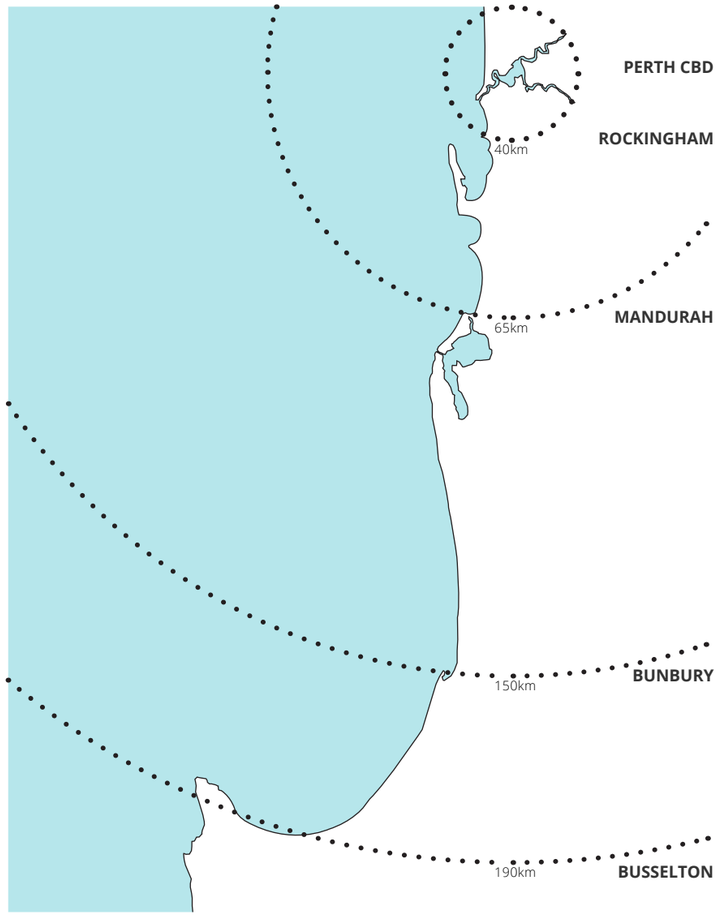
This Landscape Strategy sets a framework for Embark journey ahead, represents a relaunch of the estate under new management.

Unique site with existing trees results in the evolution of strong timeless guidelines.

OBJECTIVES
Embark Landscape Strategy is intended to be an overall guide to create a unique sense of place, focusing on engagement with natural wealth of Down South Region, while retaining connections with existing form and function of the site.

FRAMEWORK + OBJECTIVES

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SOUTH WEST CONTEXT



LOCAL CONTEXT

LOCAL CONTEXT

STRATEGY 1. BACKGROUND

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Embark will be a new strategic development within the City of Busselton. It is composed of significant public open spaces that will create a range of new social and community infrastructure to the region.

FLORA



FAUNA









EXISTING SITE CHARACTER

STRATEGY 1. BACKGROUND

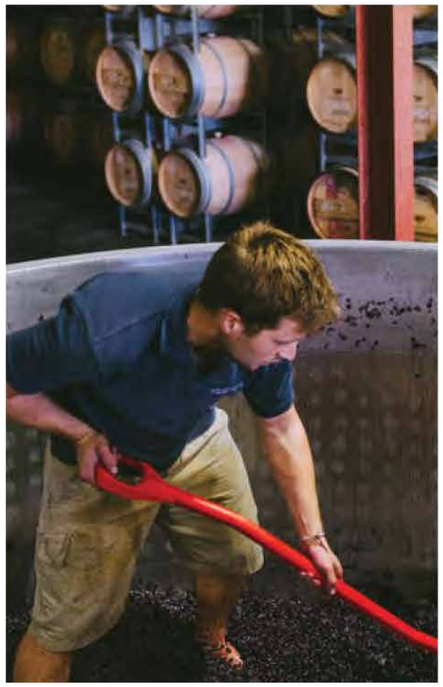
LD TOTAL

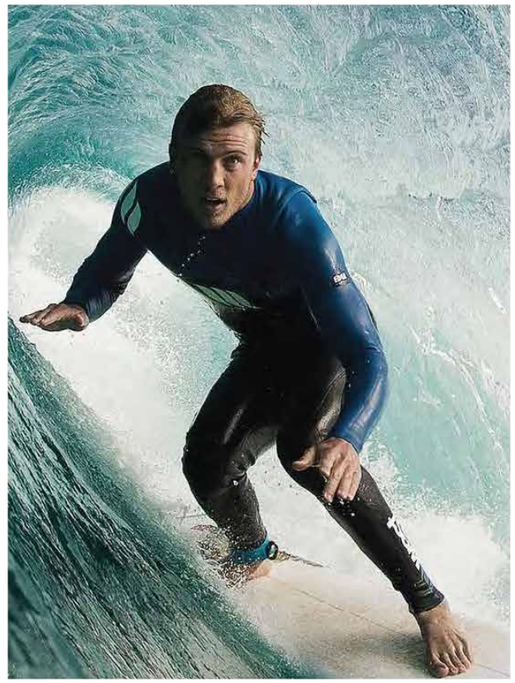
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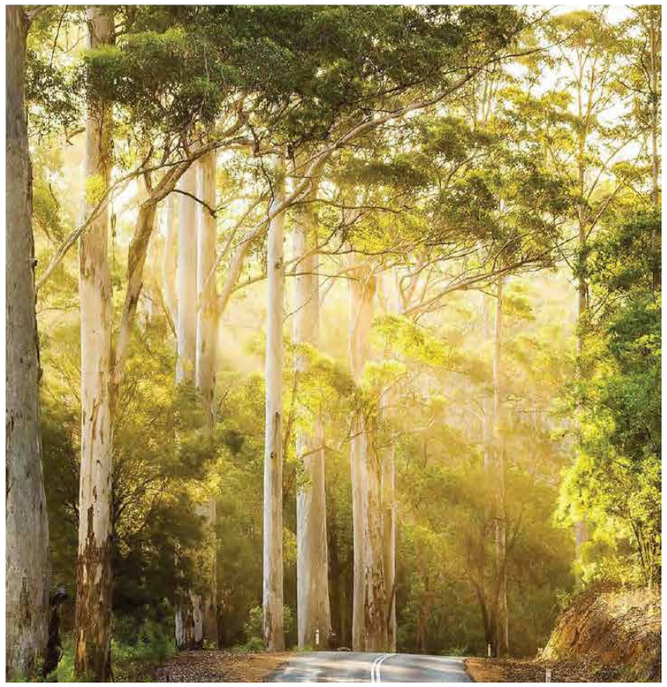












VISION: LANDSCAPE OBJECTIVES + PLACE DRIVERS

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Landscape Master Plan

Embark, Busselton

POS 4 / TOWNSQUARE

POS 4 | POS 16 | POS 1 | POS 2 | POS 15 | POS 5 | POS 7 | POS 6 | POS 3 | POS 8 | POS 16 | POS 10 | POS 9 | POS 11 | POS 12 | POS 13 | POS 14

BUSSELL HIGHWAY

OUTER BUSSELL HIGHWAY

VASSE HIGHWAY

JOSEPH DR

ALMOND BLVD

BALKANA

BLUM BLVD

AURELIAN AVENUE

MARSEILLES DRIVE

MARIGNY MEADOW

DIGONDAL ST

embark
BUSSELTON

Legend

1. Existing Public Open Space
2. Future Public Open Space
3. Landscape Buffer / Bund
4. Conservation Public Open Space
5. Open Water Body (Existing)
6. Sewer Pump Station
7. Creek and Seasonal Drainage Flow Corridor (opportunity for pedestrian network and crossings in Wetland and Conservation POS)

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton.
Road reserve boundary and existing trees to be confirmed with additional feature survey.

Public Open Space

- Turf
- POS Irrigated Shrub Planting
- Existing POS - Infill Tubestock Planting
- Drainage Basin Planting
- Landscape Buffer - Low Treat Vegetation
- Verge Planting
- Median Swale Planting
- Shade Structure
- Seating Node
- Playground
- POS Sports Facilities
- Formal Path Network
- Informal Path Network

Note: Pathway varies in width.

- Pockets of retain vegetation and significant individual trees where possible
- Proposed Roundabout Tree
- Proposed Boulevard / Median Tree
- Proposed Boulevard and Feature Avenue Trees
- Proposed Access Corridor Trees for Western Ringtail Possum Habitat
- Proposed Street Trees
- Proposed POS Trees

Land Use

- Proposed Future Residential Lots
- Supermarket/Specialties (Commercial)
- Townsquare (Commercial)
- Childcare (Commercial)
- Retirement Village
- Primary School (Public Purpose)

YOLK PROPERTY GROUP

LD TOTAL

CLIENT **YOLK PROPERTY GROUP** | PROJECT NO **10.7096** | REVISION **C** | DATE **16.12.2022** | SCALE **1:5000 @ A1**

0 50 100 250m

NORTH

SITE DIAGRAMS: ANALYSIS + STRATEGIES

Embark
Busselton

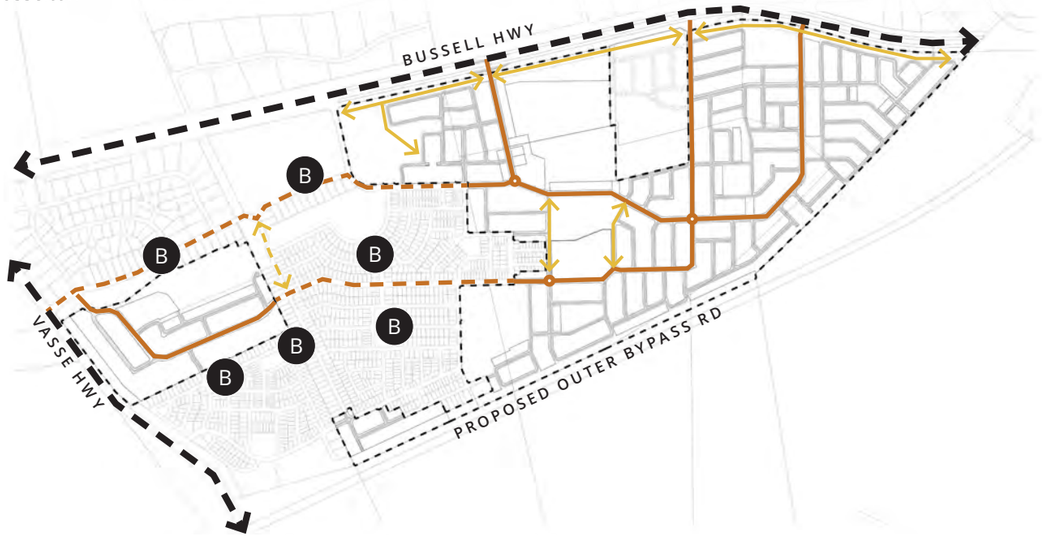


DIAGRAM 1. **STREET HIERARCHY + PEDESTRIAN / CYCLE STRATEGY**

- Existing High Traffic Roads
- Existing bus stop
- Existing Neighborhood Connector Roads
- Neighborhood Connector Roads
- Local Access Streets
- Proposed Key Pedestrian / cycle connection



DIAGRAM 3. **PUBLIC OPEN SPACE STRATEGY + KEY ENTRY POINTS**

- Commercial
- Town Centre
- Primary School co-located with DOS
- Child Care
- Retirement Village
- Sewer Pump Station
- Entry Statement - Main gateway
- Entry Statement - Artwork + Landmark
- Entry Statement - Wall + Signage
- Entry Boulevard - Green Spine / Link



DIAGRAM 4. **WESTERN RINGTAIL POSSUM AND GREY KANGAROO CORRIDORS**

- Western Ringtail Possum Habitat / Access Corridor
- Grey Kangaroo Habitat / Access Corridor
- Public Open Space
- Commercial and School Site

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POS LANDSCAPE TYPOLOGY

Embark
Busselton



NOTE:
Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

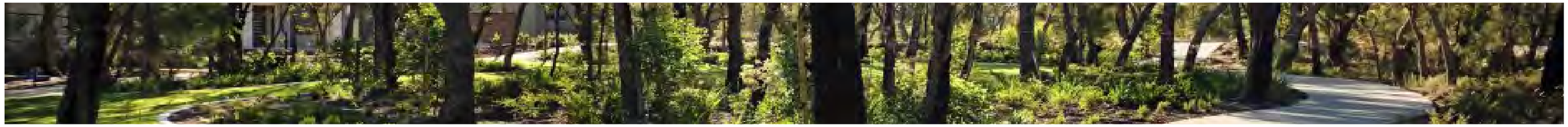
Existing POS
- Conservation POS
- District POS
- Neighborhood POS
- Local POS
- Landscape Buffer

Proposed POS
- Townsquare
- Conservation POS
- District POS
- Neighborhood POS
- Local POS
- Landscape Buffer

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POS HIERARCHY AND ASSETS

Embark
Busselton



CONSERVATION PUBLIC OPEN SPACES

KEY POINTS
- usually 1ha to approx 7ha in size
- Includes restoration areas along planted with native vegetation.
- Seating next to shared pathway invite the user to enjoy the detail of the natural, informal landscape and planting.
- Pockets of ecological restoration zones.

MINIMUM REQUIREMENTS
- No earthworks and weed free park.
- 3m wide vehicle access gates for maintenance, service and emergency vehicles (includes fire access)
- Cement stabilised limestone trail surfacing.
- Benches/Seating (to be off access track and on concrete pad).
- Pedestrian access control gates (where appropriate).
- Conservation fencing.



POS 1 | 55,934m² + 2,841m² verge = 58,775m²

- Proposed amenities and landscape:
- Conservation POS
- External pedestrian paths
- Native planting
- Retained vegetation & existing topography where possible
- Revegetation areas
- Pedestrian and cycle paths

POS 2 | 21,321m² + 1,635m² verge = 22,956m²

- Conservation POS
- Pedestrian and cycle paths
- Native planting
- Retained vegetation & existing topography where possible
- Revegetation areas
- Bench seat, native plating and turf outside of conservation fence
- Drainage basin

POS 17 | 74,634m²

- Conservation POS
- Pedestrian and cycle path
- Full landscaping (with native revegatation, water wise planting and tree planting)
- Bench seats

POS 6 | 41,400m² + 3,517m² verge = **44,917m²**

- Conservation POS
- Pedestrian paths
- Small nature play area
- Native planting and revegatation area
- Retained vegetation & existing topography where possible
- Bench seats, picnic setting and shelter

POS 3 | 26,970m²

- Conservation POS
- Bench seat
- Pedestrian paths
- Native planting
- Retained Vegetation & existing topography where possible
- Revegetation areas
- Drainage basin

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POS HIERARCHY AND ASSETS

Embark
Busselton

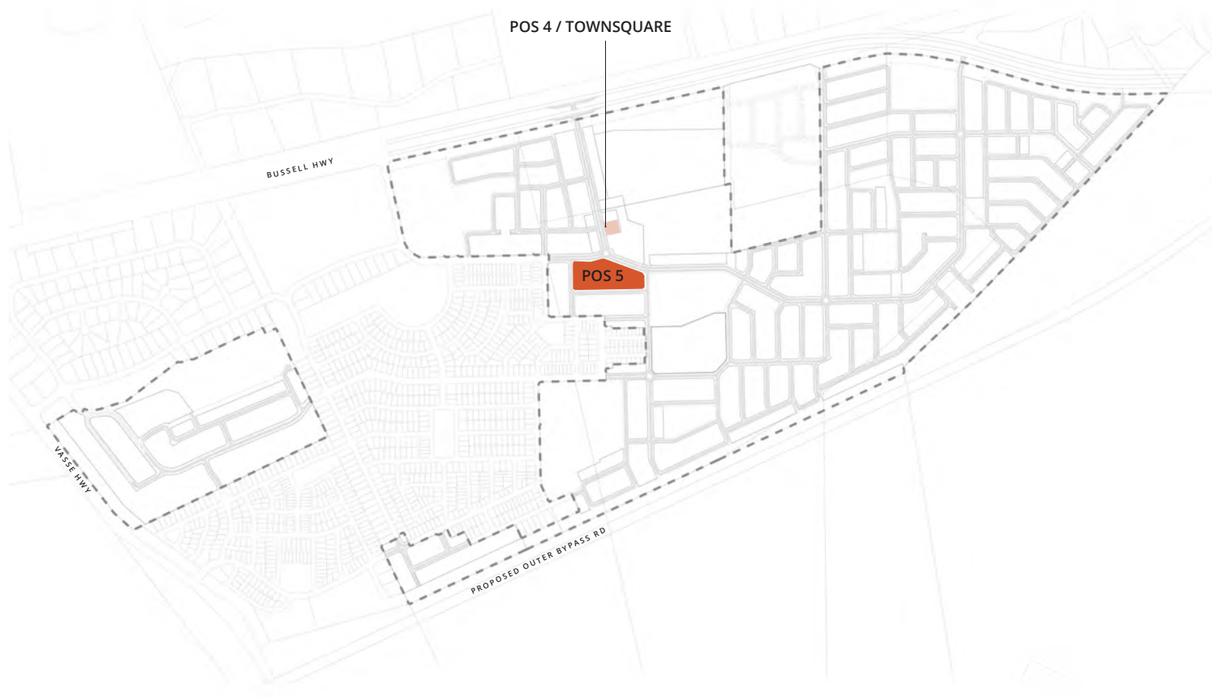




PUBLIC OPEN SPACE 4 TOWNSQUARE

KEY POINTS
- Urban Piazza/plaza town square
- A meeting space to support the immediate commercial area and surrounding community
- Potential event space
- Day/Night activities

MINIMUM REQUIREMENTS
- Clear site lines and CPTED design principles
- Places to rest and pause
- Shaded urban areas
- easy access to buildings with landscape amenity to support functional operations
- Community activated area
- Blend of Hardscape surfaces and soft landscaping, trees and lawn
- Adequate seating and shaded spaces
- Bike parking, bins, drink foutains etc to support
- Feature lighting
- Vehicle accesible for maintenance and events activation



DISTRICT PUBLIC OPEN SPACES

KEY POINTS
- Active POS with sports fields like tennis/rugby/soccer fields, and skate park.
- Regional adventure playground and skatepark
- The park provides a large active recreational space to both Embark residents and neighbouring school.
- Functional open space to service the surrounding districts
- Provides play area for all ages, BBQ facility, shelter and, exercise nodes
- Large open kick-a-bout area
- Key views are to be emphasised where possible views maintained into and out of POS and CPTED principles used to ensure sitelines
- Native trees provide shade for park users and viewing areas of the sporting activities.
- Pathways are positioned to the perimeter of the park for walkers and runners
- Toilet facilities if required.
- An artwork/sculpture maps the 'entry statement' and visually creates a way finding/ signage point.

POS 4 / TOWNSQUARE

- Town square
- Native and exotic planting, lawn
- Plaza/ hard surfaces
- Shade structure and seating nodes
- Drinking fountain, bike racks and bins
- Public art
- Access required for maintenance, service,and emergency vehicles
- Lighting



POS 5 | 26,970m²

- District POS
- Shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks, bins
- Pedestrian paths
- Shaded large play area with sport amenities
- Turf area
- Native planting



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POS HIERARCHY AND ASSETS

Embark
Busselton



NEIGHBOURHOOD PUBLIC OPEN SPACES

KEY POINTS
- usually 1ha to 3ha in size
- comprised of native vegetation beds, lawn and tree zones
- may incorporating stormwater, where indicated
- includes amenities such as shelters, play spaces, small kick-about area, paths and sometimes barbeques
- could be of a passive or active use, or a mix of both



POS 7 | 12,320m² + 1,205m² verge = 13,435m²

- Neighbourhood POS partly constructed
- Existing waterbody
- Shade play area, shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks (existing amenities)
- Continuation of pedestrian paths
- Turf area
- Native planting
- Bench seat

POS 8 | 13,646m²+1,825m² verge = 15,471m²

- Shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks
- Play area, swings & slides
- Pedestrian paths
- Shade play area
- Turf area
- Native planting

POS 11 | 29,426m² + 2,473m² verge = 31,899m²

- Shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks, bins
- Pedestrian paths
- Shade play area
- Turf area
- Native planting
- Drainage basin

POS 10 | 11,834m² + 2,373m² verge = 14,207m²

- Native planting and revegatation area
- Retained vegetation & existing topography where possible
- Play area
- Shelter, picnic settings, bench seats, bins
- Turf area
- Pedestrian and cycle path

POS 9 | 12,774m² + 1,559m² verge = 14,333m²

- Native planting and revegatation area
- Retained vegetation & existing topography where possible
- Play area
- Bench seat
- Turf area
- Pedestrian path

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POS HIERARCHY AND ASSETS

Embark
Busselton



LOCAL PUBLIC OPEN SPACES

KEY POINTS
- from 1,500m2 to 1,5ha
- medium sized open space
- is an intimate destination to provide passive recreation or
- small scale play options where needed
- retained vegetation & existing topography where possible



POS 6 - PAW North | 1,310m² + 197m² verge = **1,507m²**

- Local POS
- Native planting
- Pedestrian path to Commercial/Retirement Village
- Bench seat
- Retained vegetation & existing topography where possible



POS 9 SOUTH | 2,328m2 + 343m2 verge = **2,671m2**

- Local POS
- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Small nature play and a bench seat
- Turf area
- Pedestrian path



POS 13 | 7,235m² + 1,330m² verge = **8,565m²**

- Local Park
- Pedestrian paths
- Shelter, picnic settings, bench seats
- Play area, swings and slides
- Turf area
- Native planting
- Bin



POS 12 | 5,077m² + 1,176m² verge = **6,253m²**

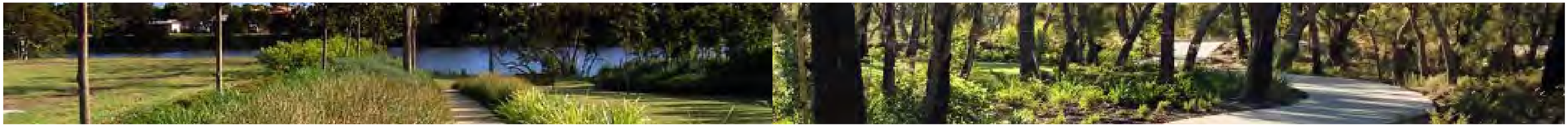
- Local Park
- Pedestrian paths
- Shelter, picnic settings, bench seats
- Play area, swings and slides
- Turf area
- Native planting
- Bin



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POS HIERARCHY AND ASSETS

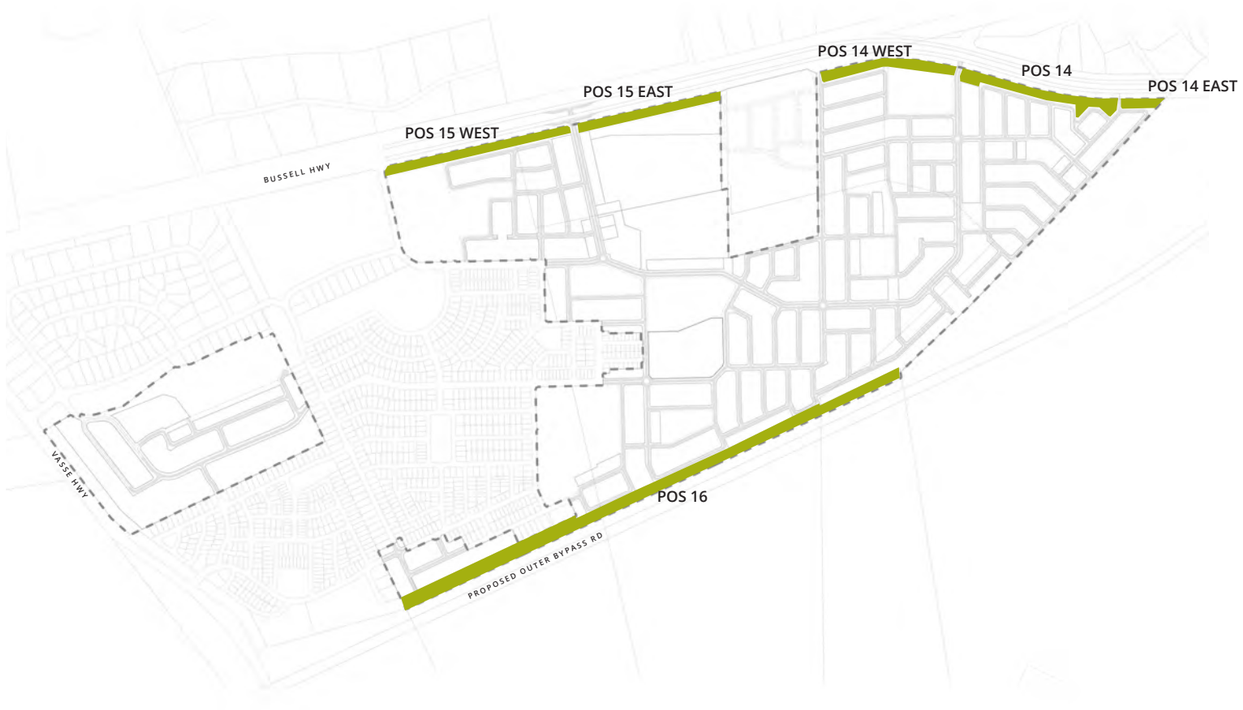
Embark
Busselton



LANDSCAPE BUFFER / BUND PUBLIC OPEN SPACES

KEY POINTS
- Linked green corridors for habitat, sound attenuation and open natural areas
- Retain existing trees

MINIMUM REQUIREMENTS
- Revegetation to be undertaken in accordance with the WRPMP (western ringtail possum managment plan)



POS 14 | 66,045m²

- Landscape Buffer
- Sequance of 3x POS areas
- Tree bush retention where possible
- Full landscaping (with native revegatation, water wise planting and tree planting)
- Pedestrian and cycle path
- Bench seats

POS 15 | 54,000m2

- Landscape Buffer
- 2x Entry POS linear parks
- Pedestrian and cycle path
- Full landscaping (with native revegatation, water wise planting and tree planting)
- Bench seats

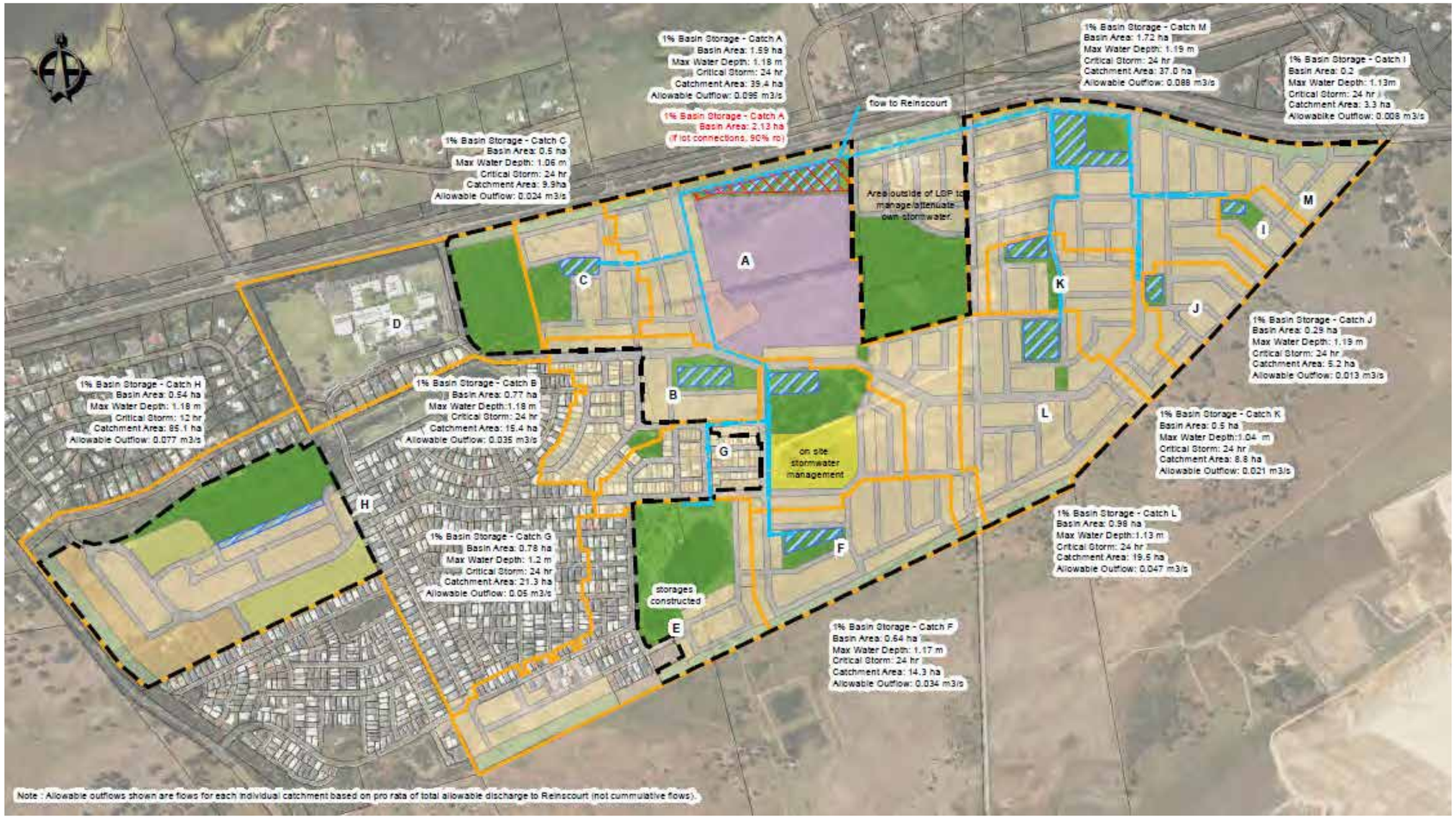
POS 16 | 59,805m² + 2,372m² verge = **62,177m²**

- Landscape Buffer
- Full landscaping (with native revegatation, water wise planting and tree planting)
- Maintenance track (3m wide) along Outer Bussell Hwy
- Drainage road swale and FSAR track (6m wide) along future roads

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STORMWATER AND DRAINAGE PLAN

Embark
Busselton



NOTE: Diagram and base is indicative only. Refer to UWMP for detailed hydro modelling results. POS civil and landscape detail design will determine final layout of proposed stormwater storage basins and road swales.

Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

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POS 1 and 2 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



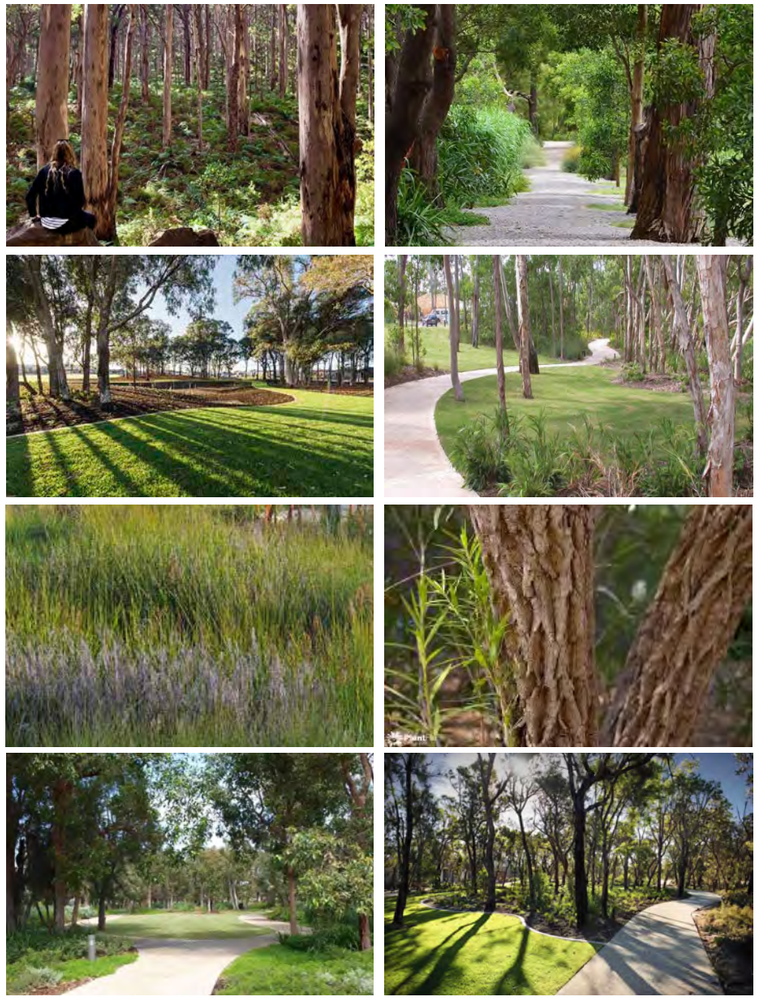
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Retained vegetation and existing topography
2. Conservation fence
3. Planted drainage basin
4. Pedestrian path
5. Garden bed with native planting
6. Pockets of turf areas



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 3 LANDSCAPE CONCEPT PLAN

Embark
Busselton

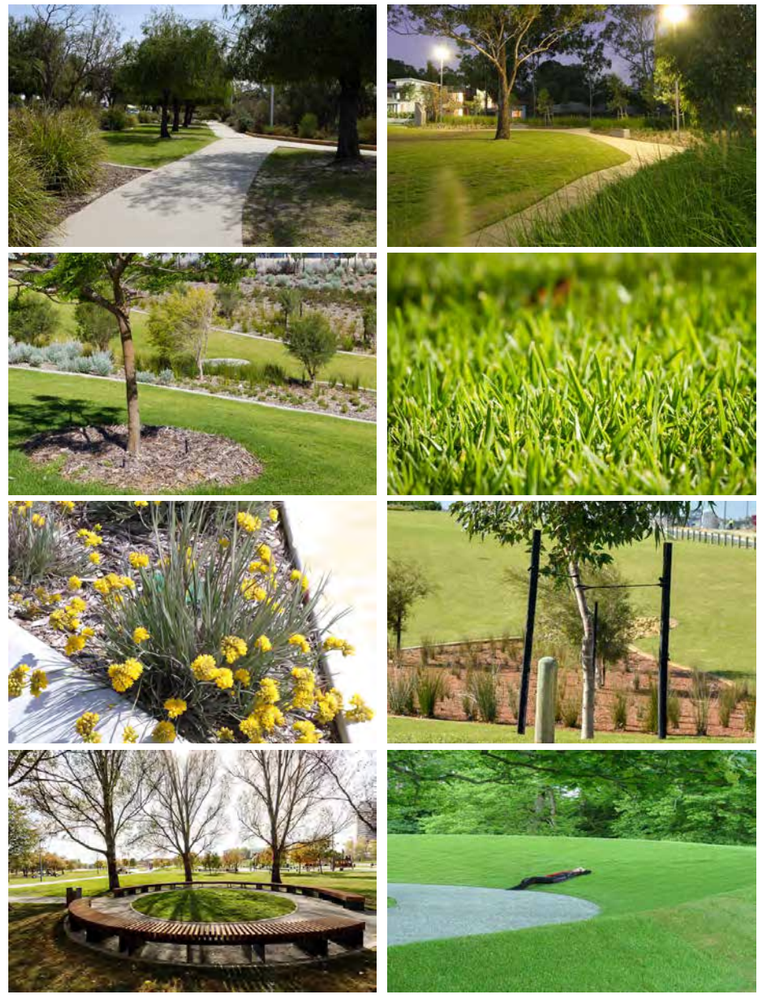


KEY PLAN

Legend

1. Retained vegetation and existing topography where possible
2. Planted drainage basin
3. Pedestrian path
4. Turf area
5. Potential Solar Farm. Peppercorn lease to Land lease operator





PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 4 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

Legend

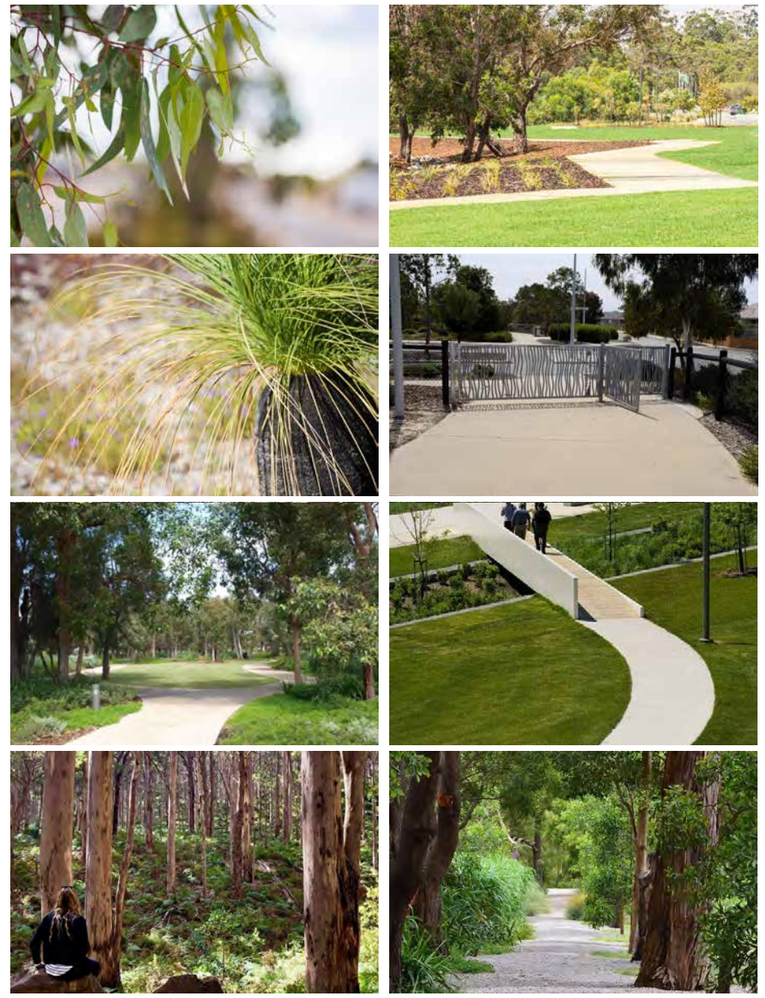
1. Retained vegetation and existing topography where possible
2. Living stream
3. Conservation fence
4. Pedestrian paths
5. Garden beds with native shrub planting and trees



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 4 / TOWNSQUARE LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



Legend

1. Townsquare plaza

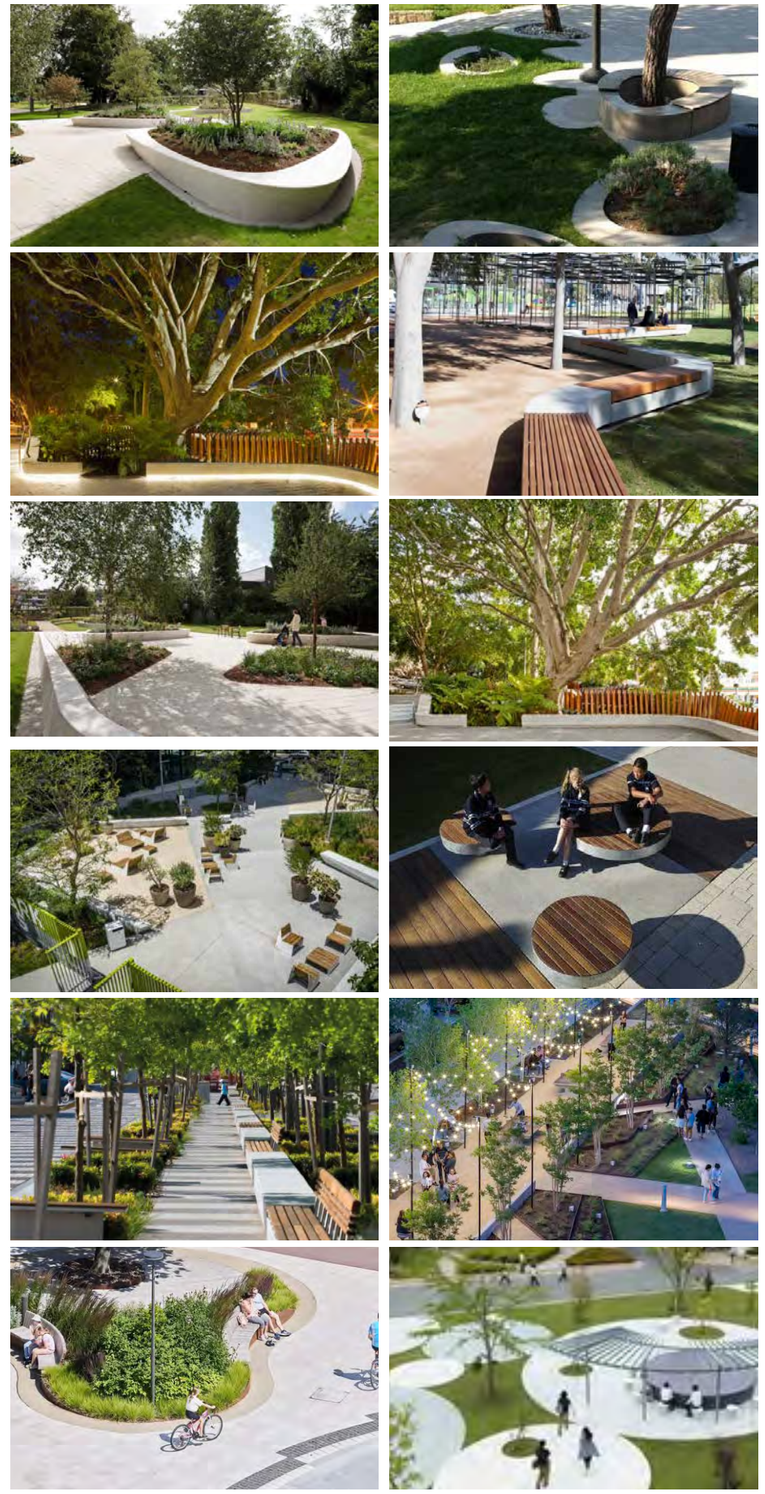
Proposed amenities and landscape:
- Seating nodes
- Shade structures
- Drinking fountain
- Bike racks
- Bins
- Access required for maintenance, service and emergency vehicles
- Native and exotic planting

2. Childcare
3. Retirement Village
4. Supermarket/Specialties
5. Boulevard and feature avenue trees
6. Residential lots

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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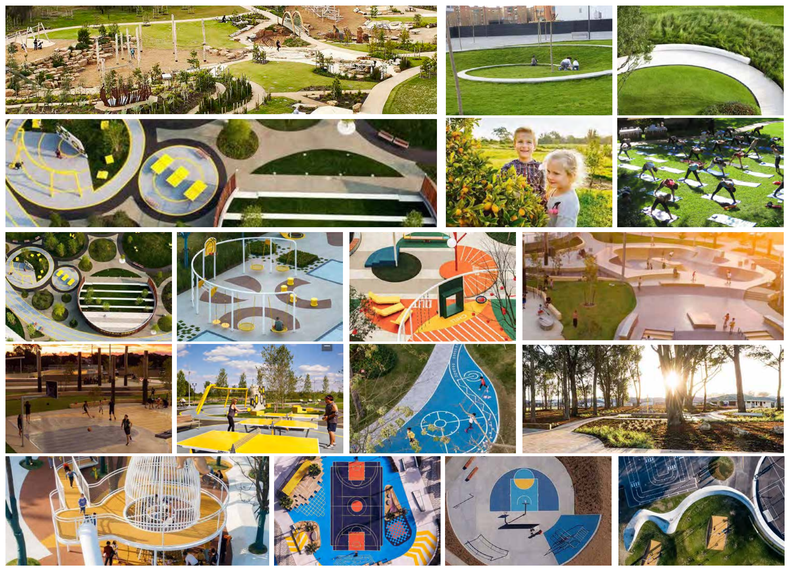
Landscape Master Plan

Embark, Busselton

embark BUSSELTON

Legend

1. Feature landmark artwork
2. Formal park entry with signage, feature seating, bike parking
3. Buffer verge planting and street trees, widened footpaths to accommodate running, bikes and pedestrians
4. Large kick-about lawns with sports goals
5. Enclosed basketball/multisports court with low tired seating areas
6. Shaded community meeting place with interpretive paving and artwork elements
7. Shade structure, BBQ areas, seating and picnic settings
8. Adventure playground with landmark themed play tower, flying fox, pendulum swing, enclosed junior play area, bouldering and climbing features
9. Natureplay area located amongst woodland area - winding discovery trails, fallen log, rope and loose parts play, interpretive and educational signage
10. Teenage hangout space
11. Skate, scoot and bmx park with large shade structure areas
12. Pump track
13. Revegetated woodland areas with winding trails, seating and picnic areas
14. Potential zone for outdoor gym classes. Peppercorn lease to gym located in the commercial town centre.



KEY PLAN



YOLK PROPERTY GROUP

LD TOTAL

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton.
Road reserve boundary and existing trees to be confirmed with additional feature survey.

CLIENT YOLK PROPERTY GROUP | PROJECT NO 10.7096 | REVISION A | DATE 16.12.2022 | SCALE 1:500 @ A1

0 10 100m NORTH

POS 5 PRECEDENT IMAGES

Embark
Busselton



ZONE A. ADVENTURE PLAYGROUND
















ZONE B. SKATE PARK











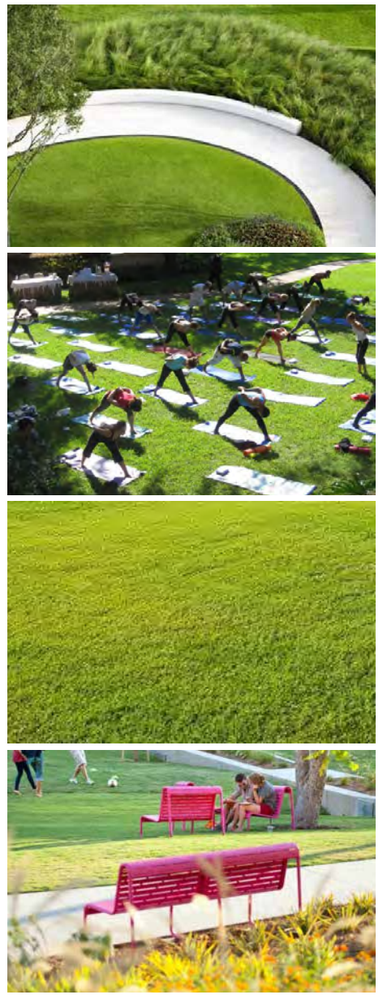



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ZONE C. KICKABOUT AREA, VERGE AND FEATURE PLANTING, CONNECTIVITY







ZONE D. SPORT AMENITIES









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POS 6 and POS 6 / PAW NORTH LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



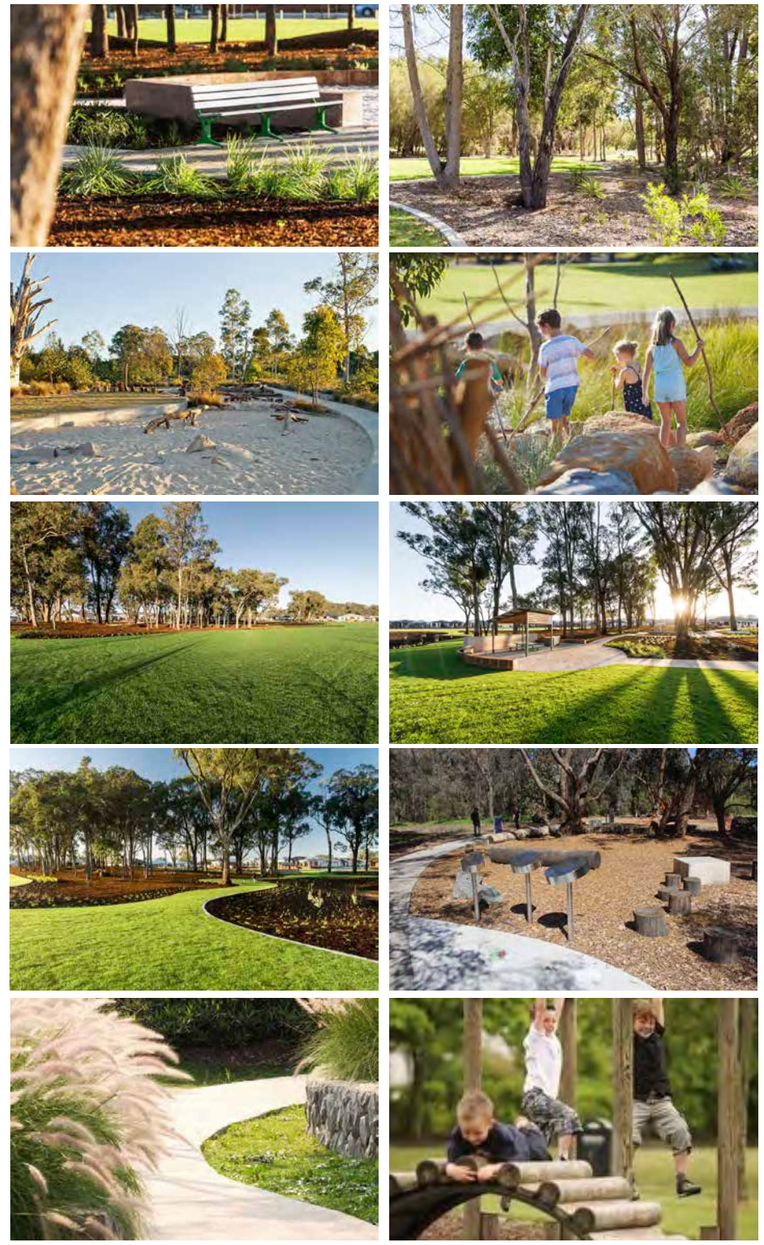
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Retained vegetation and existing topography where possible
2. Garden beds with native shrub planting and trees
3. Formal path network
4. Informal path network
5. Node with shelter and picnic setting
6. Seating node
7. Irrigated open turfed area
8. PAW path network to Retirement Village
9. Community Veggie garden



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 7 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



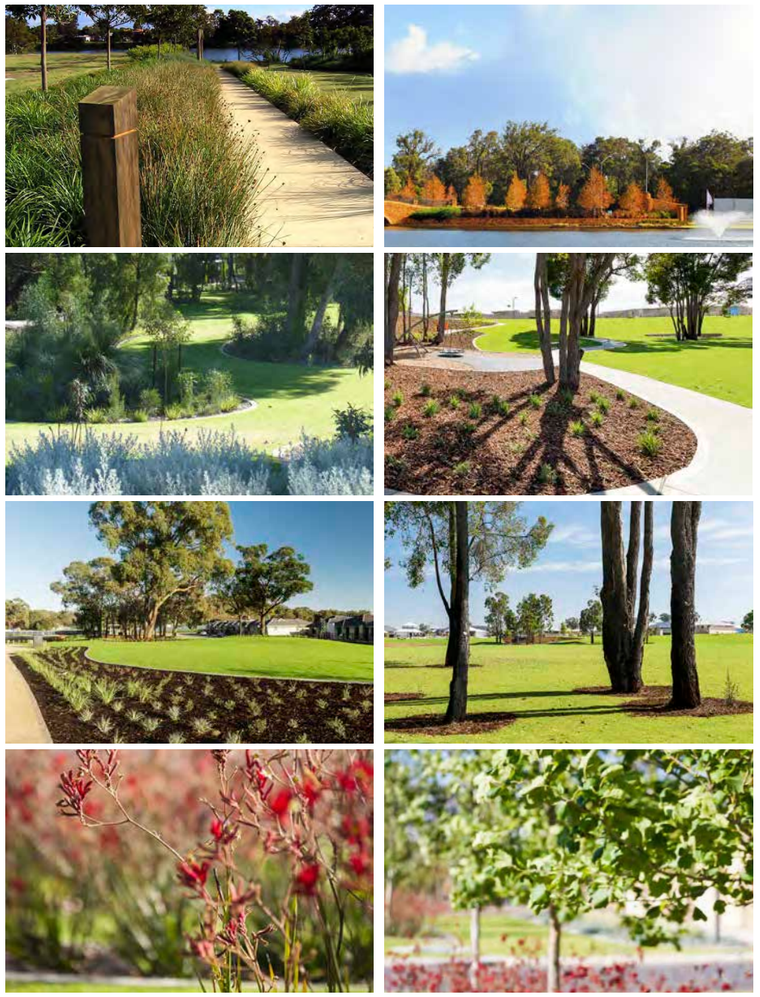
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Existing POS - native planting and path network, shade structures and play-ground, planted drainage basin
2. Continuation of pedestrian and cycle path
3. Avenue and native trees
4. Irrigated garden bed planting
5. Irrigated open turf area
6. Low treat vegetation to future residen-tial lots



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

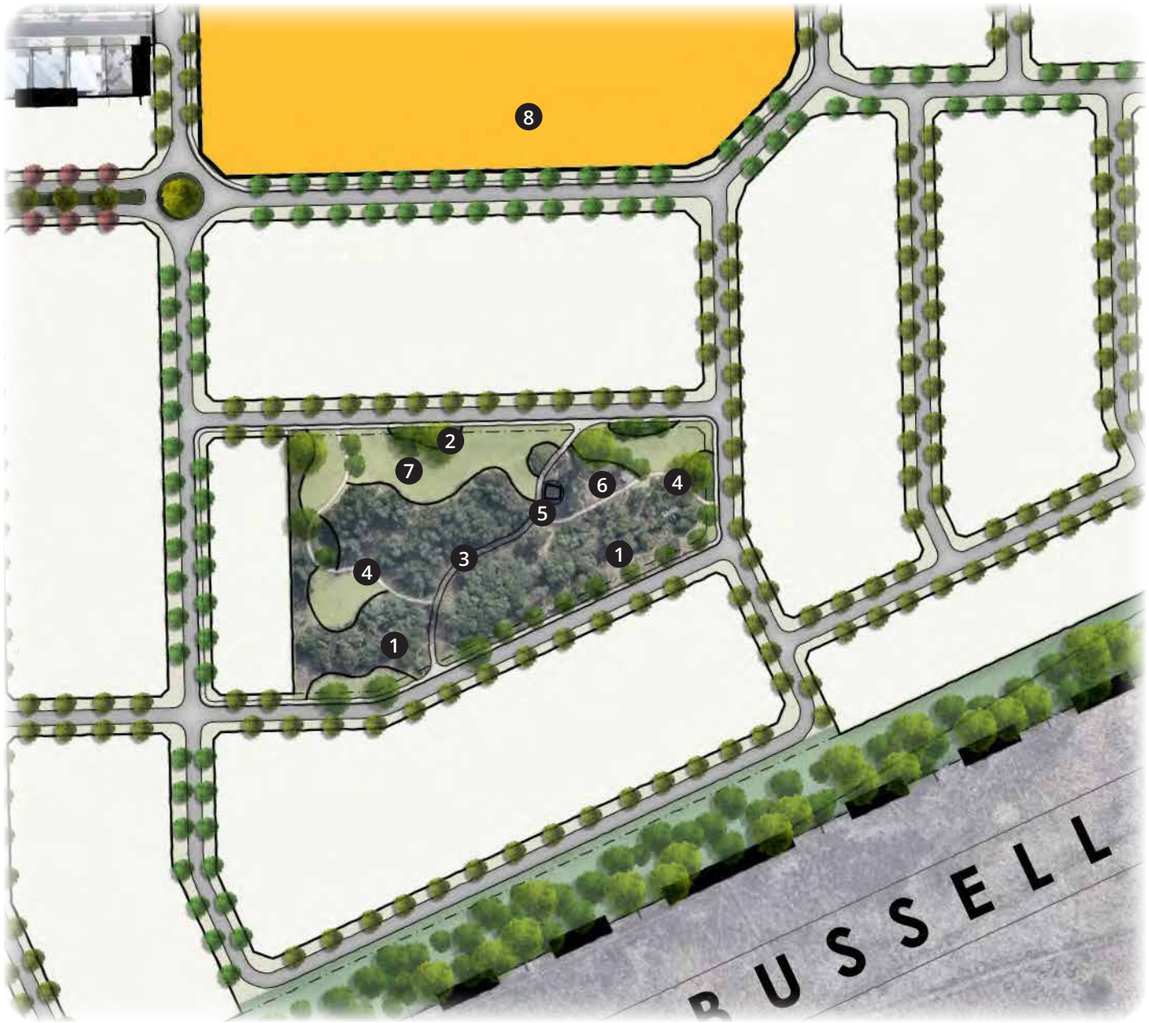
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POS 8 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



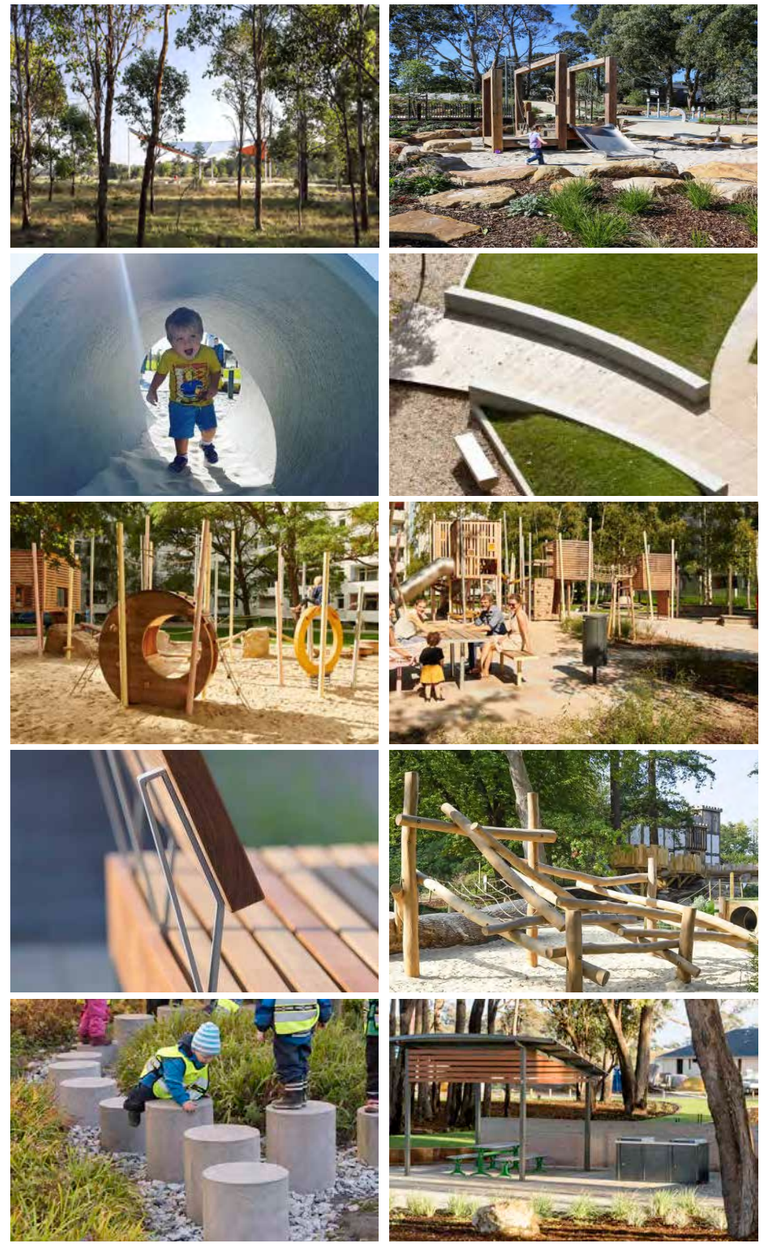
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Retained vegetation and existing topography where possible
2. Garden beds with native shrub planting and trees
3. Formal path network
4. Informal path network
5. Node with shelter and picnic setting
6. Playground
7. Irrigated open turfed area
8. Future Primary School
9. Landscape Buffer / Bund



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 9 NORTH AND SOUTH, AND POS 10 LANDSCAPE CONCEPT PLAN

Embark
Busselton

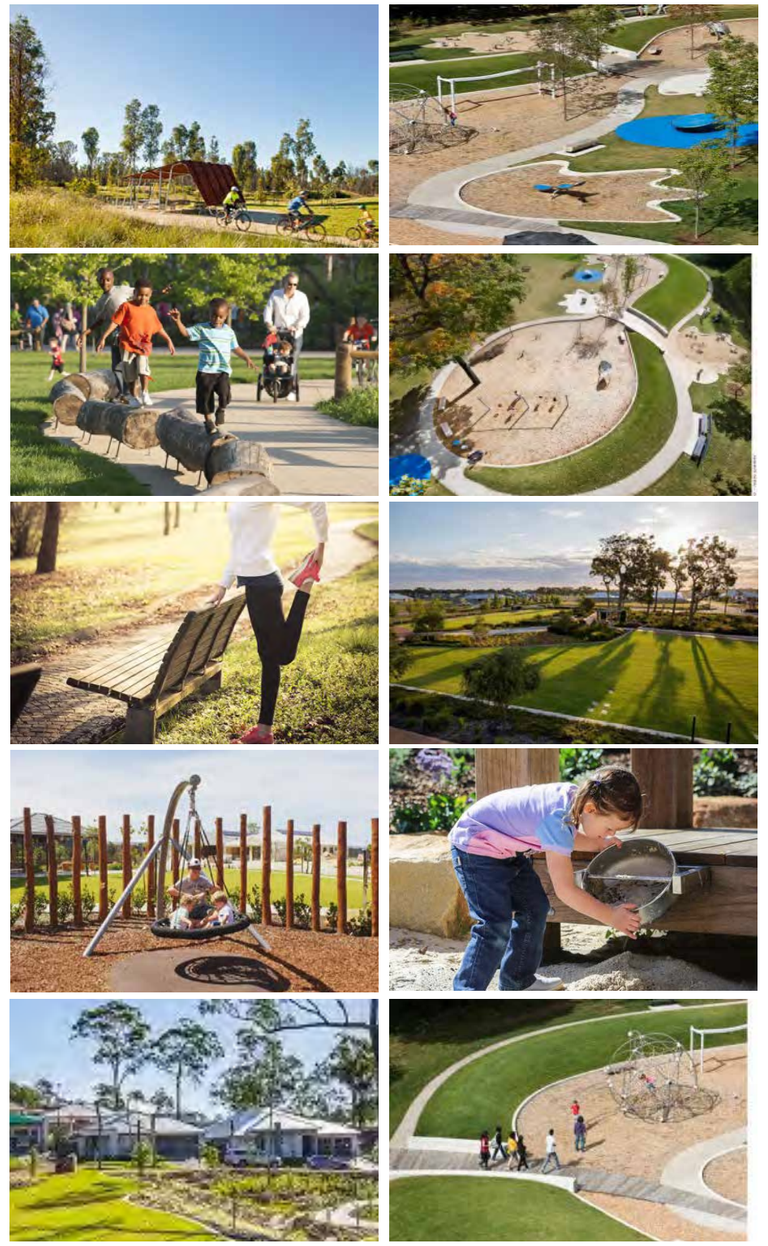


KEY PLAN



Legend

1. Retained vegetation and existing topography where possible
2. Garden beds with native shrub planting and trees
3. Pedestrian and cycle path network
4. Seating nodes
5. Node with shelter and picnic setting
6. Play area
7. Irrigated open turfed area



PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 11 LANDSCAPE CONCEPT PLAN

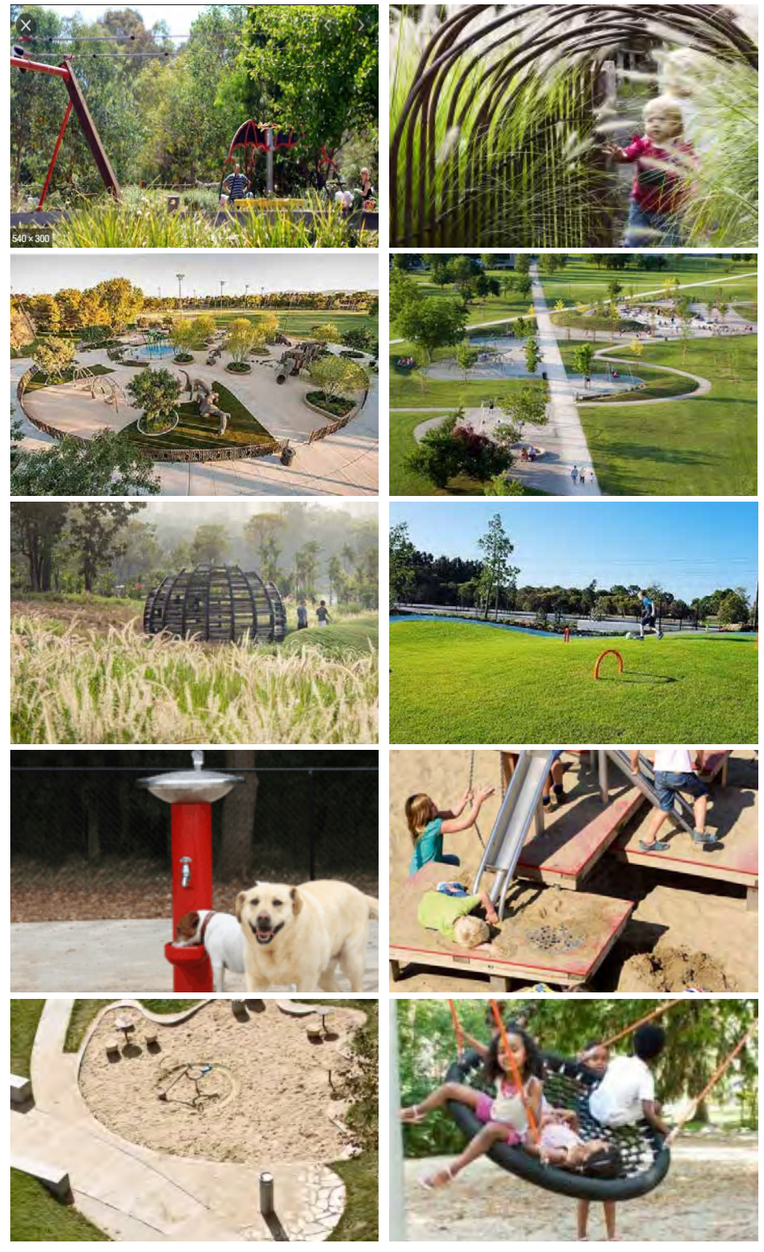
Embark
Busselton



KEY PLAN



1. Open turf area
2. Irrigated shrub and tree planting
3. Formal path network
4. Informal path network
5. Shade play area
6. Node with shelter, picnic settings, BBQ, bike racks and drinking fountain, bins
7. Planted drainage basin



PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

STRATEGY 3. POS PRELIMINARY CONCEPTS

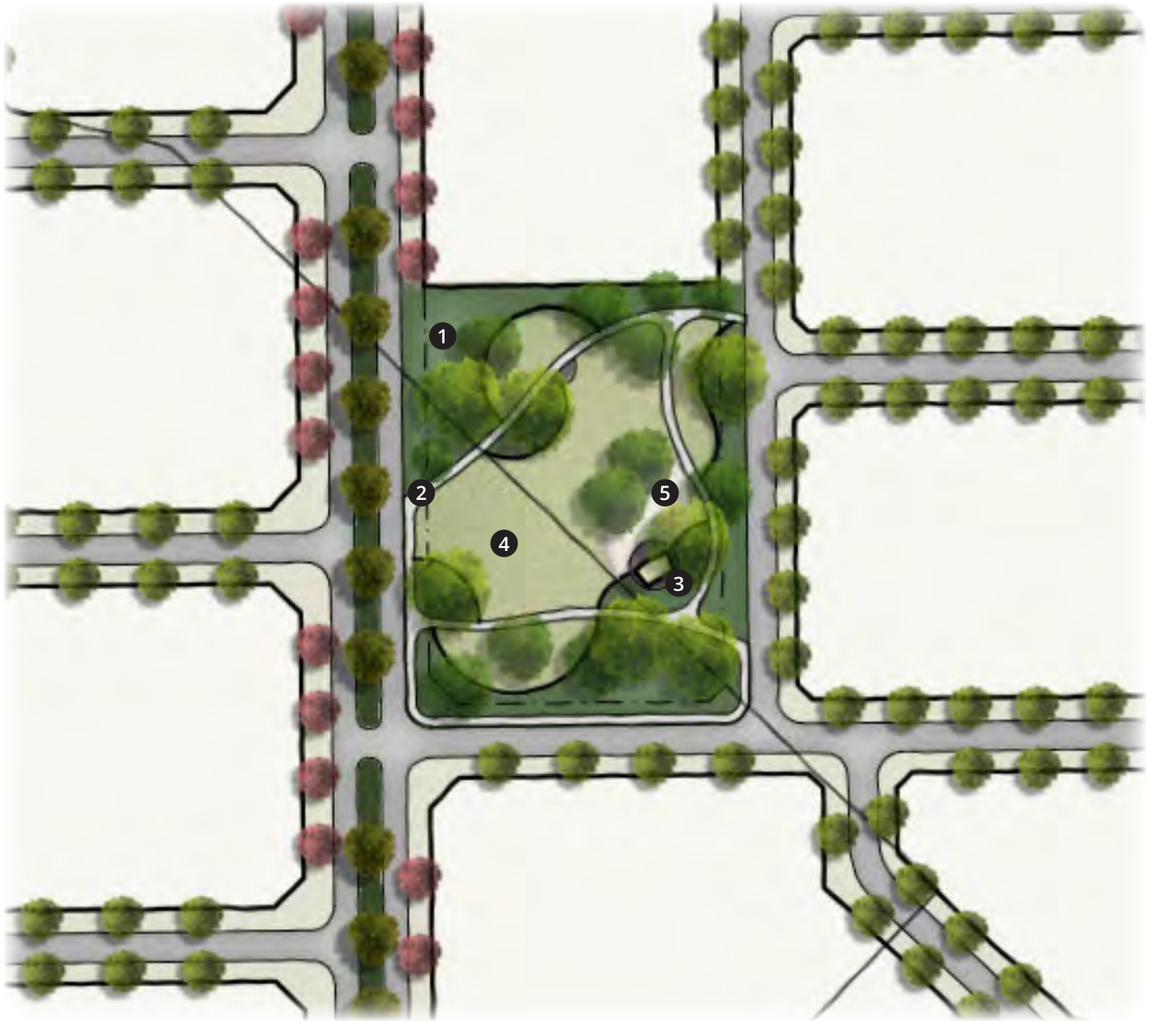
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POS 12 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



Legend

1. Garden beds with native shrub planting and trees
2. Pedestrian path network
3. Node with shelter and picnic setting
4. Irrigated open turfed area
5. Playground

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 25 50m

North



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

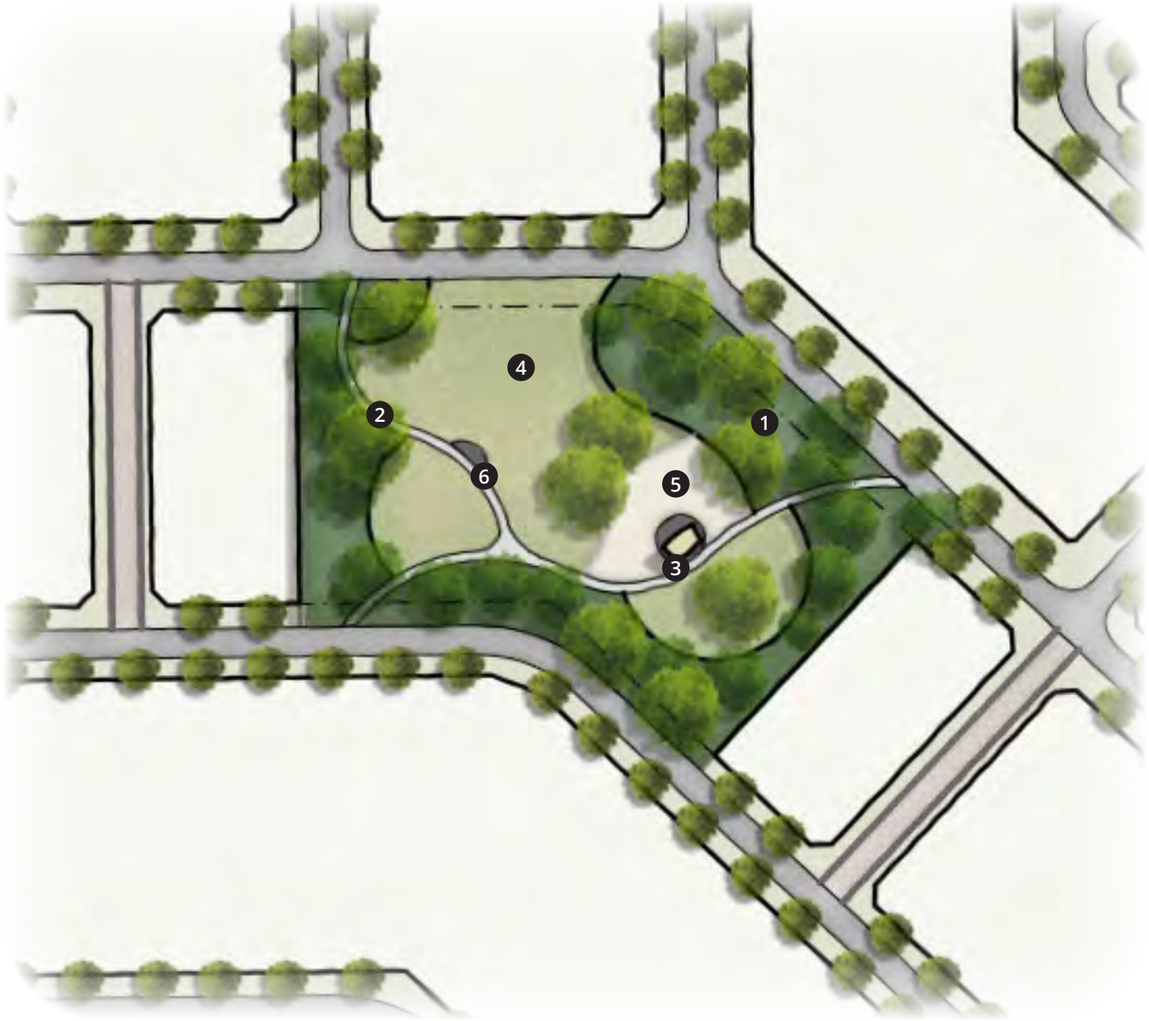
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POS 13 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



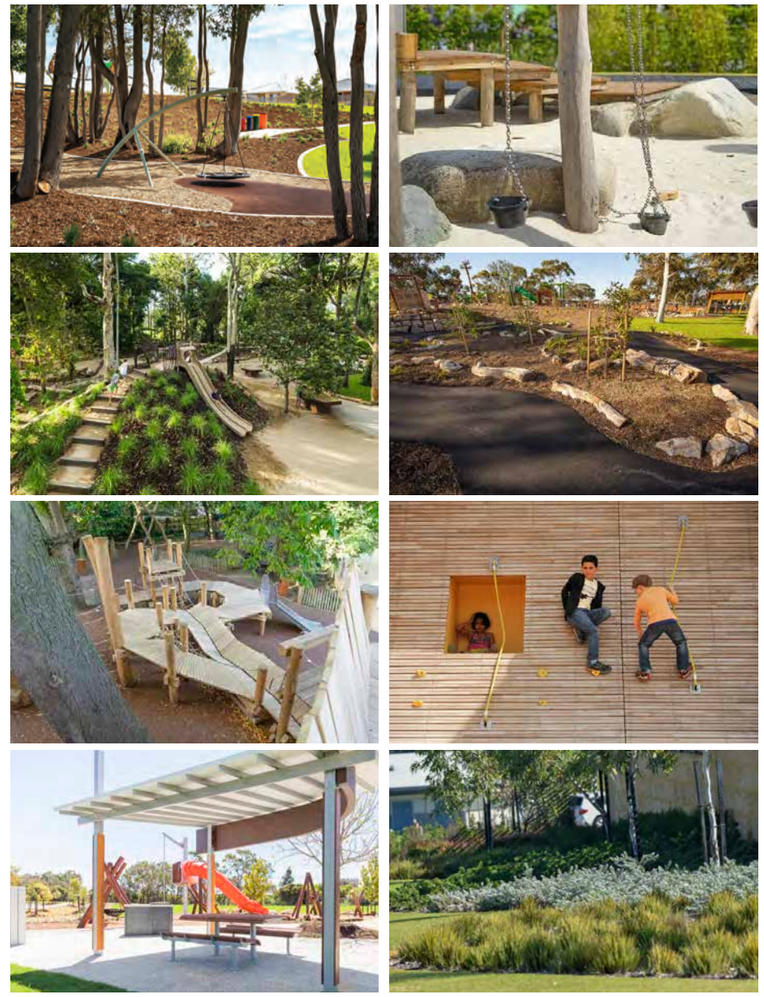
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Garden beds with native shrub planting and trees
2. Pedestrian path network
3. Node with shelter and picnic setting
4. Irrigated open turfed area
5. Playground
6. Bench seat



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 14 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

Legend

1. Pedestrian and cycle paths
2. Seating nodes
3. Retained vegetation and existing topography where possible
4. Native shrub planting and trees











NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

© LD TOTAL 2022

POS 15 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

Legend

1. Retained vegetation and existing topography where possible
2. Native shrub planting and trees
3. Conservation fence
4. Irrigated turf to verge entry



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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POS 16 LANDSCAPE CONCEPT PLAN

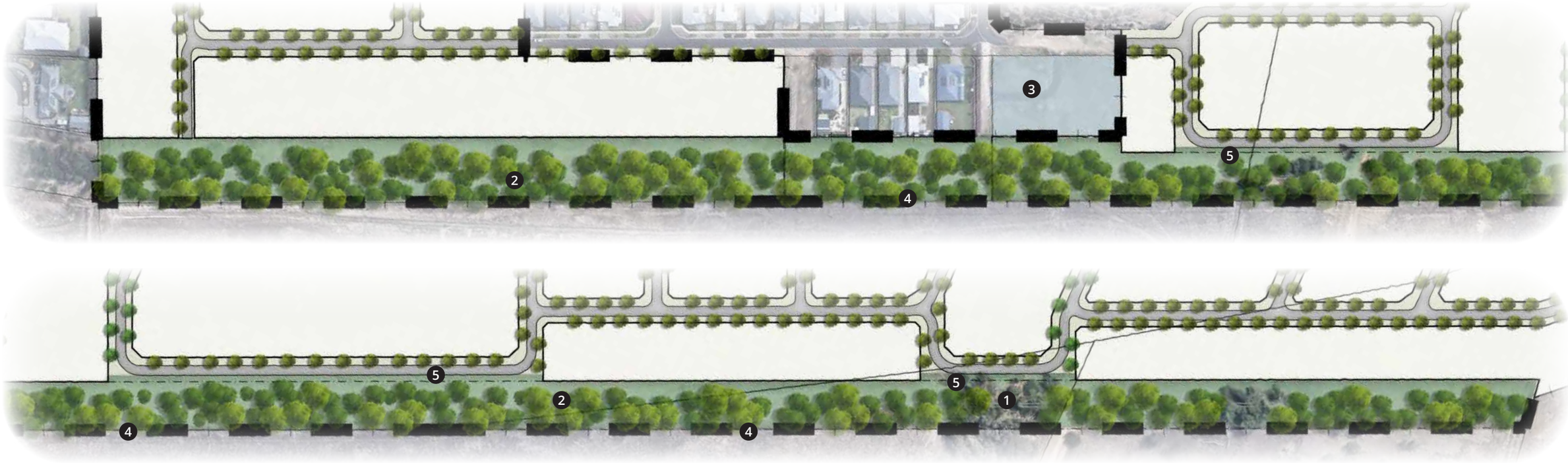
Embark
Busselton



KEY PLAN

Legend

1. Retained vegetation and existing topography where possible
2. Native shrub planting and trees
3. Water Treatment
4. Maintenance track (3m wide) along Outer Bussell Hwy
5. Drainage road swale and FSAR track (6m wide) along future roads



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

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SOFTSCAPE

Embark
Busselton

POS

BIOFILTERS / DRAINAGE

TREES

Eucalyptus gomphocephala
Tuart

Agonis flexuosa
WA Peppermint

Eucalyptus rudis
Flooded Gum

Melaleuca lanceolata
Rottnest Tea Tree

Melaleuca preissiana
Moonah

Melaleuca rhaphiophylla
Freshwater paperbark








SEDGES

Ficinia nodosa
Knotted Club Rush

Juncus pallidus
Pale Rush

Lepidosperma gladiatum
Coastal Sword Sedge

Patersonia occidentalis
Purple Flag





WATER TOLERANT SHRUBS

Eremophila glabra
Tar Bush

Hakea prostrata
Harsh Hakea

Hypocalymma angustifolium
White Myrtle

Kunzea micrantha
Kunzea






SHRUBS - TALL

Acacia cochlearis
Coast Wattle

Melaleuca lanceolata
Rottnest Island Tea Tree

Acacia pulchella
Prickly Moses

Calothamnus quadrifidus
One-Sided Bottlebrush

Xanthorrhoea preissii
Grasstree

Pericalymma ellipticum
Swamp teatree








SHRUBS - MEDIUM

Dianella revoluta
Flax Lily

Olearia axillaris
Coast Daisy Bush

Westringia 'Blue Gem'
Blue Gem

Patersonia occidentalis
Purple flag

Calothamnus sanguineus
Silky leaved blood flower

Gompholobium tomentosum
Hairy yellow pea








SHRUBS - LOW

Grevillea crithmifolia
Fine-Lweaved Grevillea

Myoporum insulare
Coastal Boobialla

Conostylis candicans
Grey Cottonheads

Banksia nivea
Honeypot dryandra

Anigozanthos manglesii
Red & Green Kangaroo Paw

Dampiera linearis
Common Dampiera








GROUND COVERS

Hypocalymma robustum
Swan River Myrtle

Myoporum parvifolium
Creeping boobialla

Melaleuca huegelii
Chenille Honey-Myrtle





STRATEGY 3. SOFTSCAPE PALETTE

LD TOTAL

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STREET TREE MASTER PLAN

Embark
Busselton

TREE SELECTION

Street trees have been selected for their form, height and relationship to existing trees focusing on WA native species and deciduous trees away from waterbodies.

Tree spacing relates to the scale and use of the street and the desire to create a shaded micro-climate that encourages walking and reduces heat island effects. Generally, wider road reserves are planted with larger tree species. The design of the streetscapes has been primarily driven by the proposed boulevard 'green' spine of Embark with median swale, Western Ringtail Possum habitat and wildlife linkage, and public open space relationships.

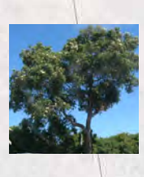
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

BUSSELL HIGHWAY
JOSEPH DR
ALMOND PARKWAY
OAKS BLVD
AURELIAN AVENUE
MARSEILLES DRIVE
DIGORDAS ST
VASSE HIGHWAY
OUTER BUSSELL HIGHWAY

Legend



Proposed RAB - Platanus acerifolia
London Plane Tree



Corymbia calophylla
Marri



Platanus acerifolia
London Plane Tree



Eucalyptus victrix 'Little Ghost Gum'
Dwarf Ghost Gum



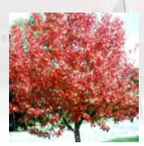
Hakea laurina
Pin-cushion Hakea



Melaleuca quinquenervia
Board-leaved Paperbark



Melaleuca leucadendron
Weeping Paperbark



Pyrus usseriensis
Manchurian Pear



Agonis flexuosa
WA Peppermint

LD TOTAL

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STREETSCAPE SECTIONS

Embark
Busselton



KEY PLAN



SECTION AA. TYPICAL 26M ROAD RESERVE WITH PARKING

Note: Tree alignment (2.4m - 3m)

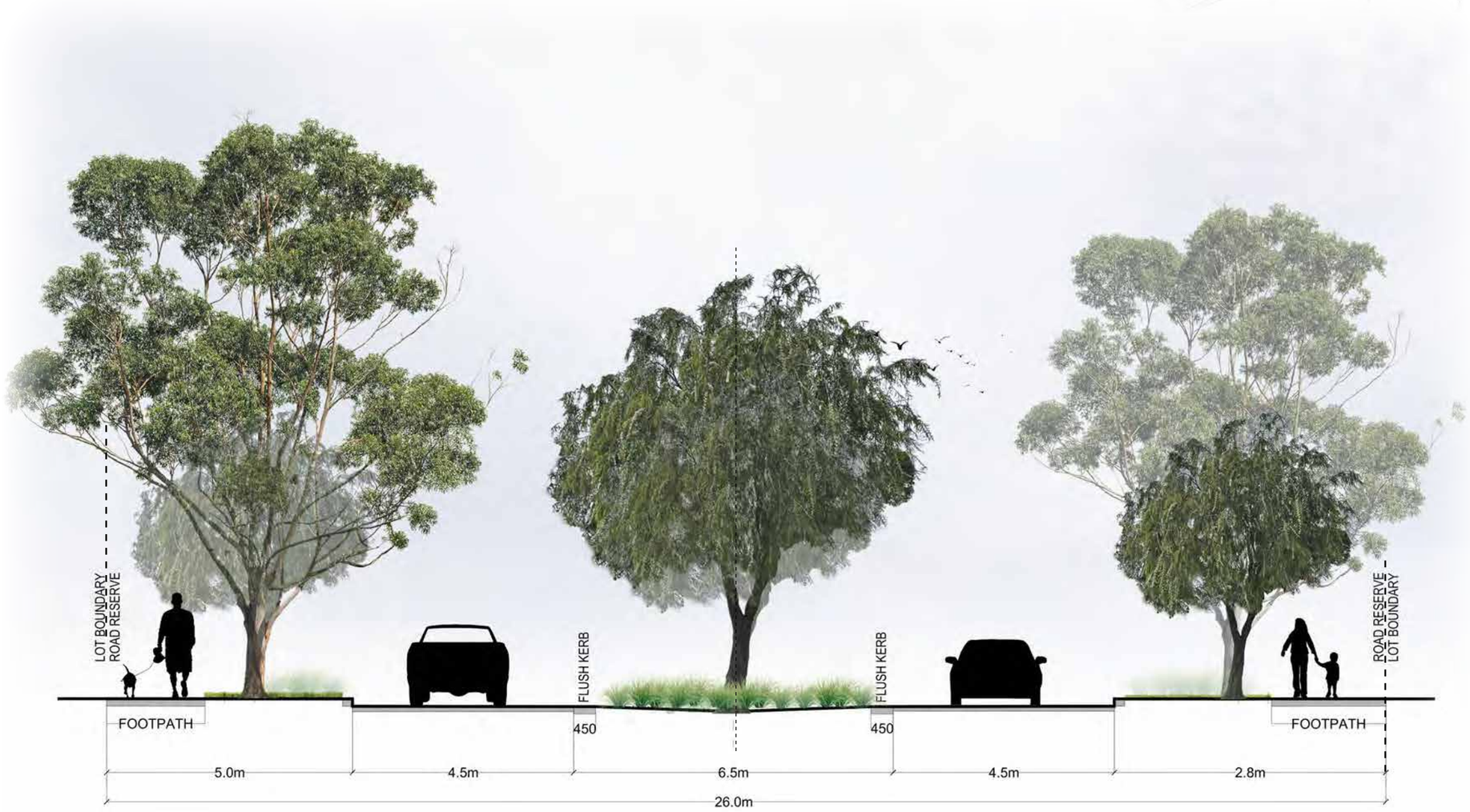
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STREETSCAPE SECTIONS

Embark
Busselton



KEY PLAN



SECTION BB. TYPICAL 26M ROAD RESERVE WITH PARKING

Note: Tree alignment (2.4m - 3m)

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STREETSCAPE SECTIONS

Embark
Busselton



KEY PLAN



SECTION CC. TYPICAL 17M ROAD RESERVE

Note: Tree alignment (2.4m - 3m)

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STREETSCAPE SECTIONS

Embark
Busselton



KEY PLAN



SECTION DD. TYPICAL 15M ROAD RESERVE
Note: Tree alignment (2.4m - 3m)

LD TOTAL

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BORE AND MAINLINE STRATEGY

Embark
Busselton



STRATEGY 5. IRRIGATION STRATEGY

LD TOTAL

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EMBARK
IRRIGATION SCHEDULE

2 December 2022

PUBLIC OPEN SPACE	Total area m2	POS Type	Irrigation rate (kL/ha/yr)	Irrigated Area (m²)	% Irrigated Long-term	Turf m2	Long-term (Turf) volume (kL/yr)	% Irrigated (Planting) Establishment	Planting m2	Establishment (Planting) volume (kL/yr)	Responsibility
POS 1 (only verges are irrigated)	58,775	Conservation Park		2,939	2%	1,176	793	3%	1,763	1,190	Developer
POS 2 (only verges are irrigated)	22,956	Conservation Park		1,836	2%	459	310	6%	1,377	930	Developer
POS 3	26,970	Conservation Park		13,485	20%	5,394	3,641	30%	8,091	5,461	Developer
POS 4 / Townsquare	2,500	Townsquare		2,250	25%	625	422	65%	1,625	1,097	Developer
POS 5	22,194	District POS		18,865	60%	13,316	8,989	25%	5,549	3,745	Developer
POS 6	44,917	Conservation Park		22,459	20%	8,983	6,064	30%	13,475	9,096	Developer
POS 6 PAW North	1,507	Local Park		1,356	10%	151	102	80%	1,206	814	Developer
POS 7	13,435	Neighbourhood Park		11,420	60%	8,061	5,441	25%	3,359	2,267	Developer
POS 8	15,471	Neighbourhood Park		8,509	25%	3,868	2,611	30%	4,641	3,133	Developer
POS 9	14,333	Neighbourhood Park		7,883	25%	3,583	2,419	30%	4,300	2,902	Developer
POS 9 South	2,671	Local Park	6,750.0	1,469	10%	267	180	45%	1,202	811	Developer
POS 10	14,207	Neighbourhood Park		7,814	25%	3,552	2,397	30%	4,262	2,877	Developer
POS 11	31,899	Neighbourhood Park		17,544	25%	7,975	5,383	30%	9,570	6,460	Developer
POS 12	6,253	Local Park		4,690	35%	2,189	1,477	40%	2,501	1,688	Developer
POS 13	8,565	Local Park		6,424	35%	2,998	2,023	40%	3,426	2,313	Developer
POS 14 West	27,109	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 14 Central	31,359	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 14 East	7,577	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 15 East	25,668	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 15 West	28,333	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 16	62,177	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 17 (only verges are irrigated)	74,634	Conservation Park		1,493	1%	746	504	1%	746	504	Developer
TOTAL POS m2	543,510			130,435.41			42,756.09			45,287.81	

MAIN DISTRUBTORS / COLLECTORS	Total length (linear meter)	Street Type (refer LSP)	Irrigated area (m²)		% Irrigated (Planting) Establishment		Establishment (Planting) volume (kL/yr)	Responsibility
Streetscapes - Main Boulevard (median / roundabouts)	2,700	District Distributor B	13,500		100%		9,113	Developer
TOTAL	2,700.00		13,500.00				9,112.50	

TOTAL POS + Streetscapes Irrigation for turf and planting establishment **97,156 (kL/Yr)**

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LD TOTAL

Head Office Perth

172 Burswood Road, Burswood, WA 6100
(08) 6436 1111

Bunbury

7 Mason Street, Bunbury, WA 6230
(08) 9725 6555

Melbourne

10 Thomas Street, Yarraville, VIC 3013
(03) 9548 3283

Gold Coast

Unit 1/5 Traders Way, Currumbin, QLD 4551
(07) 5607 0508

Sunshine Coast

Unit 1/159 Mark Road, Caloundra West, QLD 4551
(07) 5325 1508

Appendix G

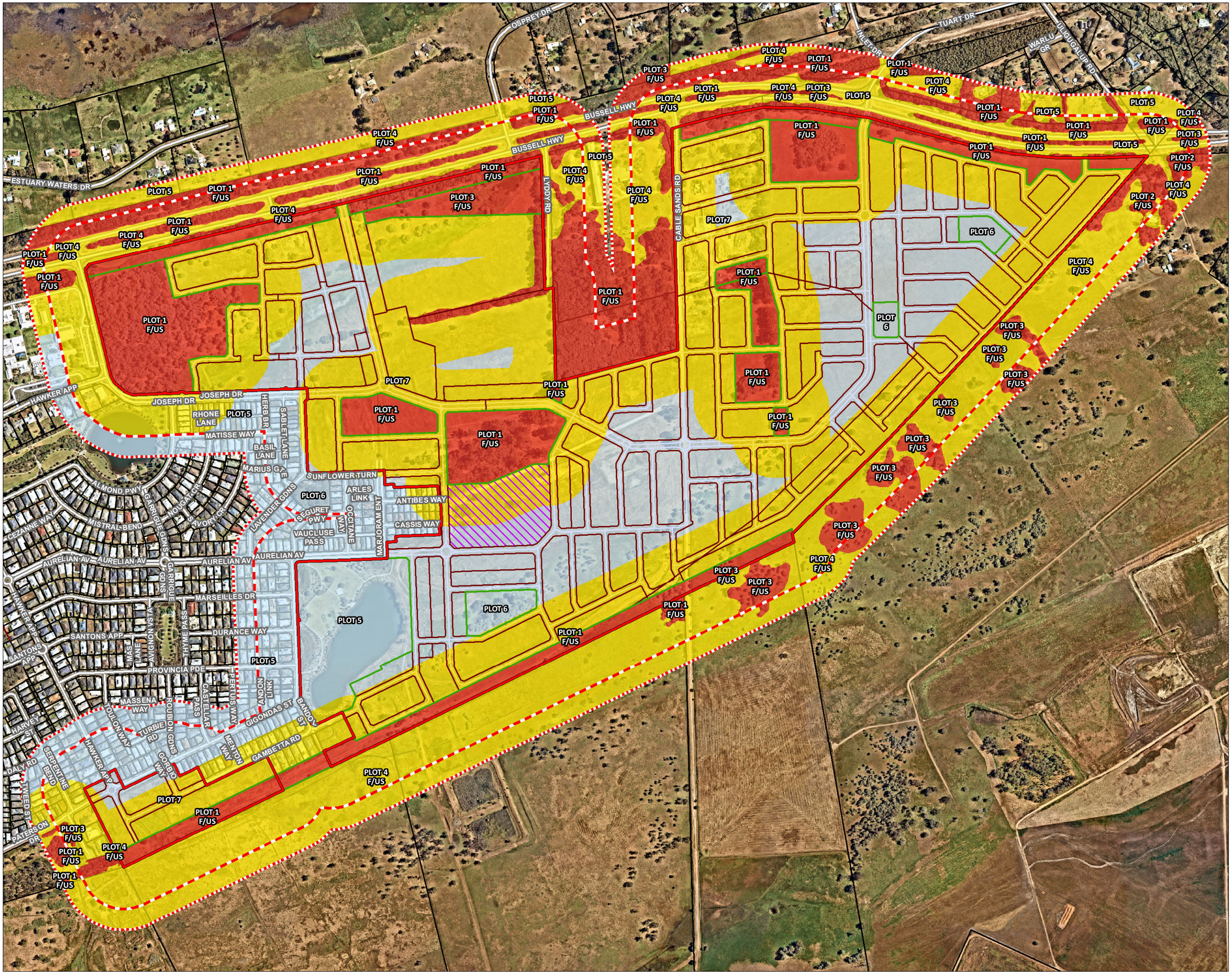
Bushfire Management Plan

Appendix H

Local Water Management Strategy (LWMS)

Appendix G

Bushfire Management Plan



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Proposed development
- Primary school
- Lake
- POS

Hazard level

- Extreme
- Moderate
- Low
- Proposed carriageways
- Roads

strategen JBS&G

Job No: 62376	
Client: Yolk Property Group	
Version: A	Date: 17-May-2023
Drawn By: droberts	Checked By: CT

Scale 1:8,300 at A3

0 100 200
metres

Coord. Sys. GDA 1994 MGA Zone 50

Provence Estate
Yalyalup, WA

POST-DEVELOPMENT BUSHFIRE HAZARD LEVELS

FIGURE 6

File Name: \\jbsg-wa-ad01.jbsg.aust\JBS Perth\Projects\1)Open\Yolk Property Group\62376 Provence LSP BMP Amendment\GIS\Maps\R01_Rev_A\62376_06_A3_PostDevBHLs.mxd
Image Reference: www.nearmap.com© - Imagery Date: 30. September 2022.

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: Embark Busselton Structure Plan Amendment

Suburb: Yalyalup **State:** WA **P/code:** 6280

Local government area: City of Busselton

Description of the planning proposal: Structure Plan Amendment

BMP Plan / Reference Number: 62376 R01 **Version:** Rev 1 **Date of Issue:** 17/05/2023

Client / Business Name: Almond Lake Pty Ltd

Reason for referral to DFES	Yes	No
Has the BAL been calculated by a method other than method 1 as outlined in AS3959 (tick no if AS3959 method 1 has been used to calculate the BAL)?	☐	☒
Have any of the bushfire protection criteria elements been addressed through the use of a performance principle (tick no if only acceptable solutions have been used to address all of the BPC elements)?	☐	☒
Is the proposal any of the following special development types (see SPP 3.7 for definitions)?		
Unavoidable development (in BAL-40 or BAL-FZ)	☐	☒
Strategic planning proposal (including rezoning applications)	☒	☐
Minor development (in BAL-40 or BAL-FZ)	☐	☒
High risk land-use	☐	☒
Vulnerable land-use	☐	☒

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.)?

Structure Plan Amendment

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
Louisa Robertson	Level 3	BPAD 36748	28/02/2024
Company		**Contact No.**	
JBS&G		08 9792 4797	

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

Signature of Practitioner LM Robertson **Date** 17/05/2023

Embark Busselton

Almond Lake Pty Ltd

Bushfire Management Plan (Structure Plan Amendment)

145,704 | 62376

17 May 2023

BPAD Bushfire Planning & Design Accredited Practitioner Level 3

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Appendix B Vegetation plots – Photographs and description
Appendix C City of Busselton Firebreak Notice
Appendix D Asset Protection Zones – Standards (Schedule 1) and explanatory notes from the Guidelines
Appendix E Vehicular access – Explanatory notes from the Guidelines

1. Proposal details

1.1 Background

Almond Parkway Pty Ltd (the proponent) is lodging a Structure Plan Amendment to guide ongoing urban development within Embark Busselton (formerly Provence Estate), Yalyalup, in the municipality of the City of Busselton (the City). The Structure Plan Amendment follows approval of the previous Provence Structure Plan which was submitted in 2020.

The Structure Plan Amendment area (refer to Figure 1 and Figure 2) encompasses Lots 2, 9032 and 9034 Bussell Highway. Lots 6 and 22 and a portion of Lot 9034 in the southwest (known as Yalyalup Corner) are excluded from the Amendment area, however this Bushfire Management Plan (BMP), has covered these areas to maintain consistency of the bushfire management approach among the proponent's land holdings and to ensure futureproofing of the future adjoining development stages. Lot 9000 (to the west) has not been considered within this BMP as this land is under separate ownership and significantly separated from the project area.

The Development Concept Plan for the Structure Plan Amendment area is contained within Figure 1 and identifies proposed:

- Residential development cells with a range of R-code densities (R25-R40)
- Special Use – Retirement village site
- Public Purposes – Primary school site
- Commercial childcare and supermarket/specialities sites
- Indicative internal road layout including neighbourhood connectors and an additional connection to Bussell Highway (with four more connections as part of the wider Structure Plan area)
- Areas of Public Open Space (POS) and drainage in accordance with the EPBC Act Approval requirements, including landscape buffers to existing and future major roads.

Key modifications to the previously endorsed Structure Plan design include:

- Modified lot layout and mix of residential typologies
- Modified road layout including adjusted position of the proposed additional road connection to Bussell Highway
- Reconfiguration of the Neighbourhood Centre
- Potential Retirement Living precinct and childcare facilities
- Sporting oval to be located within the primary school site.

As mentioned above, this BMP will consider the full Structure Plan area (excluding Lot 9000) holistically to ensure consistency of bushfire management planning for the site.

Stage 1 subdivision (see Figure 2) was approved by the Western Australian Planning Commission (WAPC) on 9 September 2022 (WAPC Ref: 162371) and subdivision clearances are currently being sought by the proponent. Construction of Yalyalup Corner is currently being progressed, with subdivision approval being granted on 21 December 2017 (WAPC Ref: 155785).

1.2 Site description

The project area (as defined in Figure 2) is approximately 185 ha and occupies a large portion of undeveloped rural land which is currently subject to livestock grazing and was previously used for

sand-mining purposes. There are scattered patches of remnant native forest and wetland scrub vegetation throughout the project area that will be largely retained within proposed POS.

The project area is surrounded by (see Figure 2):

- existing residential development within adjoining Provence Estate, directly to the west of the project area boundary
- the vegetated Bussell Highway reserve immediately north, which runs parallel to the project area
- cleared farmland and fragmented remnant native vegetation to the north of Bussell Highway and directly to the east and south.

1.3 Bushfire prone designation

The vast majority of the project area is designated as bushfire prone on the *Map of Bush Fire Prone Areas* (DFES 2021; see Plate 1) due to on-site and adjoining vegetation hazards, including large areas of grassland.

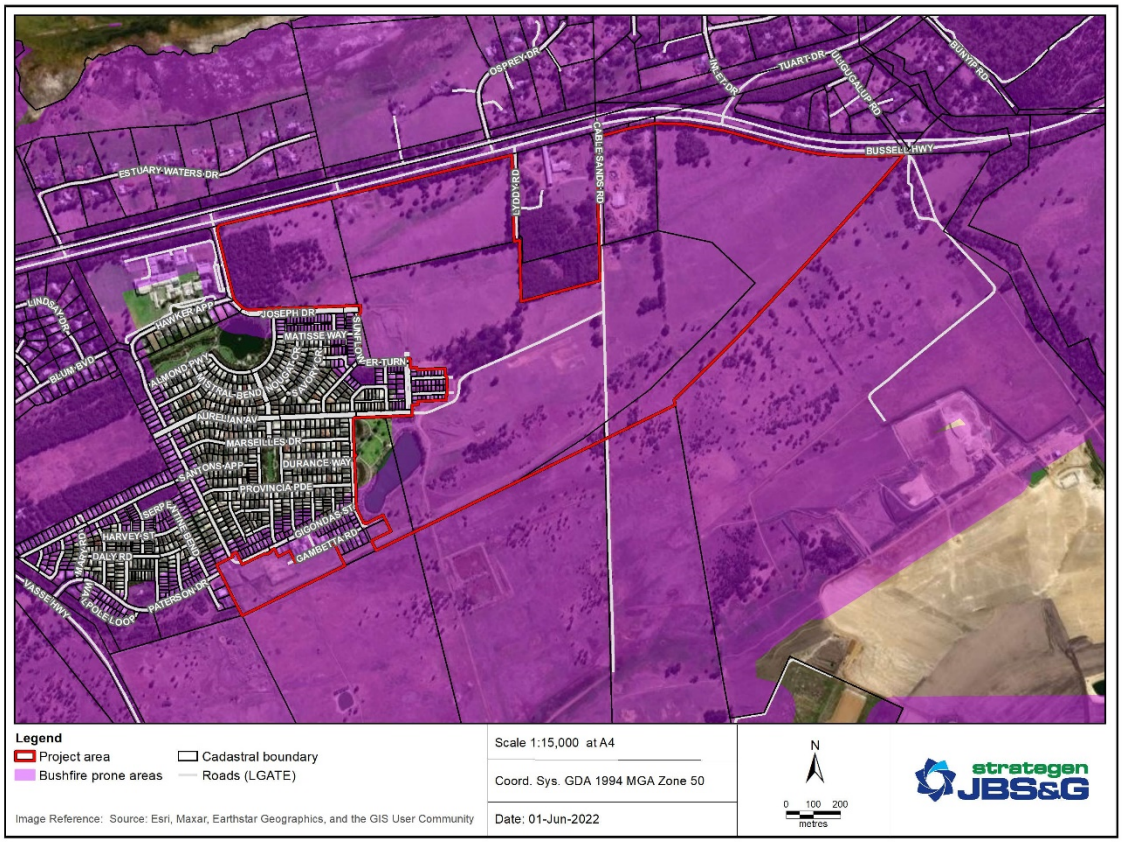


Plate 1: Map of Bush Fire Prone Areas (DFES 2021)

1.4 Purpose

This Bushfire Management Plan (BMP) has been prepared to address requirements under Policy Measures 6.2 and 6.3 of *State Planning Policy 3.7 Planning in Bushfire-Prone Areas* (SPP 3.7; WAPC 2015) and *Guidelines for Planning in Bushfire-Prone Areas Version 1.4* (the Guidelines; WAPC 2021).

1.5 Other plans/reports

Other reports that have been prepared for the project area are listed below.

1.5.1 2020 Provence Structure Plan

Reports prepared for Satterley Property Group to support the previous Provence Structure Plan application (2020) include:

- Provence Structure Plan (RPS 2020)
- Bushfire Management Plan (Ecosystem Solutions 2020)
- Environmental Assessment Report (RPS Group 2020)
- Local Water Management Strategy (JDA 2019)
- Transport Assessment (Jacobs 2020)
- Landscape Assessment (Emergency Associates 2020).

1.5.2 Current Structure Plan Amendment

JBS&G is aware of the following reports being prepared to accompany the current Structure Plan Amendment include:

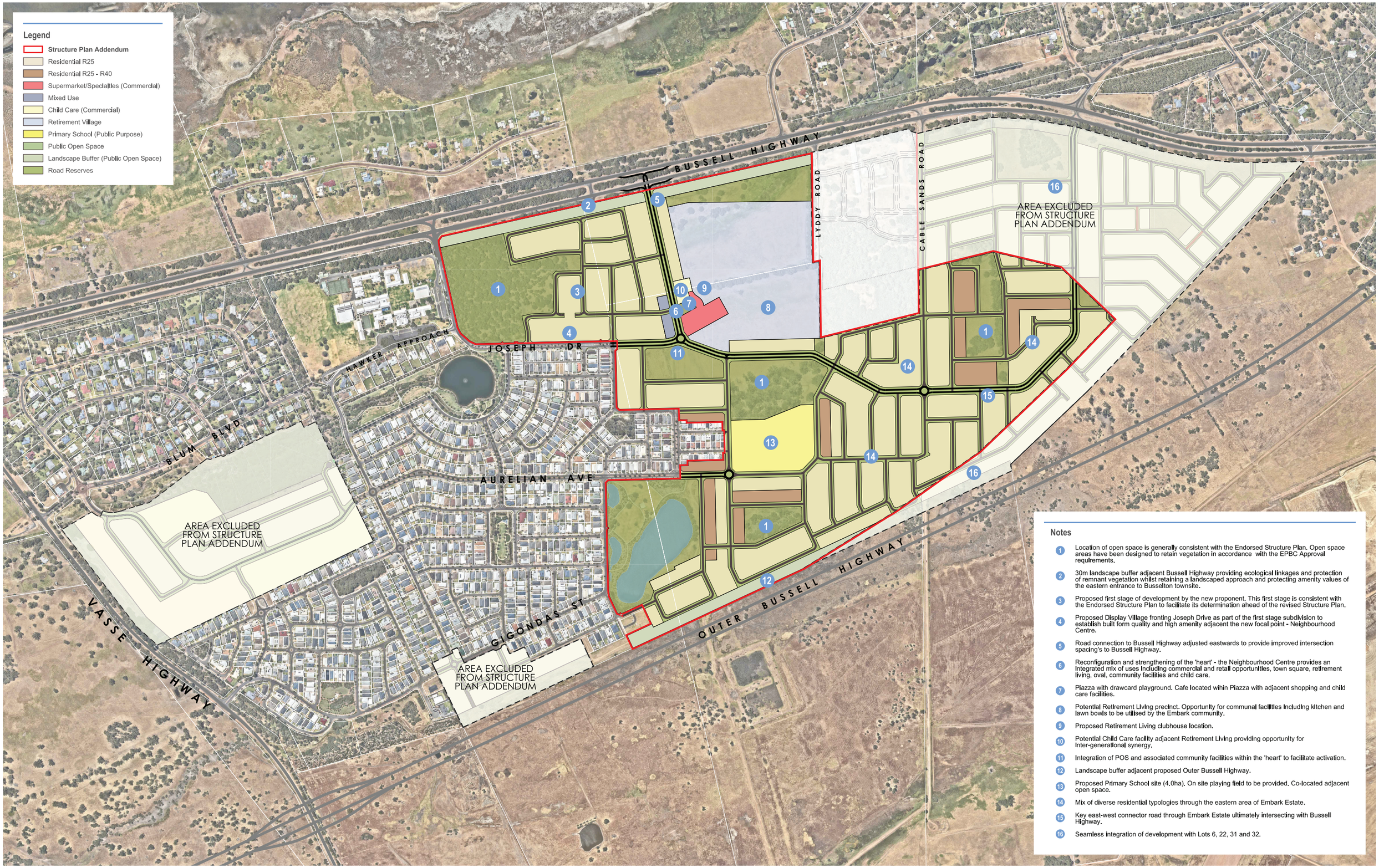
- Landscape Strategy (LD Total 2022)
- Environmental Assessment Report (RSP Group 2022)
- Western Ringtail Possum management Plan addendum (RSP Group 2022).

1.5.3 Stage 1 Embark Busselton, approved subdivision

- Bushfire Management Plan (JBS&G 2022) – prepared to support the subdivision application
- Bushfire Management Plan Compliance Report (JBS&G 2022) – in progress, currently being prepared to assist with WAPC subdivision clearances.
- Landscape Concept Plan (LD Total 2022).

1.5.4 Yalyalup Corner (portion Lot 9034), approved subdivision

- Bushfire Attack Level Contour Map Report (JBS&G 2022) – in progress, currently being prepared to rationalise BAL contours based on future landscaping/revegetation of the southern bund adjacent to the future Outer Bussell Highway.



Notes

1. Location of open space is generally consistent with the Endorsed Structure Plan. Open space areas have been designed to retain vegetation in accordance with the EPBC Approval requirements.
2. 30m landscape buffer adjacent Bussell Highway providing ecological linkages and protection of remnant vegetation whilst retaining a landscaped approach and protecting amenity values of the eastern entrance to Busselton townsite.
3. Proposed first stage of development by the new proponent. This first stage is consistent with the Endorsed Structure Plan to facilitate its determination ahead of the revised Structure Plan.
4. Proposed Display Village fronting Joseph Drive as part of the first stage subdivision to establish built form quality and high amenity adjacent the new focal point - Neighbourhood Centre.
5. Road connection to Bussell Highway adjusted eastwards to provide improved intersection spacing's to Bussell Highway.
6. Reconfiguration and strengthening of the 'heart' - the Neighbourhood Centre provides an integrated mix of uses including commercial and retail opportunities, town square, retirement living, oval, community facilities and child care.
7. Piazza with drawcard playground. Cafe located wihin Piazza with adjacent shopping and child care facilities.
8. Potential Retirement Living precinct. Opportunity for communal facilities including kitchen and lawn bowls to be utilised by the Embark community.
9. Proposed Retirement Living clubhouse location.
10. Potential Child Care facility adjacent Retirement Living providing opportunity for Inter-generational synergy.
11. Integration of POS and associated community facilities within the 'heart' to facilitate activation.
12. Landscape buffer adjacent proposed Outer Bussell Highway.
13. Proposed Primary School site (4.0ha). On site playing field to be provided. Co-located adjacent open space.
14. Mix of diverse residential typologies through the eastern area of Embark Estate.
15. Key east-west connector road through Embark Estate ultimately intersecting with Bussell Highway.
16. Seamless integration of development with Lots 6, 22, 31 and 32.

Development Concept Plan - Structure Plan Addendum

EMBARK ESTATE, YALYALUP

A Yolk Property Group Project

scale:
1:10,000@A3 | 1:5,000@A1

0 100 200m

plan:
22/010/022B

date:
20/12/2022

aerial:
Jan 2022

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Taylor Burrell Barnett



Legend

- Project area
- Structure Plan Amendment Area
- Area excluded from Structure Plan Amendment and BMP
- Stage 1 Embark (approved subdivision)
- Yalyalup Corner (approved subdivision)
- Cadastral boundary
- Environmentally sensitive areas (DWER)

Legislated lands and waters (DBCA)

- Section 5(1)(h) Reserve
- Nature reserve
- National Park
- State Forest

Geomorphic Wetlands

- Conservation
- Watercourses
- Roads

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Job No: 62376	
Client: Yolk Property Group	
Version: A	Date: 09-Dec-2022
Drawn By: jcrute	Checked By: CT

Scale 1:15,000 at A3

0 250 500
metres

Coord. Sys. GDA 1994 MGA Zone 50

Provence Estate
Yalyalup, WA

SITE OVERVIEW

FIGURE 2

File Name: W:\Projects\1)Open\Yolk Property Group\62376 Provence LSP BMP Amendment\GIS\Maps\R01_Rev_A\62376_02_A3_SiteOverview.mxd
Image Reference: Source: Esri, Maxar, Earthstar Geographics, and the GIS User Community

2. Environmental considerations

2.1 Native vegetation - modification and clearing

Although it is evident that the project area has been historically cleared and is currently subject to livestock grazing, there are several areas of remnant native vegetation scattered throughout that hold environmental value.

RPS has prepared an Environmental Assessment Report (EAR; 2022a) to accompany the Structure Plan application which identifies the key environmental outcomes:

- Protection of 10.45 ha of Western Ringtail Possum (WRP) habitat within POS.
- Protection of 70 potential Black Cockatoo habitat trees within POS.
- Revegetation within the proposed landscape buffers to Bussell Highway (in the north) and Outer Bussell Bypass (in the south)
- Implementation of the WRP management plan (Coffer 2009) and addendum (RSP 2022b) to protection WRP in their habitat and ensure compliance EPBC approval conditions
- Establishment of best practice water sensitive urban design and stormwater drainage management as per the Water Management Strategy prepared by JDA Consulting Hydrologists.
- Implementation of management measures to suitably reduce potential bushfire impact on future habitable buildings.

JBS&G understands that numerous environmental surveys have been conducted across the site in relation to previous planning stages and the recently endorsed Structure Plan application.

A summary of environmental values sourced via review of the EAR and publicly available data over the project area are discussed in Table 1.

Table 1: Summary of environmental values

Environmental value	Mapped as occurring within or adjacent to the project area		Description
	Within	Adjacent	
Environmentally Sensitive Area	✘	✓	The closest known ESA is less than 500m from the project area, north of Bussell Highway. The ESA is associated with the Geomorphic Wetlands which includes both Conservation Wetlands and Multiple Use Wetlands (Vasse Wonnerup Wetlands) as well as the Tuart Forest National Park and Sabina Nature Reserve. The proposed development is not known to impact on this ESA.
Swan Bioplan Regionally Significant Natural Area	✘	✘	N/A
Ecological linkages	✓	✓	The proposed on-site POS areas (including landscape buffers to Bussell Higher and the Outer Bussell Highway) and existing native vegetation within the project area form a vegetated link between fauna habitable within the project area and surrounds.

Environmental value	Mapped as occurring within or adjacent to the project area		Description
Wetlands	✓	✓	Multiple Use wetlands (MUW; Geomorphic wetlands of the swan coastal plain) are located within several lineal bands across the project area. MUWs have few important ecological attributes and functions remaining and there are no restrictions to development within these areas. The Vasse Wonnerup Wetlands (Conservation and Multiple-Use) are identified north of Bussell Highway and are a listed Ramsar site. The proposed development is not known to impact these wetland areas.
Waterways	✓	✓	An artificial lake exists in the southwest portion of the project area. Sabina River runs in a northerly direction crossing the Bussell Highway, just east of the project area boundary. Vasse River is located 3 km west of the project area and runs in a northerly direction into the Vasse Estuary. Water Management Strategy has been prepared as per EBPC approval conditions and subsequently endorsed to ensure hydrological regimes and quality of ground and surface water are maintained and protected. Urban Water Management Plans will be prepared at subdivision stage.
Threatened Ecological Communities listed under the EPBC Act	✗	✓	Tuart Woodlands and Forests of the Swan Coastal Plain Threatened Ecological Community are mapped as occurring less than 1 km to the north-east of the project area. Tuart/Peppermint forest within the project area is identified for retention within POS.
Threatened and priority flora	✗	Mapping layer not available	Given the historical clearing and consequential grazing of the land, it is considered that threatened and priority flora are unlikely to occur within the grassland area proposed for development. This is confirmed by a study by Ecosystem Solutions in 2016 that did not record any Threatened or Priority flora species.
Fauna habitat listed under the EPBC Act	✓	✓	All of the existing native vegetation within the project area is mapped as being located within an area containing suitable habitat for western ringtail possums. Black Cockatoo roosting sites have been confirmed to occur within 10km of the project area and there are confirmed breeding areas for Carnaby's Black Cockatoo mapped as occurring within the north-east of the project area. Furthermore, the majority of species within the project area are suitable for foraging habitat for Black Cockatoos. The survey by Ecosystem Solutions identified 77 potential breeding trees within the site. The previous Structure Plans have regulated Matters of National Environmental Significance to date through conditions outlines within conditional approval of EPBC 2004/1878 in April 2006 and variation in July 2008.
Threatened and priority fauna	✓	Likely	Vegetation surveys carried out by Ecosystem Solutions (2016) identified WRP within the project area. Areas containing WRP will be conserved within proposed POS.
Bush Forever Site	✗	✗	N/A
DBCA managed lands and waters (includes legislated lands and waters and lands of interest)	✗	✓	The project area is surrounded by several land parcels managed by DBCA including: • Sabina Nature Reserve (north) • Ludlow State Forest (north) • Tuart Forest National Park (north) • Ngari Capes Marine Park (north-west) • Millbrook State Forest (south-east) • Whicher National Park (south) • Jarrahwood State Forest (south-east). The proposed development is not expected to impact these areas.
Conservation covenants	✗	✗	N/A

Environmental value	Mapped as occurring within or adjacent to the project area		Description
Heritage Place	✘	✓	There is a registered Aboriginal Heritage Site (ID38904) north of the project area which is associated with the Vasse Wonnerup Wetlands. The proposed development is not expected to impact this area.

2.2 Revegetation / Landscape Plans

A Landscape Strategy has been prepared by LD Total (2023) to guide future landscaping, revegetation, and retention of existing remnant native vegetation throughout the project area. Relevant pages from this plan are included in Appendix A.

Landscaping treatments within POS are proposed to comprise:

- Retention of existing native vegetation on-site within POS. Certain areas will be subject to revegetation to improve Western Ringtail Possum (WRP) habitat.
- Retention of existing native vegetation and revegetation along the northern boundary to create a northern 'ecological linkage' for WRP and maintain visual amenity.
- Revegetation of a bund along the southern project area boundary as a buffer to the future Outer Bussell Highway.
- Establishment of low threat landscaping including irrigated garden beds, open turfed areas, playgrounds and paths.

Detailed landscaping plans will be prepared for each stage of subdivision to ensure proposed landscaping meets the separate objectives of bushfire mitigation, biodiversity protection, and water management.

3. Bushfire assessment results

3.1 Assessment inputs

3.1.1 Methodology

Vegetation classification

JBS&G assessed classified vegetation and exclusions within the project area and adjoining 150 m (the assessment area) through on-ground verification on 15 June 2022 in accordance with *AS 3959-2018 Construction of Buildings in Bushfire-Prone Areas* (AS 3959; SA 2018) and the *Visual Guide for Bushfire Risk Assessment in Western Australia* (DoP 2016).

Georeferenced site photos and a description of the vegetation classifications and exclusions are contained in Appendix B, with vegetation plots being depicted in Figure 3 (pre-development conditions) and Figure 4 (post-development conditions).

Effective slope

JBS&G assessed effective slope under classified vegetation within the assessment area through on-ground verification on 15 June 2022 in accordance with AS 3959. Results were cross-referenced with DPIRD 2m contour data and are depicted in Figure 3.

The topography of the project area and surrounding land is characterised by flat and low-lying land, typical of the surrounding Vasse and Busselton locales. Elevation ranges from 4 m Australian Height Datum (AHD) to 12 m AHD. As such, land under classified vegetation has an effective slope of 0 degrees (i.e. flat/upslope) in relation to future proposed development.

3.1.2 Pre-development inputs

Existing classified vegetation

Regional vegetation surveys and mapping of the Swan Coastal Plain indicate the project area and adjacent land is contained within the Yoongarillup Complex and the Cokelup Complex. These vegetation complexes are described as:

- Woodland to tall woodland of *Eucalyptus gomphocephala* (Tuart) with *Agonis flexuosa* (Peppermint) in the second storey. Less consistently an open forest of *Eucalyptus gomphocephala* (Tuart) – *Eucalyptus marginata* (Jarrah) – *Corymbia calophylla* (Marri). South of Bunbury is characterized by *Eucalyptus rudis* (Flooded Gum) – *Melaleuca species* open forests.
- Closed-scrub/woodland of *Melaleuca species* over sedges and annually renewed herbs on inundated clay flats. Fringing open forest of *Eucalyptus rudis, Corymbia calophylla – Banksia littoralis – E. gomphocephala*.

The vegetation complexes described above are generally consistent with the vegetation structures observed during the site assessment, which comprise a combination of Class A Forest (Peppermint woodland; Peppermint woodland with Jarrah, Marri and Tuart; and mature Tuart forest), Class B Woodland (Eucalypts over grassland), and Class D Scrub (*Melaleuca species* over grassland).

Existing low threat vegetation and non-vegetated areas

Existing low threat vegetation and non-vegetated areas within and surrounding the project area comprise the following:

- Non-vegetated area excluded under Clause 2.2.3.2 (e), including footpaths, buildings, roads, and water bodies.

- Low threat vegetation excluded under Clause 2.2.3.2 (f), including grassland maintained below 100 mm in height with enforceability for ongoing management under the City's annual firebreak notice (Appendix C), existing low threat landscaped and managed POS areas, manicured lawns and managed residential gardens and properties.

Summary of inputs

A summary of the assessed pre-development classified vegetation, exclusions and effective slope within the project area and adjacent 150 m are listed in Table 2 and illustrated in Figure 3.

Table 2: Pre-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class A Forest	Flat/upslope (0°)	Forest vegetation dominated by *Agonis flexuosa* (WA peppermint), *Eucalyptus marginata* (Jarrah) *Eucalyptus gomphocephala* (Tuart) and *Corymbia calophylla* (Marri) 10-30 in height with a multi-tiered fuel structure, including a juvenile eucalypt/shrubby understorey.
2	Class B Woodland	Flat/upslope (0°)	Woodland vegetation comprising *Agonis flexuosa* or mature Eucalypts. Sparse canopy cover and low surface fuels are evident. The understorey is characterised by grassland which is primarily grazed.
3	Class D Scrub	Flat/upslope (0°)	Scrub vegetation comprised of mature melaleuca trees, up to 6 m in height.
4	Class G Grassland	Flat/upslope (0°)	Unmanaged grassland vegetation greater than 10 cm in height at maturity.
5	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	Existing non-vegetated areas (i.e., cleared vacant lots, roads, driveways, buildings, footpaths) and low threat managed vegetation (i.e. mowed lawns, managed gardens, existing dam, slashed road verges, managed POS, street trees).

3.1.3 Post-development inputs

Post-development classification considers vegetation that will be cleared to facilitate construction of the proposed urban and commercial cells, along with retention and rehabilitation of existing remnant native vegetation within POS throughout the project area.

The post-development vegetation classifications for all land external to the project area are expected to remain the same as for the pre-development classifications. If external vegetation is altered prior to future planning stages, the change in vegetation condition is to be captured through a future BHL assessment or BAL contour map assessment.

Classification of Public Open Space

A summary of the proposed POS cells, landscaping/revegetation treatments and potential classification under AS 3959 are detailed in Figure 2. Refer to the Landscape Plan (Appendix A) for the POS locations and further details on proposed landscaping.

Table 3: Proposed landscaping treatments and classification/exclusion under AS 3959

POS Cell/area	Location	Proposed landscaping treatments	Potential AS 3959 classification/exclusion	Post-development BHL assessment	
				AS 3959 classification/exclusion	Plot
POS 1	Conservation POS adjacent west of Stage 1 Embark	Rehabilitation of existing Peppermint woodland with understorey species.	Class A Forest	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
		Minor areas of turf in the southeast adjacent to Stage 1.	Minor areas of low threat vegetation (Exclusion 2.2.3.2 [f])		

POS Cell/area	Location	Proposed landscaping treatments	Potential AS 3959 classification/exclusion	Post-development BHL assessment	
				AS 3959 classification/exclusion	Plot
POS 2	Conservation POS internal to Stage 1 Embark	Rehabilitation of existing Peppermint woodland with understorey species.	Class A Forest	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
		Fringing areas of turf and managed garden beds.	Low threat vegetation (Exclusion 2.2.3.2 [f])		
POS 3	Directly north of the proposed Retirement Village site	Retention of existing wetland scrub vegetation and planted drainage basins.	Class D Scrub with vegetation retention areas and drainage basins.	Class D Scrub (precautionary noting detailed design will be considered at subdivision stage)	Plot 3
		Open turf areas.	Low threat vegetation (Exclusion 2.2.3.2 [f])		
POS 4	Lot 9003	N/A Lot 9003 is not considered within this BMP			
POS 5	Town Square	Open turf areas, irrigated shrub and tree planting, revegetated woodland areas, sports facilities and playground.	Combination of low threat vegetation (Exclusions 2.2.3.2 [e] & [f]) and areas subject to native planting/revegetation (e.g. Class C Shrubland, Class D Scrub, Class B Woodland, Class A Forest)	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
POS 6	Adjacent to school site and PAW north	Retention of mature Tuart forest	Class A Forest	Class A Forest	Plot 1
		Native garden beds, open turf areas.	Low threat vegetation (Exclusions 2.2.3.2 [e] & [f])	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
POS 7	Existing POS adjoining Lake	Existing irrigated garden beds, open turf, drainage basins	Low threat vegetation (Exclusions 2.2.3.2 [e] & [f])	Low threat vegetation (Exclusions 2.2.3.2 [e] & [f])	Plot 5
POS 8	South of school site	Retention of scrub and forest vegetation	Exclusion [b] – single areas of vegetation less than 1 ha in area and not within 100 m of classified vegetation	Exclusion [b]	Plot 6
		Native garden beds, open turf, playground			
POS 9 & 10	In the east of the site	Retention of existing forest vegetation	It is anticipated that future landscaping can be designed to meet exclusion under exclusion clauses 2.2.3.2 [b], [c], [d], [e] or [f], but may include areas of classified vegetation (e.g. Class C Shrubland, Class D Scrub, Class B Woodland, Class A Forest).	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
		Native garden beds, open turf, playground			
POS 11	In the northeast of the site	Retention of existing forest vegetation	Class A Forest	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
		Drainage basin	Class C Shrubland/Class D Scrub		
		Native garden beds, open turf, playground	Low threat vegetation (Exclusions 2.2.3.2 [e] & [f])		
POS 12 & 13	In the east of the site	Native garden beds, open turf, playground	Low threat vegetation (Exclusions 2.2.3.2 [e] & [f]), or Exclusion [b])	Exclusion [b] (precautionary – demonstrates that any unmanaged vegetation will be excludable)	Plot 6

POS Cell/area	Location	Proposed landscaping treatments	Potential AS 3959 classification/exclusion	Post-development BHL assessment	
				AS 3959 classification/exclusion	Plot
POS 14	Landscape buffer to Bussell Highway in the northeast of the site	Retention of existing forest vegetation, native shrub planting and trees	Class A Forest (noting areas of low threat vegetation and drainage may be incorporated into the buffer)	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
POS 15	Landscape buffer to Bussell Highway in the northwest of the site	Retention of existing forest vegetation, native shrub planting and trees	Combination of Class A Forest and Class C Shrubland, to be confirmed during detailed design	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1
POS 16	Landscape buffer to the Outer Bussell Highway in the south of the site	Retention of minimal existing vegetation, native shrub planning and trees, drainage swales	Combination of Class A Forest and Class C Shrubland, to be confirmed during detailed design	Class A Forest (precautionary noting detailed design will be considered at subdivision stage)	Plot 1

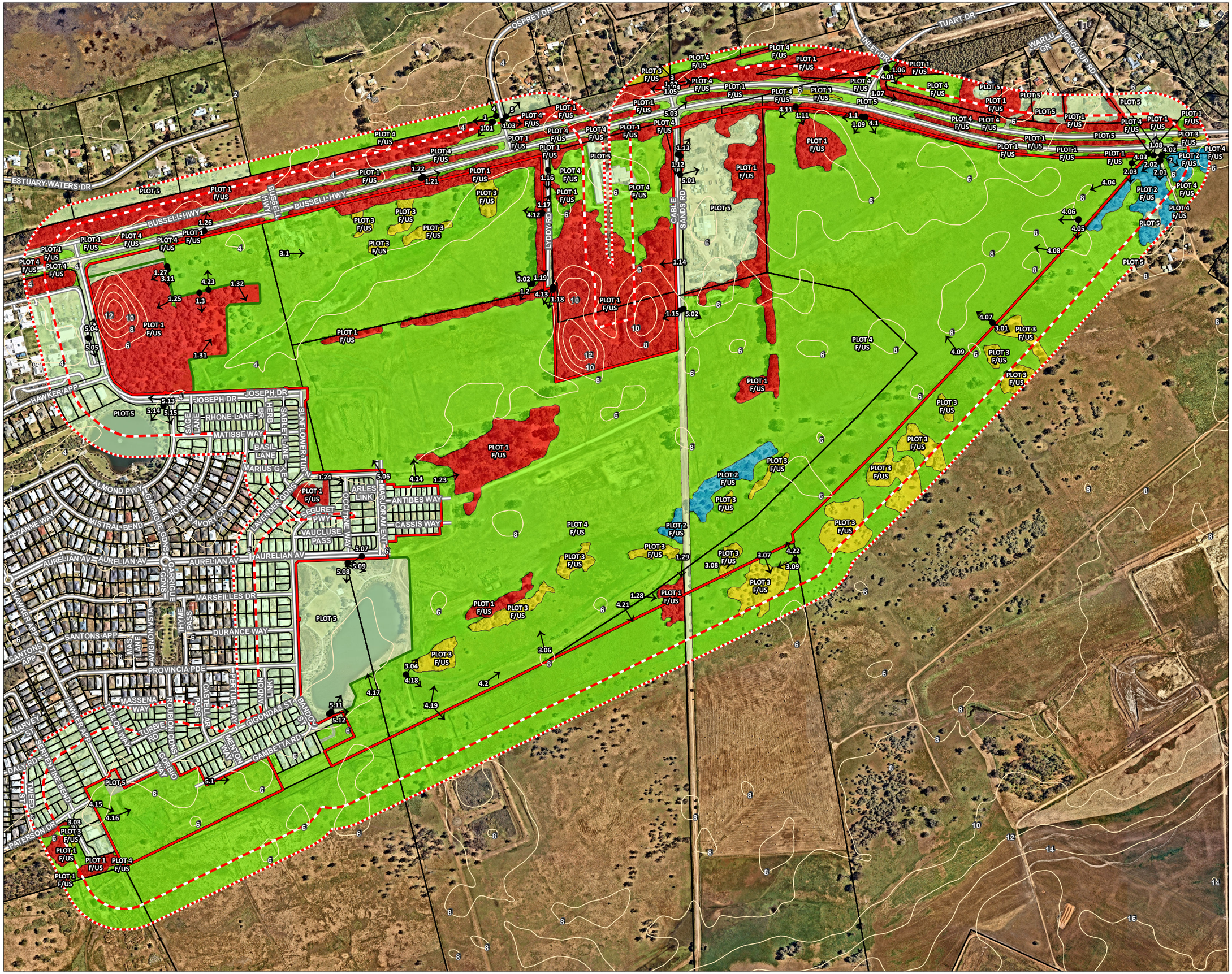
Summary of inputs

A summary of the anticipated post-development classified vegetation, exclusions and effective slope within the project area and adjacent 150 m are listed in Table 4 and illustrated in Figure 4.

Table 4: Post-development vegetation classifications/exclusions and effective slope

Vegetation plot	Vegetation classification	Effective slope	Comments
1	Class A Forest	Flat/upslope (0°)	• As per the pre-development conditions, aside from minor areas of forest vegetation that will be cleared to facilitate urban development. • Includes additional forest revegetation within the landscape buffers to Bussell Highway and the future Outer Bussell Highway and other areas of POS. • Several areas of pre-development forest may be excludable post-development by meeting low threat vegetation criteria, however have been classified as forest as a precautionary measure (to be confirmed through detailed design) • Includes areas of POS where there is potential for revegetation to occur (precaution only until detailed landscaping design is available).
2	Class B Woodland	Flat/upslope (0°)	• As per pre-development conditions external to the project area (adjacent northeast). • Remnant pre-development woodland vegetation will be cleared for future urban development within the project area.
3	Class D Scrub	Flat/upslope (0°)	• As per pre-development conditions external to the project area (adjacent east). • POS 3 contains existing scrub vegetation. The entire cell has been classified as scrub as a precaution until detailed landscaping design is available.
4	Class G Grassland	Flat/upslope (0°)	• Grassland within the project area will be fully cleared on completion of development construction. • Areas of grassland external to the project area have been classified where the firebreak notice does not provide for enforcement of management of this land.
5	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])	N/A	As per pre-development conditions, except where revegetation is proposed (e.g. adjacent to the Joseph Drive/Bussell Highway intersection).
6	Excluded – Clause 2.2.3.2 [b]	N/A	Various POS cells that will be excludable due to the vegetation being single areas of vegetation less than 1 ha in area and not within 100 m of classified vegetation.

Vegetation plot	Vegetation classification	Effective slope	Comments
7	Area to be modified to low threat (Excluded Clause 2.2.3.2 [e] and [f])	N/A	All areas within the project area that will be cleared and managed in a low threat/non-vegetated state on an ongoing basis.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- POS
- Lake

Vegetation classification

- Class A Forest
- Class B Woodland
- Class D Scrub
- Class G Grassland
- Clause 2.2.3.2 (e) & (f)

- Photo point directions
- Topographic contours (mAHD)
- Roads

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Job No: 62376	
Client: Yolk Property Group	
Version: A	Date: 13-Dec-2022
Drawn By: jcrute	Checked By: CT

Scale 1:8,300 at A3

0 100 200
metres

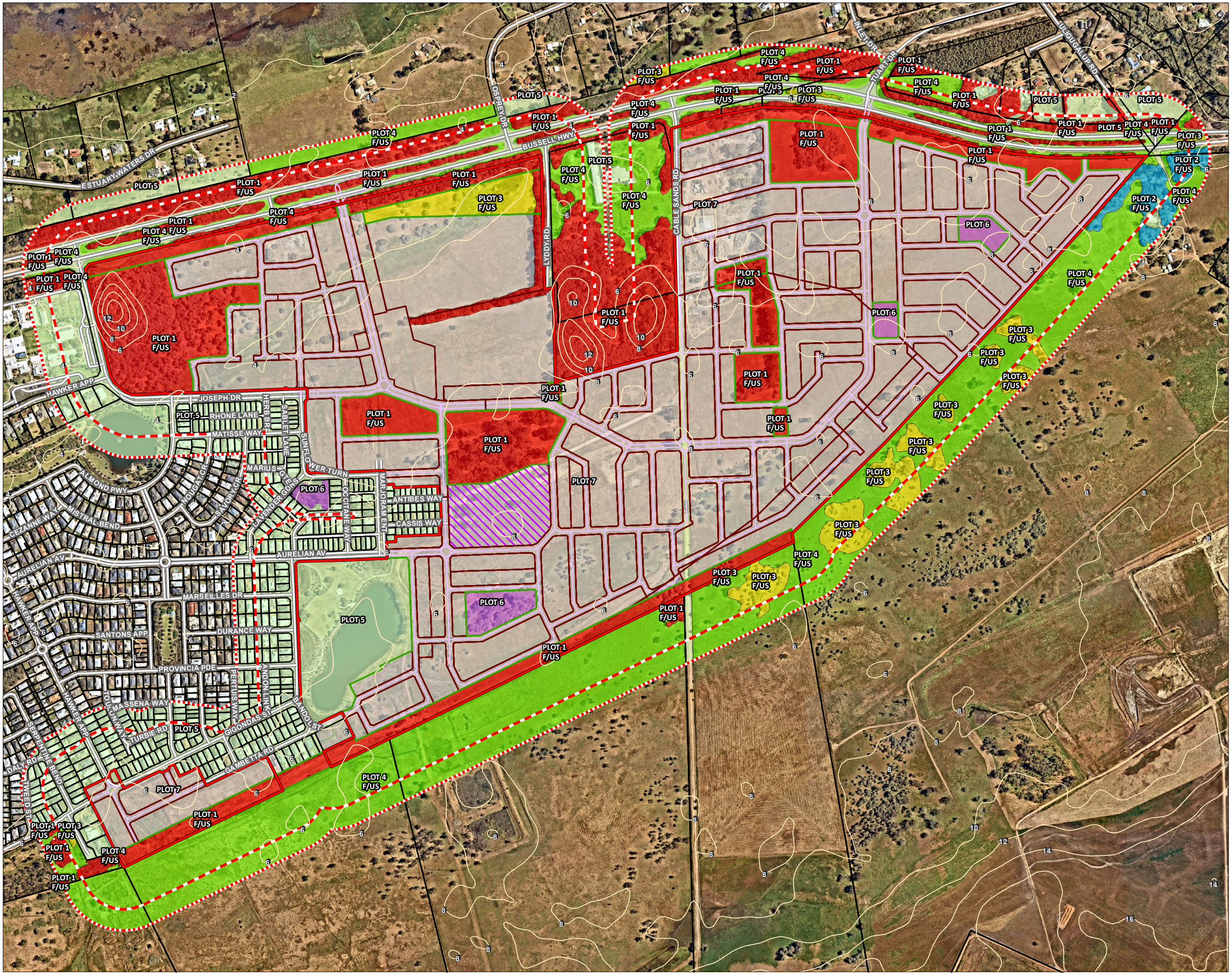
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Provence Estate
Yalyalup, WA

PRE-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 3

File Name: W:\Projects\1)Open\Yolk Property Group\62376 Provence LSP BMP Amendment\GIS\Maps\R01_Rev_A\62376_03_A3_PreDevVegClass.mxd
Image Reference: www.nearmap.com© - Imagery Date: 30. September 2022.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Proposed development
- Primary school
- Lake
- POS

Vegetation classification

- Class A Forest
- Class B Woodland
- Class D Scrub
- Class G Grassland
- Clause 2.2.3.2 (b)
- Clause 2.2.3.2 (e) & (f)
- Area to be modified to non-vegetated and low threat state
- Topographic contours (mAHD)
- Proposed carriageways
- Roads

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Job No: 62376	
Client: Yolk Property Group	
Version: A	Date: 17-May-2023
Drawn By: droberts	Checked By: CT

Scale 1:8,300 at A3

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Coord. Sys. GDA 1994 MGA Zone 50

Provence Estate
Yalyalup, WA

POST-DEVELOPMENT VEGETATION CLASSIFICATION AND EFFECTIVE SLOPE

FIGURE 4

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3.2 Assessment outputs

3.2.1 Bushfire Hazard Level (BHL) assessment

Pre and post-development vegetation extents have been assigned a bushfire hazard level in accordance with the methodology detailed in Appendix Two of the Guidelines as outlined in Table 5.

Table 5: Bushfire hazard levels and characteristics

Bushfire hazard level	Characteristics*
Extreme	• Class A Forest • Class B Woodland (05) • Class D Scrub • Any classified vegetation with a greater than 10° slope.
Moderate	• Class B Low woodland (07) • Class C Shrubland • Class E Mallee/Mulga • Class G Grassland, including sown pasture and crops • Class G Grassland: Open woodland (06), Low open woodland (08), Open shrubland (09) • Vegetation that has a low hazard level but is within 100 metres of vegetation classified as a moderate or extreme hazard, is to adopt a moderate hazard level.
Low	• Low threat vegetation may include areas of maintained lawns, golf courses, public recreation reserves and parklands, vineyards, orchards, cultivated gardens, commercial nurseries, nature strips and windbreaks • Managed grassland in a minimal fuel condition (insufficient fuel is available to significantly increase the severity of the bushfire attack). For example, short-cropped grass to a nominal height of 100 millimetre • Non-vegetated areas including waterways, roads, footpaths, buildings and rock outcrops.
*Vegetation classifications from AS 3959-2018 Table 2.3.	

3.2.1.1 Pre-development

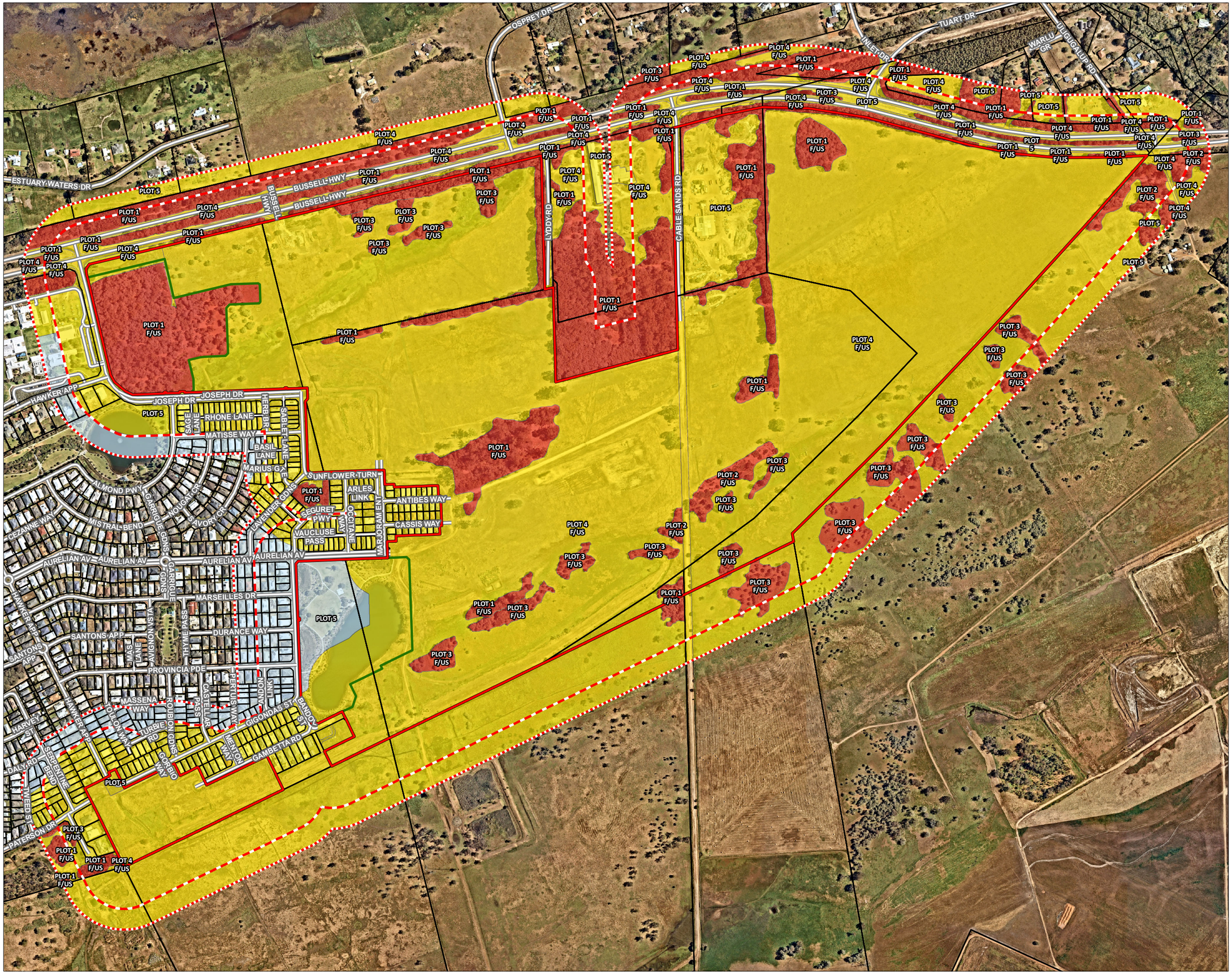
The pre-development bushfire hazard levels have been mapped within the project area and adjacent 150 m. The bushfire hazard levels have been assessed on the basis of the vegetation discussed in Section 3.1.2 (i.e. the current pre-development extent of vegetation within and surrounding the project area).

The pre-development BHL assessment (refer to Figure 5) shows that based on the existing vegetation, the project area contains land with **Low**, **Moderate** and **Extreme** bushfire hazard levels.

3.2.1.2 Post-development

The anticipated post-development bushfire hazard levels have been mapped to demonstrate that the future bushfire hazard levels will be acceptable for future development to occur within the project area. The bushfire hazard levels have been assigned on the basis of the vegetation discussed in Section 3.1.3 and the future expected vegetation extent within and surrounding the project area.

The post-development BHL assessment (refer to Figure 6) demonstrates that all future habitable development has capacity to be located on land with either a **Low** or **Moderate** bushfire hazard level.



Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- POS
- Lake

Hazard level

- Extreme
- Moderate
- Low
- Roads

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Job No: 62376	
Client: Yolk Property Group	
Version: A	Date: 13-Dec-2022
Drawn By: jcrute	Checked By: CT

Scale 1:8,300 at A3

0 100 200
metres

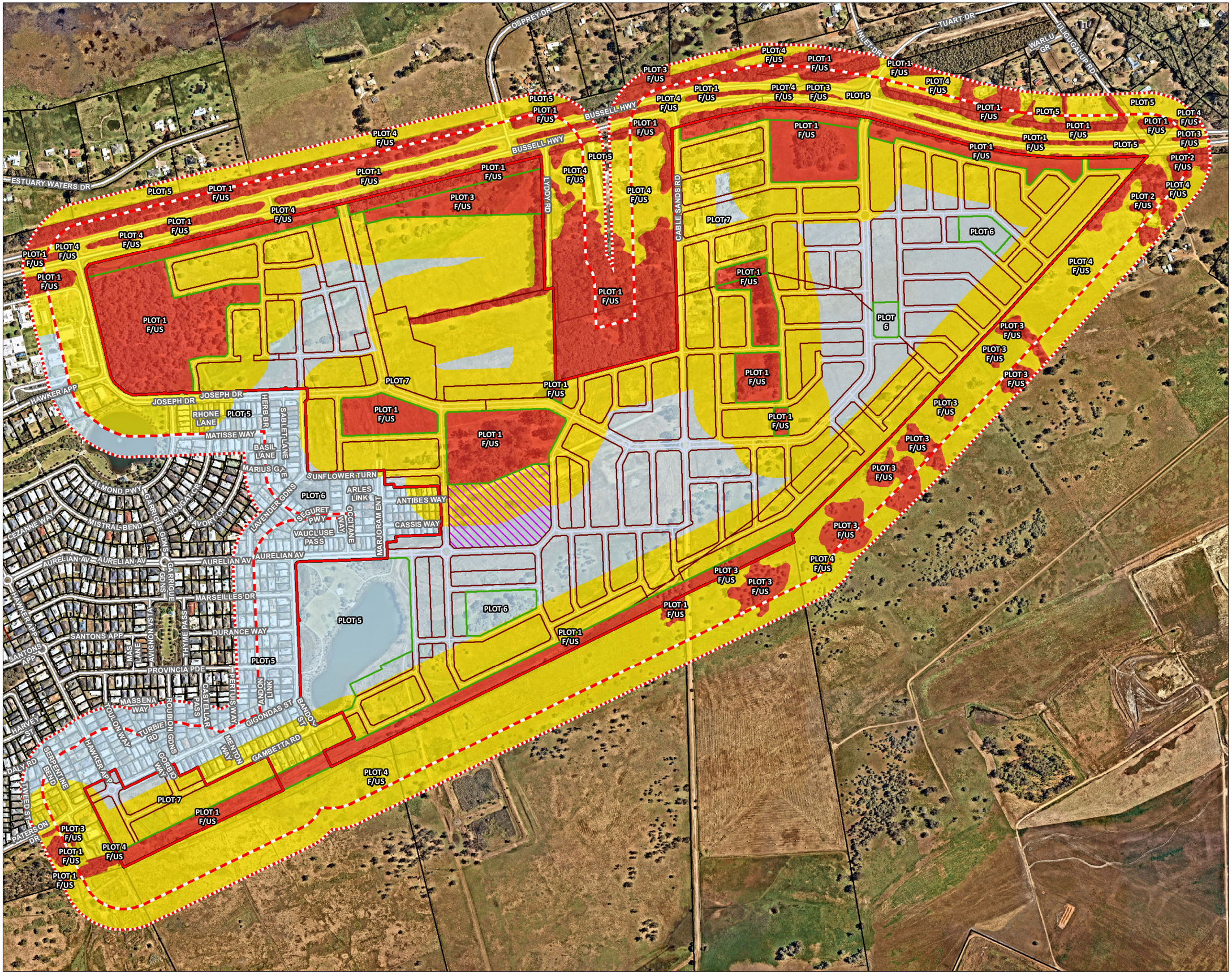
Coord. Sys. GDA 1994 MGA Zone 50

Provence Estate
Yalyalup, WA

PRE-DEVELOPMENT
BUSHFIRE HAZARD LEVELS

FIGURE 5

File Name: W:\Projects\1)Open\Yolk Property Group\62376 Provence LSP BMP Amendment\GIS\Maps\R01_Rev_A\62376_05_A3_PreDevBHLs.mxd
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Legend

- Project area
- 100m assessment area
- 150m assessment area
- Cadastral boundary
- Proposed development
- Primary school
- Lake
- POS

Hazard level

- Extreme
- Moderate
- Low
- Proposed carriageways
- Roads

strategen JBS&G

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Client: Yolk Property Group	
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Scale 1:8,300 at A3

0 100 200
metres

Coord. Sys. GDA 1994 MGA Zone 50

Provence Estate
Yalyalup, WA

POST-DEVELOPMENT BUSHFIRE HAZARD LEVELS

FIGURE 6

File Name: \\jbsg-wa-ad01.jbsg.aust\JBS Perth\Projects\1)Open\Yolk Property Group\62376 Provence LSP BMP Amendment\GIS\Maps\R01_Rev_A\62376_06_A3_PostDevBHLs.mxd
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4. Identification of bushfire hazard issues

4.1 Bushfire context

Bushfire prone vegetation surrounding the project area is predominantly rural pastureland and established residential areas, interspersed with areas of remnant standing vegetation comprising Eucalypt/Peppermint forest, Peppermint woodland, and scrub over grassland. There also several large areas of State Forest within 2-10 km of the project area which have potential to support carriage of a bushfire toward the site.

Tuart Forest National Park and Ludlow State Forest are located approximately 2 km to the northeast of the project area and comprise large areas of Tuart/Eucalypt/Peppermint forest and woodland with potential for landscape scale bushfire behaviour. The Bussell Highway road reserve, which runs immediately parallel to the northern project area boundary (and the future landscape buffer) is vegetated with a corridor of Eucalypt/Peppermint vegetation with connectivity to the abovementioned vegetation, and therefore has potential to support bushfire spread toward the project area and on-site conservation POS under adverse northerly and morning easterly wind conditions. Despite the connectivity to vegetation hazards within the wider area, the narrow width of the landscape buffer will act to moderate fire behaviour at the development interface in comparison to a fully developed, steady state bushfire.

The Whicher National Park and the Jarrahwood State Forest are less than 10 km to the south and have potential to support landscape scale bushfire due to vast expanses of intact Jarrah-Marri forest vegetation. There is potential for a fire occurring within this vegetation to spread toward the project area over the grassed landscape and via tree fringed drainage lines and roads under predominant summer morning and afternoon south westerly wind conditions. However, given the significant low fuel buffers provided by existing developed portions of Provence Estate, the risk is considered to be manageable in respect of the project area at the developed interfaces. Perimeter access at the exposed/non-developed interfaces will also assist with a fire suppression response prior to buildings being impacted, if required. The large areas of grassland between the forest reserves and project area are somewhat fragmented by the low threat areas in the landscape, such as the Busselton-Margaret River Airport and runway, which may act to moderate fire behaviour in the local area.

The Vasse Wonnerup Wetlands located to the north of Bussell Highway present permanent grassland and shrubland fuels which have potential to support bushfire spread under northerly wind conditions. Bussell Highway provides a significant interface/buffer between these areas and the project area.

In terms of internal bushfire hazards, many of the POS cells will be isolated amongst the residential landscape, therefore unmanaged vegetation within these area poses minimal risk to habitable development within the project area. The more substantial stands of retained/rehabilitated vegetation (including off-site dense forest located between Liddy Road and Cable Sands Road) will be addressed through provision of perimeter access (for a direct fire suppression response) and provision of building setbacks to create suitable separation.

Bush Fire Brigades stationed within the Busselton townsite on Cammilleri Court are expected to provide a best-case emergency suppression response time of 15-20 minutes should a bushfire threaten development within the project area. Perimeter roads will facilitate a direct fire suppression response at the development interface and multiple access/egress options will enable evacuation of the area by occupants and ingress by firefighters.

Although there is bushfire risk within the locality of Yalyalup, this is considered to be manageable for the project area due to the predominantly grassland interfaces, patchiness of remnant vegetation surrounding the project area and sufficient emergency services access as the vegetation interfaces

that will be incorporated into detailed subdivision design. The proposed subdivision has been designed to minimise the risk posed by these hazards through the bushfire mitigation measures proposed within this BMP, which are discussed below and in Section 5. These responses have been factored in to proposed development as early as possible at all stages of the planning process to ensure a suitable, compliant and effective bushfire management outcome is achieved for protection of future life, property and environmental assets.

4.2 Bushfire hazard issues and proposed mitigation measures

Examination of strategic development design in accordance with the Structure Plan, bushfire context and pre-development and post-development bushfire hazard levels has identified bushfire hazard issues to be considered at future planning stages. These bushfire hazard issues, and proposed mitigation measures are detailed in Table 6 and are also considered in the compliance assessment in Table 7 (Section 5).

JBS&G considers the bushfire hazards within and adjacent to project area and the associated bushfire risks are manageable through the development of these mitigation measures and will result in suitable levels of defendable space, compliant APZs, suitable access provisions, appropriate firefighting water supply and increased building construction standards. These measures should be reviewed at all stages of the planning process to ensure a suitable, compliant, and effective bushfire management outcome is achieved for protection of future life, property and environmental assets.

Table 6: Bushfire hazard issues and bushfire management measures

No.	Bushfire hazard issue	Proposed mitigation measures
1	The project area is subject to bushfire risk which warrants consideration at Structure Plan and all subsequent planning stages.	Bushfire mitigation measures proposed within this strategic level BMP take into consideration the local bushfire risk context and aim to minimise these risks by providing for appropriate siting of habitable development, large areas of low threat/BAL-Low internal spaces, multiple vehicular access options, including additional connections to Bussell Highway and perimeter access to internal vegetation hazards, and an on-site fire-fighting water supply, as discussed below. Perimeter access to external vegetation hazards requires further consideration at subdivision design stage.
2	Future habitable development is to be located in areas subject to a Moderate or Low BHL	The project area contains Extreme bushfire hazard level areas not suitable for habitable development. However, the post-development BHL assessment demonstrates that on completion of development, all habitable development areas will be located on land with a Low or Moderate bushfire hazard level. A BAL contour assessment will be commissioned at future planning stages (i.e. subdivision) to demonstrate at a more detailed level that all development will be located within areas of BAL-29 or below. Therefore, the development can comply with Acceptable Solution A1.1 of the Guidelines.
3	Revegetation is expected to occur within areas of open space which requires consideration in the context of post-development bushfire hazard levels.	The BHL assessment makes some worst-case assumptions around vegetation classification and extent given landscaping design (as per Appendix A) is still conceptual. It is likely that the extent of classified vegetation within some of the POS cells will be reduced and this will be factored into BAL contour assessments prepared at subdivision stage. The on-site POS hazards will be mitigated through the provision of public roads, and APZs at the interfaces adjoining open space and will be sufficient for adjoining habitable development to achieve BAL-29 or below. Therefore, areas where revegetation is proposed are considered suitable in the context of the proposed development. BAL contour assessments carried out at subdivision stage will consider detailed landscaping design to further investigate the impacts of revegetation on habitable development and ensure that revegetation does not result in unacceptable impacts on future development. Provision of suitable separation to the POS vegetation hazards is discussed below.

No.	Bushfire hazard issue	Proposed mitigation measures
4	The retention and rehabilitation of on-site vegetation within POS will result in interfaces between vegetation hazards and habitable development. An appropriate APZ and BAL response is to be implemented at these interfaces.	All future lots proposed at the interface with vegetated POS will be provided with APZs sufficient for habitable development to achieve BAL-29. The APZs will be provided in the form of public roads, habitable building setbacks into lots (e.g. R-Code setbacks, APZ setbacks) and/or management of low threat areas within POS (as appropriate). The BAL-29 APZ widths likely to be required within the project area are as follows: • Plot 1 Class A Forest (Flat/upslope) = 21 m • Plot 2 Class B Woodland (Flat/upslope) = 14 m • Plot 3 Class D Scrub (Flat/upslope) = 13 m • Plot 3 Class G Grassland (Flat/upslope) = 8 m. APZs will be enforced through mandatory Residential Design Code (R-Code) setbacks, where the setbacks are sufficient to cater for the required BAL-29 APZ, restrictive covenant on title, and/or preparation of a Local Development Plan (LDP) as a condition of subdivision approval.
5	The Structure Plan design includes several direct interfaces between residential lots and POS. BAL impacts to the directly adjoining lots will need to be considered during detailed design at subdivision stage.	Detailed lot layout and landscaping design will be addressed at the subdivision stage of planning to ensure future habitable buildings can achieve BAL-29. For lots where the Structure Plan includes direct interfaces with POS, this will be demonstrated through consideration of separation provided by paved surfaces such as roads and paths, as well as any low threat vegetation within POS, as per an approved landscaping plan, and possible provision of APZ setbacks. Areas of native vegetation within POS may also meet the low threat criteria of AS 3959 Clause 2.2.3.2 (d), being vegetation that is <1 ha in area and not within 100 m of any areas of classified vegetation. Again, this will be determined at subdivision stage through preparation of a detailed landscaping plan.
6	Given the potential bushfire risk to the site, appropriate vehicular access is required for both egress by residents and visitors and firefighter access to and around the project area.	• The proposed internal vehicular access network will comply with the requirements of the Guidelines, with a focus on preventing entrapment of the public or firefighters in a bushfire scenario. This will be achieved through a continuous road network and all roads being through roads. • The surrounding road network and proposed internal roads will provide public road access for firefighting operations to be carried out. Perimeter roads and/or FSARs will be considered at subdivision stage to facilitate simultaneous evacuation and movements by emergency service vehicles. • Several legacy access non-compliances will be resolved by connecting the proposed road network to legacy dead-ends.
7	Any interface where perimeter roads/FSARs are not sufficient to provide the full separation required to achieve BAL-29 will require lot boundary setbacks (APZ setbacks) to ensure all habitable development is located in BAL-29 or below.	Where perimeter roads and/or FSARs are not sufficient for proposed lot boundaries to achieve BAL-29, APZ setbacks will be implemented at the vegetation interface to achieve the necessary separation. Detailed design will need to ensure the lots are of a size where the setbacks can be accommodated.
8	Future habitable buildings are to be constructed to withstand the appropriate level of bushfire attached given the project is located in a designated bushfire prone area.	Future Class 1, 2, 3 and associated 10a buildings in areas subject to BAL-12.5 or higher will be constructed to comply with the bushfire specific building construction requirements of AS 3959. Final BAL ratings will be confirmed during preparation of a BMP contour map and BMP compliance stage.

No.	Bushfire hazard issue	Proposed mitigation measures
9	Impacts of staged subdivision on bushfire risk, BALs and vehicular access will need to be considered at future planning stages.	**On-site staging buffers to mitigate temporary bushfire risk and BALs** If future development (and therefore clearing) is to occur on a staged basis, clearing in advance of adjacent areas will need to occur to ensure building construction is not inhibited by any temporary vegetation extents located within adjacent development stages yet to be cleared. This can be achieved by ensuring that each approved stage subject to construction is surrounded by a 100 m wide (or other distance confirmed by an accredited bushfire practitioner), on-site cleared or low threat buffer prior to development (not including vegetation proposed to be retained). Once the buffers are created, they will need to be maintained on a regular and ongoing basis to achieve a low threat minimal fuel condition all year round until such time that the buffer area is developed as part of the next development stage. This will assist in managing the on-site temporary vegetation hazards. **Vehicle access staging** Vehicle access arrangements will need to ensure that each stage of subdivision is provided with at least two vehicular access routes to two different destinations at all stages. This may be achieved via construction of access in advance of stages or through provision of temporary emergency access ways until two formal access roads are available.
10	The potential school and childcare centre represent vulnerable land uses and will require additional consideration of bushfire risk at subdivision and DA stage. The Retirement Village also has potential to present a vulnerable land use and requires consideration.	The proposed school and retirement village sites are relatively large and will be provided with multiple access routes, therefore future development is expected to be able to meet compliance with the bushfire protection criteria within the lot boundaries, as required. The proposed childcare site is located within the commercial centre, adjacent to the retirement village and will also be serviced by sufficient access. Both the school and retirement villages are adjacent to vegetated POS which will require consideration of BAL impacts and emergency services access to the classified vegetation. These sites will be subject to future planning and design through a development application process. It is expected that the sites will be cleared and managed to a low threat standard or will retain vegetation in accordance with a relevant exclusion under AS 3959 Clause 2.2.3.2. The sites are to be developed and managed so that they will not pose an unacceptable bushfire risk to the proposed development or to adjacent lots. Future BMPs prepared at subdivision and DA stage will consider bushfire compliance for future vulnerable land uses as well as site-specific bushfire mitigation measures, including preparation of an emergency evacuation plan at DA stage. As mentioned above, compliance is considered to be readily achievable for these sites and future land uses.
11	A reticulated water supply will need to be provided to service the project area given the density of development proposed.	Fire water will be provided via extension of reticulated water supply and hydrants from the adjoining reticulated areas to service the entirety of the development site.

5. Assessment against the bushfire protection criteria

5.1 Compliance with Elements 1 – 4

Compliance with Elements 1 – 4 of the bushfire protection criteria of the Guidelines (Version 1.4) at future planning staged is detailed in Table 7. It is anticipated that future subdivision will be able to achieve compliance with all applicable acceptable solutions.

Table 7: Compliance with the bushfire protection criteria of the Guidelines (Elements 1 – 4)

Bushfire protection criteria	Performance Principle	Method of compliance Acceptable solutions	Statement of development compliance	Compliance achievable at future planning stages
Element 1: Location	**P1** – The strategic planning proposal, subdivision and development application is located in an area where the bushfire hazard assessment is or will, on completion, be moderate or low, or a BAL–29 or below, and the risk can be managed. For unavoidable development in areas where BAL–40 or BAL–FZ applies, demonstrating that the risk can be managed to the satisfaction of the decision-maker.	**A1.1 Development location** The strategic planning proposal, subdivision and development application is located in an area that is or will, on completion, be subject to either a moderate or low bushfire hazard level, or BAL–29 or below.	The pre-development BHL assessment (Figure 5) identifies that the project area currently contains land with Low, Moderate and Extreme bushfire hazard levels. The post-development BHL assessment (Figure 6) identifies that on completion of development, all residential lots within the Structure Plan area will comprise either a **Low** or **Moderate** bushfire hazard level. The majority of land with an Extreme BHL will be restricted to POS which will not be developed for habitable purposes. Potential Extreme vegetation hazards are depicted within the proposed Retirement Village site in association with a row of trees, however, this is conservative given it is likely the trees will be managed in a low threat state. Consideration will need to be given to on-site and external classified vegetation and the appropriate setbacks for habitable development to achieve a maximum of BAL—29. This will be achieved through the following means: 1. Creation of APZs/building setbacks 2. Provision of perimeter roads at vegetation interfaces 3. Establishment and maintenance of low threat landscaping within future residential lots and potentially areas of POS (where appropriate [e.g. open turf areas, reticulated garden beds] and endorsed by the City). The project area is considered of sufficient size such that any interface with post-development classified vegetation could be readily accommodated via compliant subdivision design to ensure all future habitable development can achieve BAL-29 or lower.	✓
Element 2: Siting and design	**P2** – The siting and design of the strategic planning proposal, subdivision or development application, including roads, paths and landscaping, is appropriate to the level of bushfire threat that applies to the site. The proposal incorporates a defendable space and significantly reduces the heat intensities at the building surface thereby minimising the bushfire risk to people, property and infrastructure, including compliance with AS 3959 if appropriate.	**A2.1 Asset Protection Zone** Every habitable building is surrounded by, and every proposed lot can achieve, an APZ depicted on submitted plans, which meets the requirements set out in Schedule 1.	It is envisaged that the entirety of the project area (aside from areas of POS containing classified vegetation) will be modified to a low threat state as per provisions of AS 3959 Clause 2.2.3.2, with the low fuel standard being created prior to subdivision clearance. All future habitable development is to be located in BAL-29 or below. Any specific APZs/setbacks for lots interfacing classified vegetation will be identified at future planning stages based on future subdivision/development design and following a BAL contour assessment. APZs are to be implemented and maintained in accordance with Schedule 1 of the Guidelines (Appendix D).	✓
Element 3: Vehicular access	**P3i** – The design and capacity of vehicular access and egress is to provide for the community to evacuate to a suitable destination before a bushfire arrives at the site, allowing emergency services personnel to attend the site and/or hazard vegetation.	**A3.1 Public roads** *The minimum requirements under this acceptable solution are applicable to all proposed and existing public roads.* Public roads are to meet the minimum technical requirements in Table 6, Column 1. The trafficable (carriageway/pavement) width is to be in accordance with the relevant class of road in the Local Government Guidelines for Subdivisional Development (IPWEA Subdivision Guidelines), Liveable Neighbourhoods, Austroad standards and/or any applicable standards for the local government area.	Provisions for the construction of future public roads to relevant technical requirements under the Guidelines (refer to A3.1 and Appendix E) are to be made at the subdivision stage of planning. All proposed public roads have been designed to meet the relevant Guidelines and Standards to satisfy City requirements. The substantial road reserve widths (15 – 26 m) will provide for road widths sufficient to enable simultaneous evacuation of residents and emergency services personnel in the event of a bushfire. The existing surrounding public road network onto which internal roads are proposed to connect to consist predominantly of 6-7 m wide paved roads within the existing residential areas which comply with A3.1 standards. Bussell Highway in the north and Vasse Highway in the west are significant arterial highways which exceed Guidelines standards and will facilitate two-way vehicular access to and egress from the project area to places of relative safety.	✓
		A3.2a Multiple access routes Public road access is to be provided in two different directions to at least two different suitable destinations with an all-weather surface (two-way access).	On completion of future subdivision within the Structure Plan area, the existing public road network and proposed public internal roads will provide all occupants with the option of travelling to least two different suitable destinations via multiple access routes, as detailed below. 1. Access will be provided to Bussell Highway in the north via five possible connections, including the existing Joseph Drive connection, future connection to Cable Sands Road, and three additional	✓

Bushfire protection	Performance Principle	Method of compliance	Statement of development compliance	Compliance achievable at
		If the public road access to the subject site is via a no-through road which cannot be avoided due to demonstrated site constraints, the road access is to be a maximum of 200 metres from the subject lot(s) boundary to an intersection where two-way access is provided. The no-through road may exceed 200 metres if it is demonstrated that an alternative access, including an emergency access way, cannot be provided due to site constraints and the following requirements are met: • the no-through road travels towards a suitable destination; and • the balance of the no-through road, that is greater than 200 metres from the subject site, is wholly within BAL-LOW, or is within a residential built-out area – Figure 23.	connections. Bussell Highway leads to: a. The townsite of Busselton, approximately 4.5 km to the northwest which contains significant areas of non-bushfire prone land. b. The townsite of Bunbury, approximately 50 km to the northeast which is a large urban centre contain large areas of non-bushfire prone land. c. Other destinations, including the townsites of Dunsborough (30km to the west) and Margaret River (53 km to the southwest). 2. Access will be achieved to Vasse Highway in the west, which provides alternative access back to Bussell Highway to the north. During staged subdivision, each stage is to be provided with multiple access/ egress routes to two different suitable destinations. This will be achieved via construction of public roads in advice of later stages and/or provision of temporary compliant EAWs to the satisfaction of the Shire and DFES. Compliance with these provisions will be driven through the subdivision clearance process for each state of subdivision through preparation of a Bushfire Management Plan compliance report.	
		A3.2b Emergency access way *Where it is demonstrated that A3.2a cannot be achieved due to site constraints, or where an alternative design option does not exist, an emergency access way can be considered as an acceptable solution.* An emergency access way is to meet all the following requirements: • requirements in Table 6, Column 2; • provides a through connection to a public road; • be no more than 500 metres in length; and • must be signposted and if gated, gates must open the whole trafficable width and remain unlocked.	Based on the conceptual development design, which has avoided creation of no-through roads on ultimate build out, the proposed development would not require any permanent emergency access ways (EAWs) to provide through access to a public road. Temporary EAWs may be required for staged subdivision to ensure through access to a public road is maintained at all stages of development construction. JBS&G is aware that this strategy is being adopted for the approved Stage 1 subdivision. Any such EAWs are to be constructed to the relevant technical requirements of the Guidelines (see A3.2b and Appendix E). The developer will be responsible for maintaining any temporary EAWs until decommissioned at the appropriate time.	✓
		A3.3 Through-roads All public roads should be through-roads. No-through roads should be avoided and should only be considered as an acceptable solution where: • it is demonstrated that no alternative road layout exists due to site constraints; and • the no-through road is a maximum length of 200 metres to an intersection providing two-way access, unless it satisfies the exemption provisions in A3.2a of this table. A no-through road is to meet all the following requirements: • requirements of a public road (Table 6, Column 1); and • turn-around area as shown in Figure 24.	The conceptual development design demonstrates that the final road layout does not propose creation of any no-through roads. The proposed public roads will therefore provide for continuous vehicular access throughout the project area. Construction of subdivision within the project area will result in resolution of several existing no-through roads and temporary loop roads, including: • through connection of Cable Sands Road south into the project area • connection between Paterson Drive and Gigondas Street, resolving the Paterson Drive no-though road • connection of Bandol Street to Hawker Approach • extension of Forville Road to provide for connection of Antibes Way and Cassis Way to the wider road network. Temporary no-through roads may be required during staged subdivision will need to comply with relevant technical requirements under the Guidelines (refer A3.3 and Appendix E).	✓
	P3ii – The design of vehicular access and egress provides: • access and egress for emergency service vehicles while allowing the community to evacuate; • a defendable space for emergency services personnel on the interface • between classified vegetation and development site; and • hazard separation between classified vegetation and the subject site to reduce the potential radiant heat that may impact a lot(s).	**A3.4a Perimeter roads** A perimeter road is a public road and should be provided for greenfield or infill development where 10 or more lots are being proposed (including as part of a staged subdivision) with the aim of: • separating areas of classified vegetation under AS3959, which adjoin the subject site, from the proposed lot(s); and • removing the need for battle-axe lots that back onto areas of classified vegetation. A perimeter road is to meet the requirements contained in Table 6, Column 1.	Public perimeter roads are required at the interface between proposed lots and classified vegetation. Interfaces that require provision of perimeter roads during detailed subdivision design include: • Interface between proposed residential lots and the landscape buffers to Bussell Highway and Outer Bussell Highway • Interface between proposed residential lots and classified vegetation within other areas of POS • Interface between proposed residential lots and permanent vegetation hazards adjacent to the project area boundary (i.e. in the eastern portion of the project area). Public perimeter roads are not currently proposed along a portion of the eastern project area boundary. The vegetation at this interface is predominantly grassland, with pockets of wetland scrub. Perimeter roads should be considered for this interface during detailed subdivision design given: • The potential permanency of the adjacent vegetation hazards,	✓

Bushfire protection	Performance Principle	Method of compliance	Statement of development compliance	Compliance achievable at
		A perimeter road may not be required where: • the adjoining classified vegetation is Class G Grassland; • lots are zoned for rural living or equivalent; • it is demonstrated that it cannot be provided due to site constraints; or • all lots have frontage to an existing public road.	• Scale of the proposed development and need for firefighters to access the site perimeter to provide asset protection and prevent fire ingress into the internal portions of the site, and • The need to provide an APZ between future habitable buildings and the classified vegetation which would be incorporated into the perimeter road. Where a perimeter road cannot be provided or is unjustified, fires service access routes (FSARs) should be considered as an alternative means of providing vehicular access and hazard separation instead. There are sections along the southern portion of the project area where perimeter roads are not proposed adjacent to the future Bussell Outer Bypass. This design is consistent with the approved subdivisions over Yalyalup Corner and Gambetta Road, which were endorsed prior to contemporary requirements for perimeter access under the Guidelines. A FSAR will be provided within the landscaping buffer adjacent to Yalyalup Corner, and it is anticipated that this will be continued along the entire southern bund interface for future subdivision within the project area.	
	P3iii – Vehicular access is provided which allows: • access and egress for emergency service vehicles; • defendable space for emergency services • personnel on the interface between classified vegetation and development; and • hazard separation between classified vegetation and the site to reduce the potential radiant heat that may impact a lot(s).	**A3.4b Fire service access route** *Where proposed lots adjoin classified vegetation under AS3959 (excluding Class G Grassland), and a perimeter road is not required in accordance with A3.4a, a fire service access route can be considered as an acceptable solution to provide firefighter access, where access is not available, to the classified vegetation.* A fire service access route is to meet all the following requirements: • requirements in Table 6, Column 3; • be through-routes with no dead-ends; • linked to the internal road system at regular intervals, every 500 metres; • must be signposted; • no further than 500 metres from a public road; • if gated, gates must open the required horizontal clearance and can be locked by the local government and/or emergency services, if keys are provided for each gate; and • turn-around areas designed to accommodate type 3.4 fire appliances and to enable them to turn around safely every 500 metres.	As discussed under A3.4a above, there are several interfaces with external vegetation hazards that are not currently proposed to be provided with public perimeter roads. Perimeter roads at these interfaces should be considered during detailed subdivision design, and where public roads are not warranted, provision of FSARs is to be considered as an alternative means of providing access to the project area margins, as well as hazard separation to habitable development. It is anticipated that a FSAR will be provided within the landscape buffer to the Outer Bussell Highway, along the southern site boundary. This will enable firefighters to access vegetation hazards within the revegetated bund at the development interface. Temporary FSARs may also be required during staged subdivision to provide access to any scrub, woodland and forest vegetation hazards. FSARs are to be constructed to the relevant technical requirements of the Guidelines (see A3.4b and Appendix E). The City will be responsible for maintaining permanent FSARs on an ongoing basis, with the developer maintaining responsibility for any temporary FSARs.	✓
	P3iv – Vehicular access is provided which allows emergency service vehicles to directly access all habitable buildings and water supplies and exit the lot without entrapment.	**A3.5 Battle-axe access legs** *Where it is demonstrated that a battle-axe cannot be avoided due to site constraints, it can be considered as an acceptable solution.* There are no battle-axe technical requirements where the point the battle-axe access leg joins the effective area of the lot, is less than 50 metres from a public road in a reticulated area. In circumstances where the above condition is not met, or the battle-axe is in a non-reticulated water area, the battle-axe is to meet all the following requirements: • requirements in Table 6, Column 4; and • passing bays every 200 metres with a minimum length of 20 metres and a minimum additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres).	Creation of battle-axe lots is to be avoided wherever possible. Where unavoidable, provisions for battle-axe legs in accordance with relevant technical requirements under the Guidelines (refer to A3.5 and Appendix E) are to be made at the subdivision stage of planning. No battle-axes are proposed in the concept subdivision design.	✓
		A3.6 Private driveways There are no private driveway technical requirements where the private driveway is:	Private driveways constructed at development application/construction stage will need to meet relevant technical requirements of the Guidelines, where applicable (refer to A3.6 and Appendix E).	✓

Bushfire protection	Performance Principle	Method of compliance	Statement of development compliance	Compliance achievable at
		• within a lot serviced by reticulated water; • no greater than 70 metres in length between the most distant external part of the development site and the public road measured as a hose lay; and • accessed by a public road where the road speed limit is not greater than 70 km/h. In circumstances where all of the above conditions are not met, or the private driveway is in a non-reticulated water area, the private driveway is to meet all the following requirements: • requirements in Table 6, Column 4; • passing bays every 200 metres with a minimum length of 20 metres and a minimum • additional trafficable width of two metres (i.e. the combined trafficable width of the passing bay and constructed private driveway to be a minimum six metres); and • turn-around area as shown in Figure 28 and within 30 metres of the habitable building.		
Element 4: Water	No performance principle applies	**A4.1 Identification of future water supply** Evidence that a reticulated or sufficient non-reticulated water supply for bushfire fighting can be provided at the subdivision and/or development application stage, in accordance with the specifications of the relevant water supply authority or the requirements of Schedule 2. Where the provision of a strategic water tank(s) is required a suitable area within a road reserve or a dedicated lot the location should be identified, should be identified on the structure plan, to the satisfaction of the local government.	The Structure Plan area will be provided with a reticulated firefighting hydrants in accordance with specifications of the local water authority, Busselton Water.	✓
	P4 – Provide a permanent water supply that is: • sufficient and available for firefighting purposes; • constructed from non-combustible materials (e.g. steel), or able to maintain its integrity throughout a bushfire; and • accessible, with legal access for maintenance and re-filling by tankers and emergency service vehicles.	**A4.2 Provision of water for firefighting purposes** Where a reticulated water supply is existing or proposed, hydrant connection(s) should be provided in accordance with the specifications of the relevant water supply authority. Where these specifications cannot be met, then the following applies: • The provision of a water tank(s), in accordance with the requirements of Schedule 2; and • Where the provision of a strategic water tank(s) is applicable, then the following requirements apply: – land to be ceded free of cost to the local government for the placement of the tank(s); – the lot or road reserve where the tank is to be located is identified on the plan of subdivision; – tank capacity, construction, and fittings, provided in accordance with the requirements of Schedule 2; and – a strategic water tank is to be located no more than 10 minutes from the subject site (at legal road speeds). Where a subdivision includes an existing habitable building(s) that is to be retained, a water supply should be provided to this existing habitable building(s), in accordance with the requirements listed above.	Provisions for reticulated water supply will be addressed at the subdivision and DA stages of planning, as discussed above. It is not anticipated that strategic water tanks will be necessary.	✓

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6. Responsibilities for implementation and management of the bushfire measures

This BMP has been prepared as a strategic guide to demonstrate how development compliance will be delivered at future planning stages in accordance with the Guidelines. Aside from the preparation of future BMPs to accompany future subdivision and development applications where appropriate, there are no further items to implement, enforce or review at this strategic stage of the planning process.

Future BMPs prepared for subsequent subdivision and development applications are to meet the relevant commitments outlined in this strategic level BMP, address the relevant requirements of SPP 3.7 (i.e. Policy Measures 6.4 and 6.5 respectively) and demonstrate in detail how the proposed development will incorporate the relevant acceptable solutions or meet the performance requirements of the Guidelines. Future BMPs are to include the following detailed information:

- proposed lot layout, including any public open space (POS) and drainage areas
- detailed landscaping design/plans in regard to POS and drainage areas, consistent with the provisions of this BMP
- post development classified vegetation extent and effective slope
- BAL contour map demonstrating that proposed development areas will achieve BAL–29 or lower
- width and alignment of compliant APZs/setbacks, including enforcement mechanisms for any lots subject to an initial BAL exceeding BAL-29
- confirmation of how bushfire management will be addressed during development staging
- proposed approach to fuel management or AS 3959 application in response to on-site POS
- vehicular access provisions, including demonstration that a minimum of two access routes will be achieved for each stage of development in accordance with Acceptable Solution A3.1
- water supply provisions with regards to reticulated water
- future requirements for any future vulnerable land uses, such as provision of a Bushfire Emergency Evacuation Plan (if relevant)
- provisions for notification on Title for any future lots with a rating of BAL–12.5 or greater as a condition of subdivision
- compliance requirements with the current City's annual firebreak notice as amended
- construction of Class 1, 2, 3 or associated 10a buildings in accordance with AS 3959 to the assessed BAL rating
- requirements for BMP/BAL compliance reports as conditions of subdivision
- compliance with performance principles of the bushfire protection criteria
- proposed implementation and audit program outlining all measures requiring implementation and the appropriate timing and responsibilities for implementation.

On the basis of the information contained in this BMP, JBS&G considers the bushfire hazards within and adjacent to the project area and the associated bushfire risks are readily manageable through standard management responses outlined in the Guidelines and AS 3959. JBS&G considers that on implementation of the proposed management measures, the project area will be able to be

developed with a manageable level of bushfire risk whilst maintaining full compliance with the Guidelines and AS 3959.

7. References

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LD Total 2023, *Landscape Master Plan (Rev D)*, Embark, Busselton, LD Total, Perth.

RPS Group (RPS) 2022a, *Environmental Assessment Report, Embark Busselton Structure Plan*, RPS, Perth.

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Taylor Burrell Barnett (TBB) 2022, *Development Concept Plan – Structure Plan Addendum Area, Embark Estate, Yalyalup (17/11/2022)*, TBB, Perth.

Western Australian Planning Commission (WAPC) 2015, *State Planning Policy 3.7 Planning in Bushfire Prone Areas*, Western Australian Planning Commission, Perth.

Western Australian Planning Commission (WAPC) 2021, *Guidelines for Planning in Bushfire Prone Areas*, Version 1.4 December 2021, Western Australian Planning Commission, Perth.

8. Limitations

Scope of services

This report ("the report") has been prepared by JBS&G in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and JBS&G. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, JBS&G has relied upon data 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 expressly stated in the report, JBS&G has not verified the accuracy or 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. JBS&G has also not attempted to determine whether any material matter has been omitted from the data. JBS&G 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 JBS&G. The making of any assumption does not imply that JBS&G has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. JBS&G disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

The advice herein relates only to this project and all results conclusions and recommendations made should be reviewed by a competent person with experience in environmental investigations, before being used for any other purpose.

JBS&G accepts no liability for use or interpretation by any person or body other than the client who commissioned the works. This report should not be reproduced without prior approval by the client, or amended in any way without prior approval by JBS&G, and should not be relied upon by other parties, who should make their own enquiries.

Appendix A Landscape Plan

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Landscape Master Plan

Embark, Busselton



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

Public Open Space

- Turf
- POS Irrigated Shrub Planting
- Existing POS - Infill Tubestock Planting
- Drainage Basin Planting
- Landscape Buffer - Low Treat Vegetation
- Verge Planting
- Median Swale Planting
- Shade Structure
- Seating Node
- Playground
- POS Sports Facilities
- Formal Path Network
- Informal Path Network

Note: Pathway varies in width.

- Pockets of retain vegetation and significant individual trees where possible
- Proposed Roundabout Tree
- Proposed Boulevard / Median Tree
- Proposed Boulevard and Feature Avenue Trees
- Proposed Access Corridor Trees for Western Ringtail Possum Habitat
- Proposed Street Trees
- Proposed POS Trees

Land Use

- Proposed Future Residential Lots
- Supermarket/Specialties (Commercial)
- Townsquare (Commercial)
- Childcare (Commercial)
- Retirement Village
- Primary School (Public Purpose)
- Mixed Use

YOLK PROPERTY GROUP

LD TOTAL

CLIENT YOLK PROPERTY GROUP | PROJECT NO 10.7096 | REVISION D | DATE 19.04.2023 | SCALE 1:5000 @ A1

0 50 100 250m

NORTH

POS LANDSCAPE TYPOLOGY

Embark
Busselton



NOTE:
Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

STRATEGY 2. LANDSCAPE VISION + MASTER PLAN

POS 1 and 2 LANDSCAPE CONCEPT PLAN

Embark
Busselton

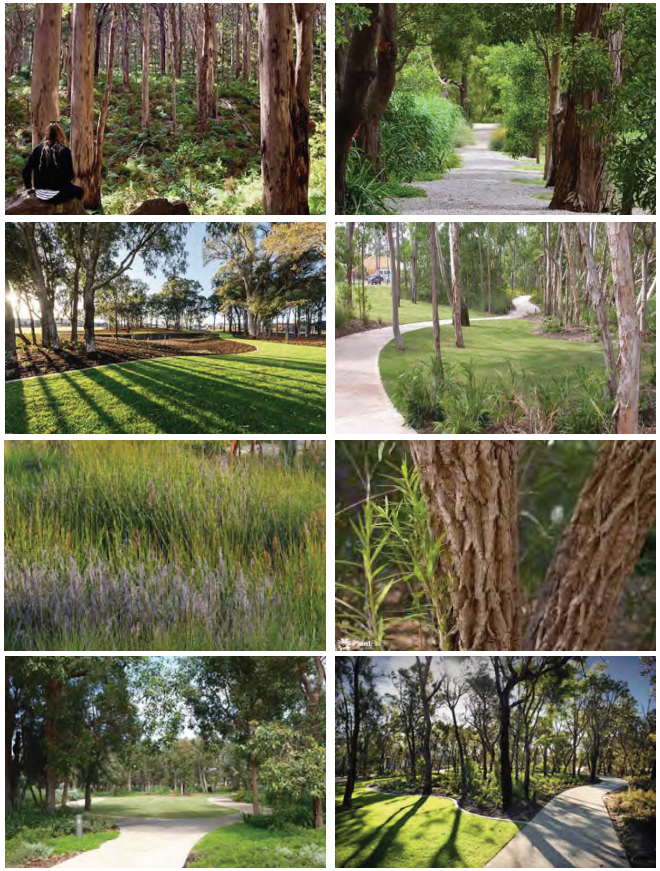


KEY PLAN



Legend

1. Retained vegetation and existing topography
2. Conservation fence
3. Planted drainage basin
4. Pedestrian path
5. Garden bed with native planting
6. Pockets of turf areas



PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 3 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

Legend

1. Retained vegetation and existing topography where possible
2. Planted drainage basin
3. Pedestrian path
4. Turf area





PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 4 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

Legend

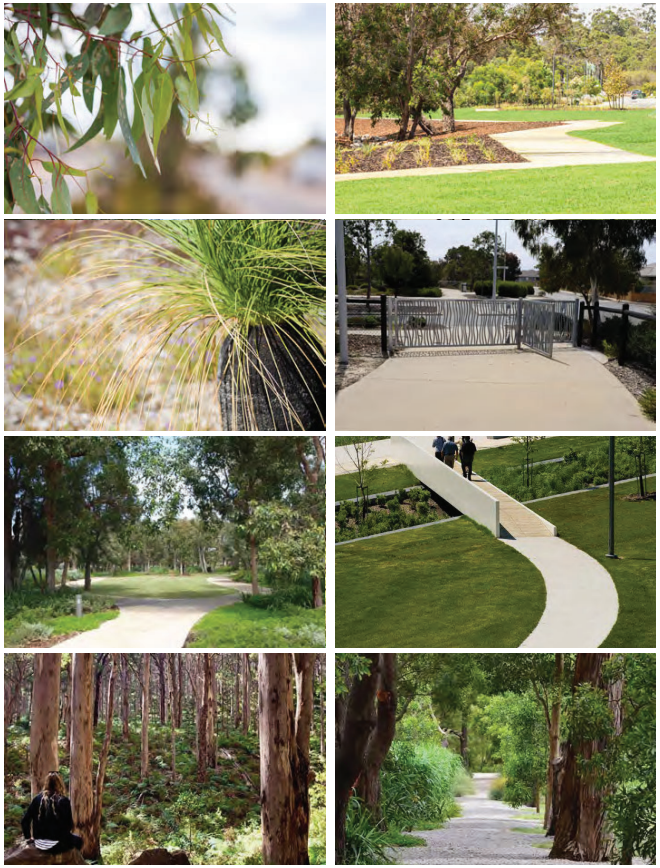
1. Retained vegetation and existing topography where possible
2. Living stream
3. Conservation fence
4. Pedestrian paths
5. Garden beds with native shrub planting and trees



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 4 / TOWNSQUARE LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



Legend

1. Townsquare plaza

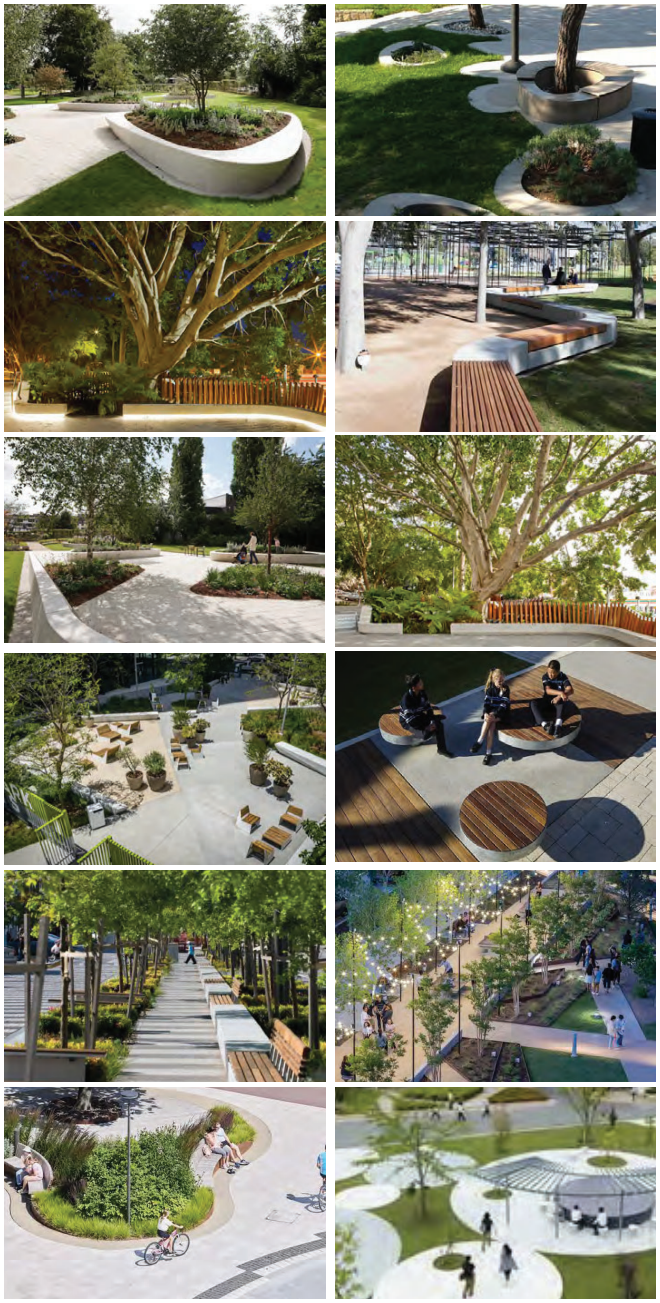
Proposed amenities and landscape:
- Seating nodes
- Shade structures
- Drinking fountain
- Bike racks
- Bins
- Access required for maintenance, service and emergency vehicles
- Native and exotic planting

2. Childcare
3. Retirement Village
4. Supermarket / Specialties
5. Boulevard and feature avenue trees
6. Residential lots

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

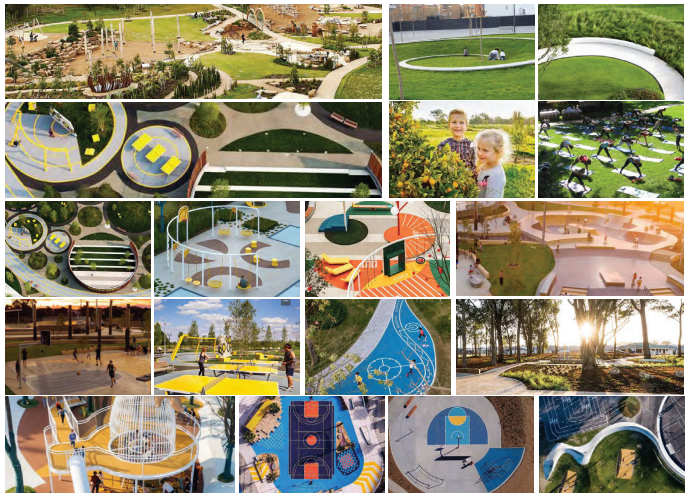
Landscape Master Plan

Embark, Busselton

embark BUSSELTON

Legend

1. Feature landmark artwork
2. Formal park entry with signage, feature seating, bike parking
3. Buffer verge planting and street trees, widened footpaths to accommodate running, bikes and pedestrians
4. Large kick-about lawns with sports goals
5. Enclosed basketball/multisports court with low tired seating areas
6. Shaded community meeting place with interpretive paving and artwork elements
7. Shade structure, BBQ areas, seating and picnic settings
8. Adventure playground with landmark themed play tower, flying fox, pendulum swing, enclosed junior play area, bouldering and climbing features
9. Natureplay area located amongst woodland area - winding discovery trails, fallen log, rope and loose parts play, interpretive and educational signage
10. Teenage hangout space
11. Skate, scoot and bmx park with large shade structure areas
12. Pump track
13. Revegetated woodland areas with winding trails, seating and picnic areas
14. Potential zone for outdoor gym classes. Peppercorn lease to gym located in the commercial town centre.



KEY PLAN



YOLK PROPERTY GROUP

LD TOTAL

CLIENT YOLK PROPERTY GROUP PROJECT NO 10.7096 REVISION A DATE 16.12.2022 SCALE 1:500 @ A1

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton.
Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 10 100m NORTH

POS 6 and POS 6 / PAW NORTH LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



Legend

1. Retained vegetation and existing topography where possible
2. Garden beds with native shrub planting and trees
3. Formal path network
4. Informal path network
5. Node with shelter and picnic setting
6. Seating node
7. Irrigated open turfed area
8. PAW path network to Retirement Village
9. Community Veggie garden



PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 7 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



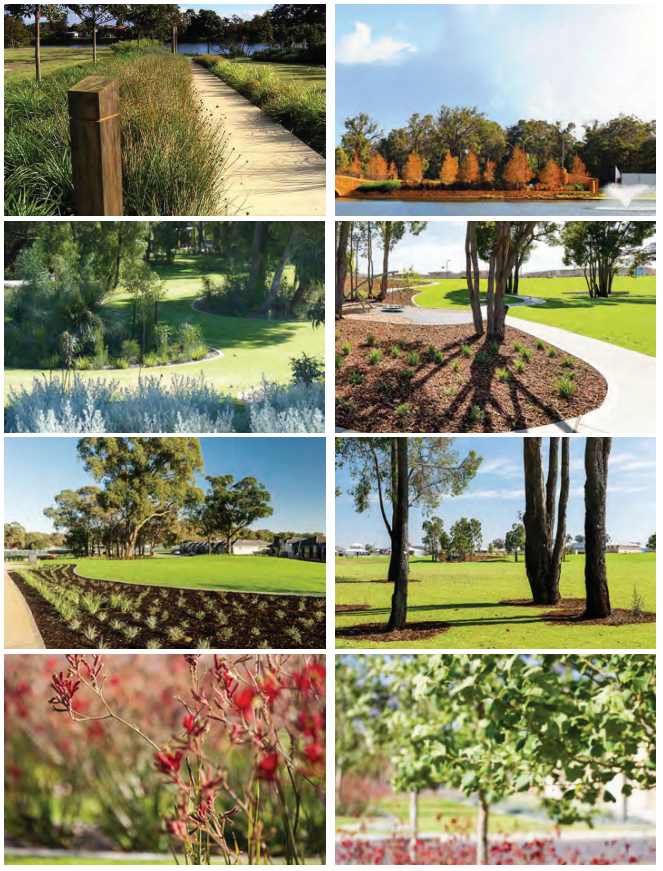
NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Existing POS - native planting and path network, shade structures and play-ground, planted drainage basin
2. Continuation of pedestrian and cycle path
3. Avenue and native trees
4. Irrigated garden bed planting
5. Irrigated open turf area
6. Low treat vegetation to future residen-tial lots



PRECEDENT IMAGES

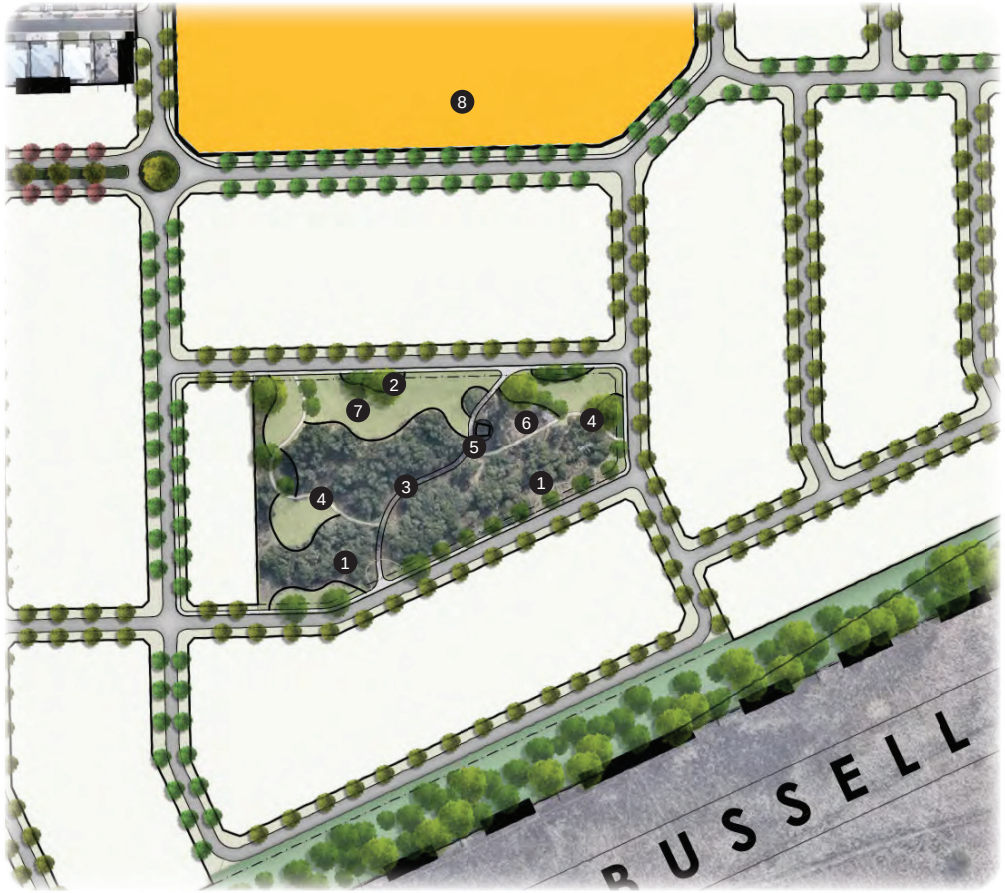
STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 8 LANDSCAPE CONCEPT PLAN

Embark
Busselton

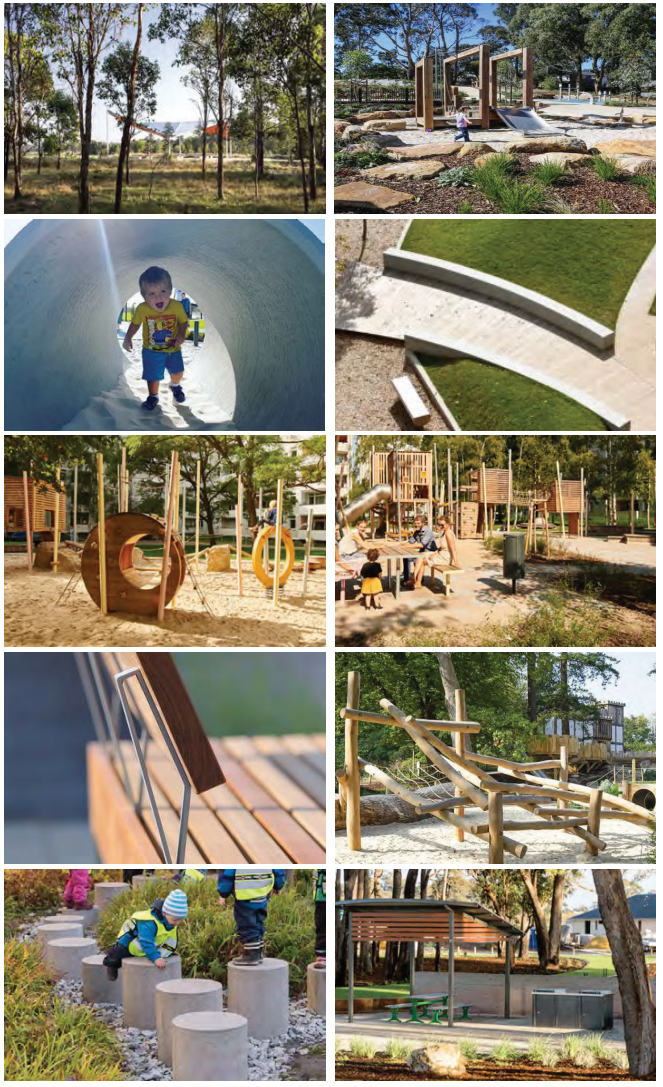


KEY PLAN



Legend

1. Retained vegetation and existing topography where possible
2. Garden beds with native shrub planting and trees
3. Formal path network
4. Informal path network
5. Node with shelter and picnic setting
6. Playground
7. Irrigated open turfed area
8. Future Primary School
9. Landscape Buffer / Bund



PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

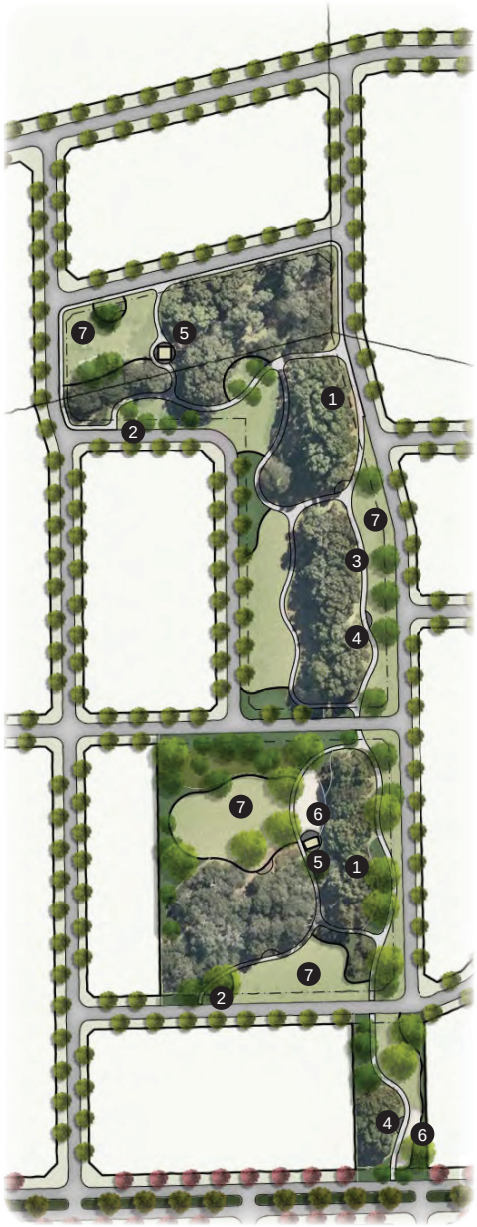
STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 9 NORTH AND SOUTH, AND POS 10 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



Legend

1. Retained vegetation and existing topography where possible
2. Garden beds with native shrub planting and trees
3. Pedestrian and cycle path network
4. Seating nodes
5. Node with shelter and picnic setting
6. Play area
7. Irrigated open turfed area



PRECEDENT IMAGES

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

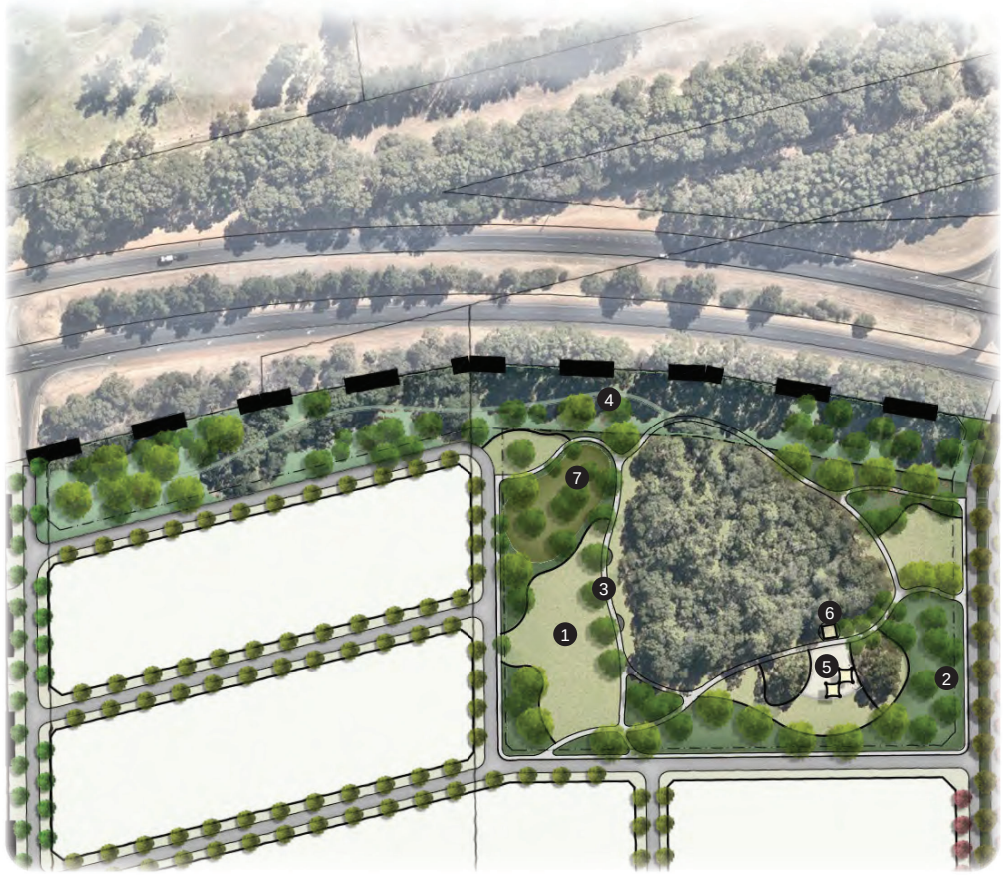
STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 11 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

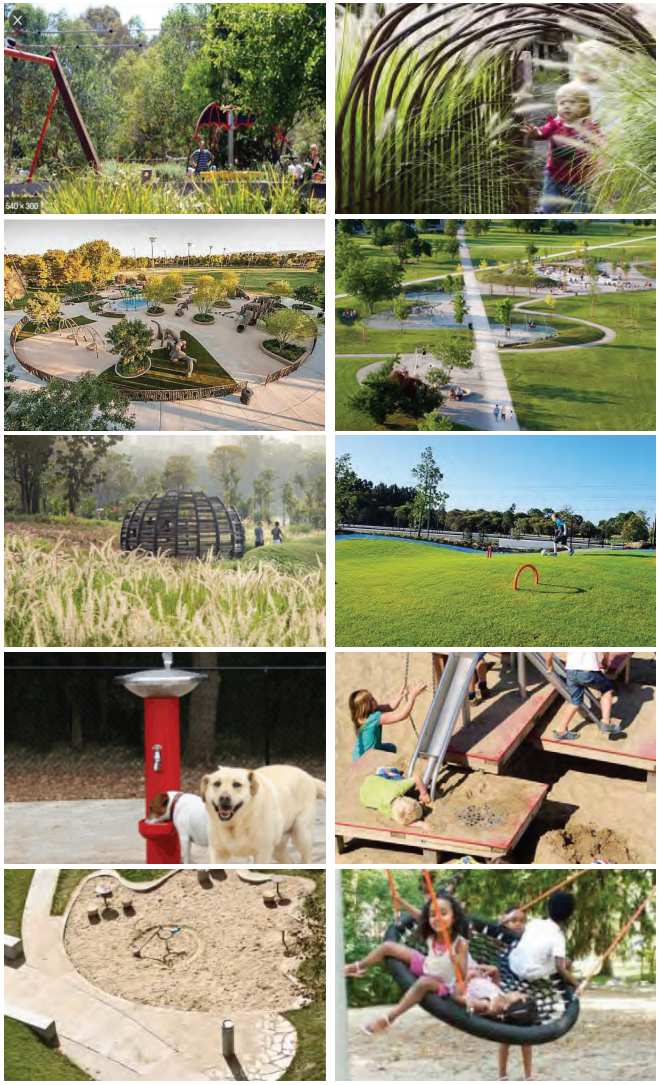


1. Open turf area
2. Irrigated shrub and tree planting
3. Formal path network
4. Informal path network
5. Shade play area
6. Node with shelter, picnic settings, BBQ, bike racks and drinking fountain, bins
7. Planted drainage basin

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

LD TOTAL

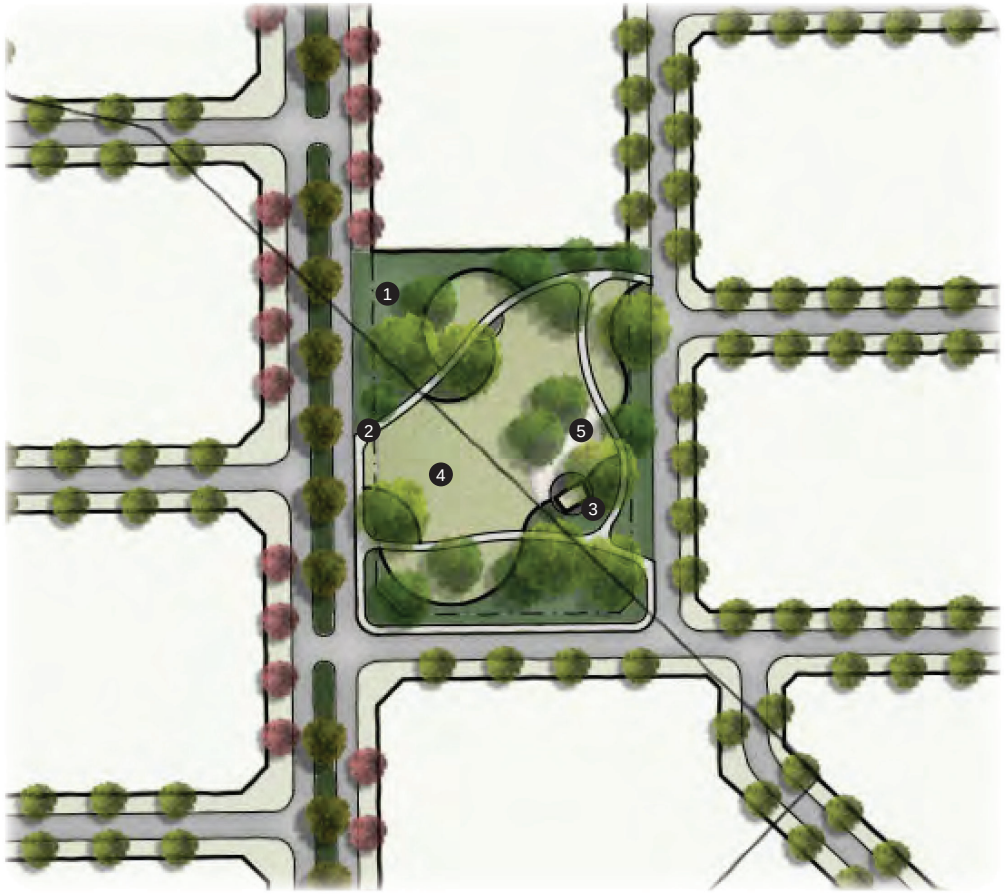
LD TOTAL 2022

POS 12 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



Legend

1. Garden beds with native shrub planting and trees
2. Pedestrian path network
3. Node with shelter and picnic setting
4. Irrigated open turfed area
5. Playground

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 25 50m

North



PRECEDENT IMAGES

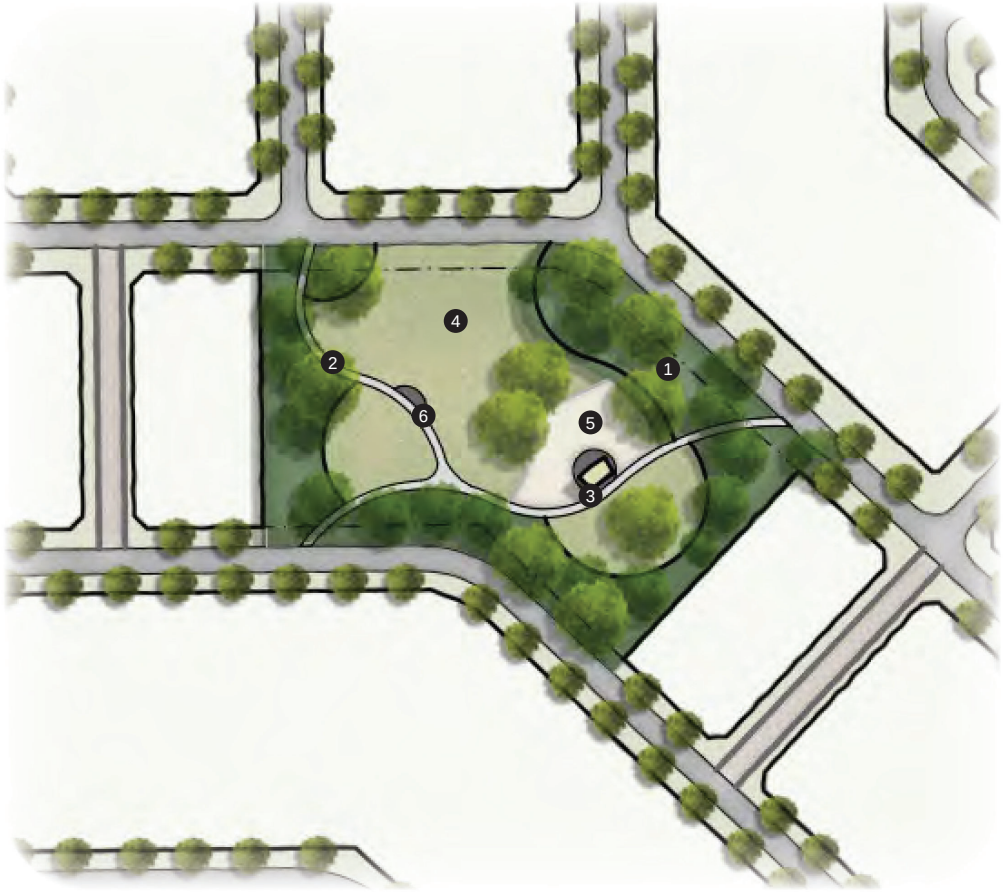
STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 13 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

Legend

1. Garden beds with native shrub planting and trees
2. Pedestrian path network
3. Node with shelter and picnic setting
4. Irrigated open turfed area
5. Playground
6. Bench seat



PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 14 LANDSCAPE CONCEPT PLAN

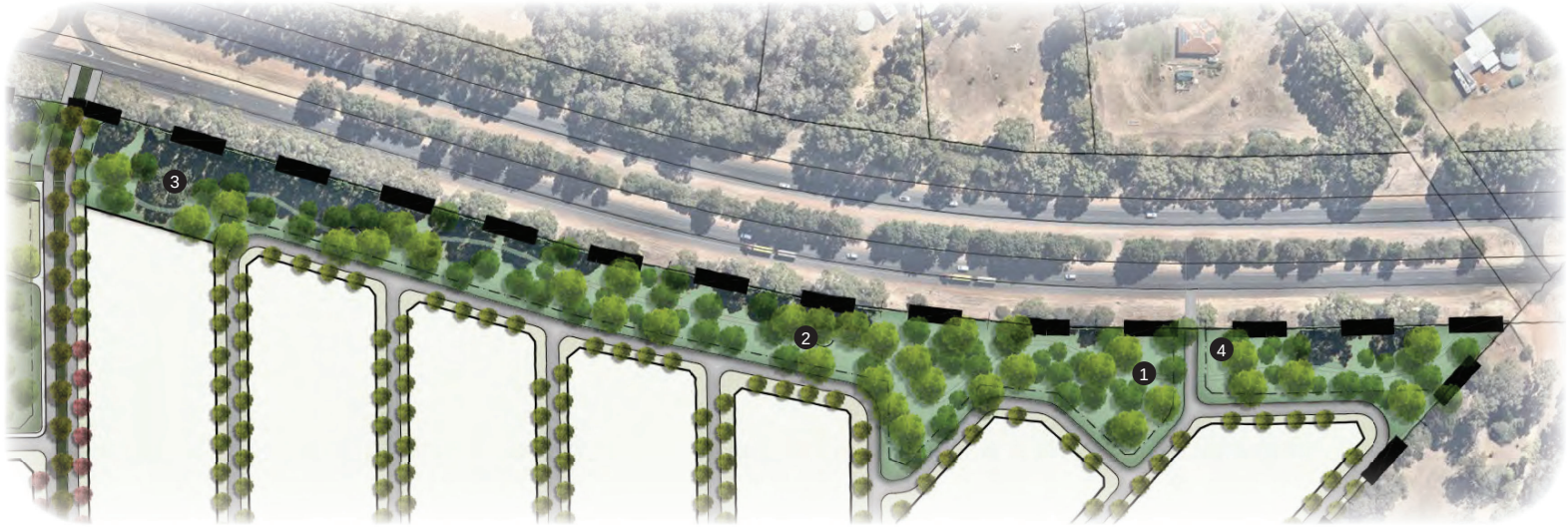
Embark
Busselton



KEY PLAN

Legend

1. Pedestrian and cycle paths
2. Seating nodes
3. Retained vegetation and existing topography where possible
4. Native shrub planting and trees











NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 15 LANDSCAPE CONCEPT PLAN

Embark
Busselton



KEY PLAN

Legend

1. Retained vegetation and existing topography where possible
2. Native shrub planting and trees
3. Conservation fence
4. Irrigated turf to verge entry



NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

POS 16 LANDSCAPE CONCEPT PLAN

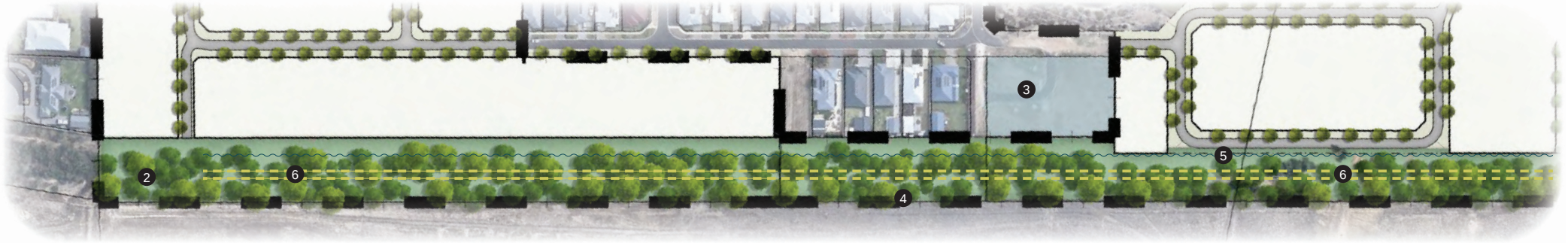
Embark
Busselton

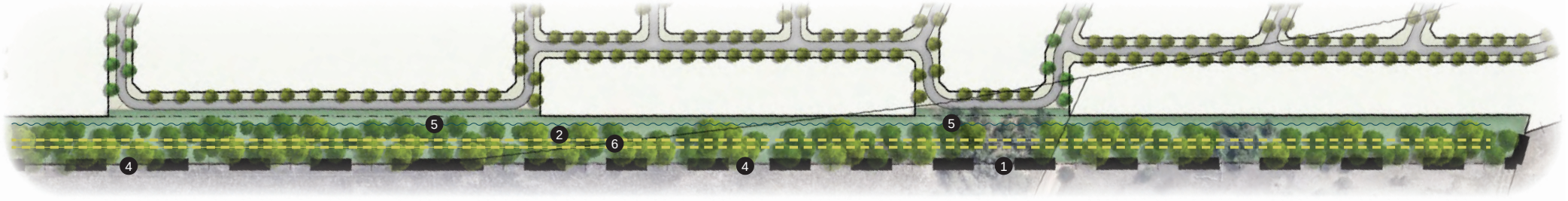


KEY PLAN

Legend

1. Retained vegetation and existing topography where possible
2. Native shrub planting and trees
3. Water Treatment
4. Maintenance track (3m wide) along Outer Bussell Hwy
5. Drainage road swale and FSAR track (6m wide) along future roads
6. Construction of the bund for noise protection





NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.

0 50 100m

North

PRECEDENT IMAGES

STRATEGY 3. POS PRELIMINARY CONCEPTS

Appendix B Vegetation plots – Photographs and description

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Plot 1		
Vegetation classification	**Pre-development**	Class A Forest
	Post-development	Combination of retained Class A Forest, and areas modified to a low threat state within proposed residential cells, or POS.

Description / justification

Forest vegetation dominated by *Agonis flexuosa* (WA peppermint), *Eucalyptus marginata* (Jarrah) *Eucalyptus gomphocephala* (Tuart) and *Corymbia calophylla* (Marri) 10-30 in height with a multi-tiered fuel structure, including a juvenile eucalypt/shrubby understorey.



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Photo ID: 1.01



Photo ID: 1.02



Photo ID: 1.03

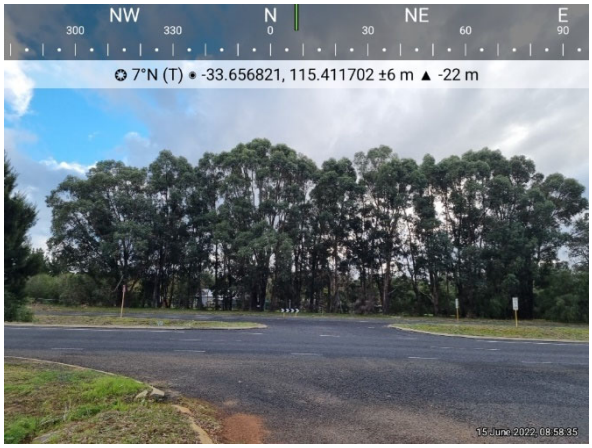


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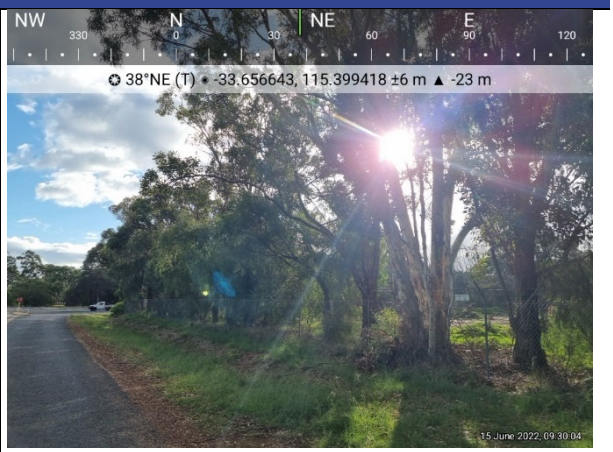
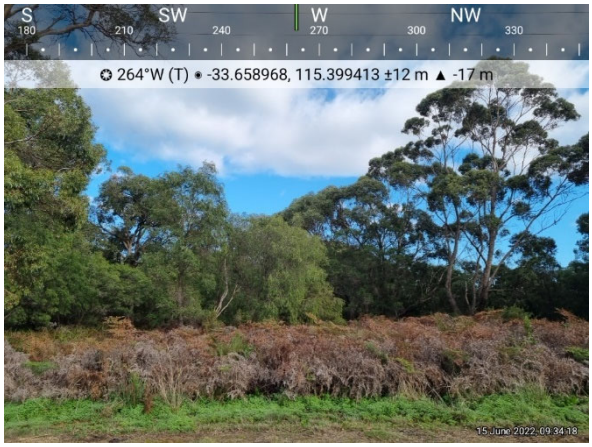


Photo ID: 1.05

©JBS&G Australia Pty Ltd

Plot 1	
 **Photo ID:** 1.06	 **Photo ID:** 1.07
 **Photo ID:** 1.08	 **Photo ID:** 1.09
 **Photo ID:** 1.10	 **Photo ID:** 1.11

©JBS&G Australia Pty Ltd

Plot 1	
 **Photo ID:** 1.12	 **Photo ID:** 1.13
 **Photo ID:** 1.14	 **Photo ID:** 1.15
 **Photo ID:** 1.16	 **Photo ID:** 1.17

©JBS&G Australia Pty Ltd

Plot 1



Photo ID: 1.18



Photo ID: 1.19



Photo ID: 1.20



Photo ID: 1.21

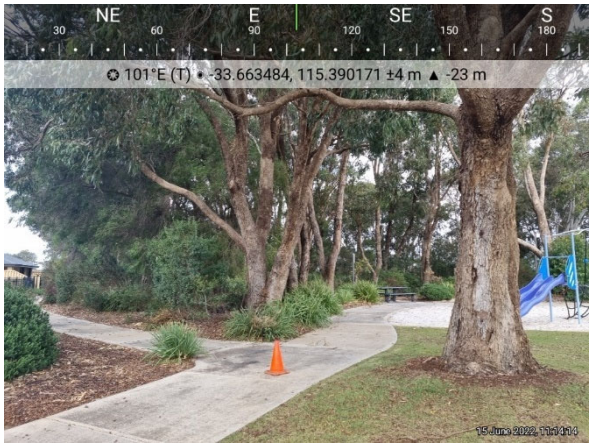
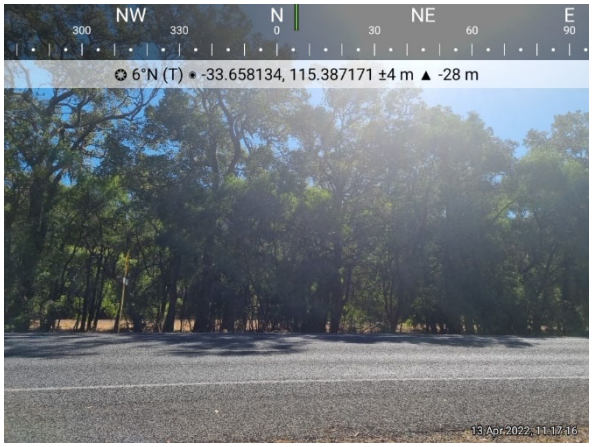


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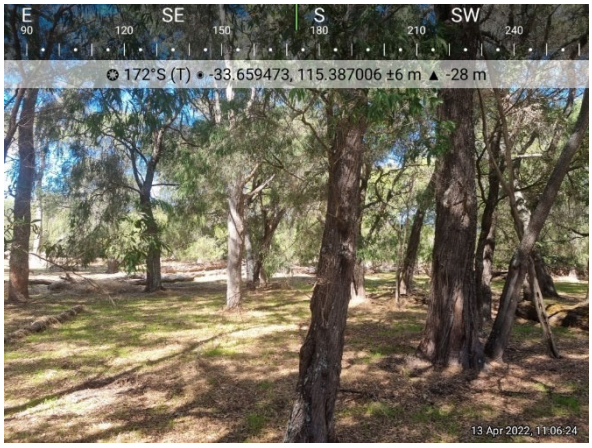


Photo ID: 1.23

©JBS&G Australia Pty Ltd

Plot 1	
 **Photo ID:** 1.24	 **Photo ID:** 1.25
 **Photo ID:** 1.26	 **Photo ID:** 1.27
 **Photo ID:** 1.28	 **Photo ID:** 1.29

©JBS&G Australia Pty Ltd

Plot 1	
 **Photo ID:** 1.30	 **Photo ID:** 1.31
 **Photo ID:** 1.32	

©JBS&G Australia Pty Ltd

Plot 2		
Vegetation classification	**Pre-development**	Class B Woodland
	Post-development	Combination of retained Class B Woodland, and areas modified to a low threat state within proposed residential cells.

Description / justification

Woodland vegetation comprising *Agonis flexuosa* or mature Eucalypts. Sparse canopy cover and low surface fuels are evident. The understorey is characterised by grassland which is primarily grazed.



Photo ID: 2.00



Photo ID: 2.01



Photo ID: 2.02



Photo ID: 2.03

©JBS&G Australia Pty Ltd

Plot 3		
Vegetation classification	**Pre-development**	Class D Scrub
	Post-development	Combination of retained Class D Scrub, and vegetation revegetated within POS, as well as areas modified to a low threat state within proposed residential cells.

Description / justification

Scrub vegetation comprised predominantly of mature melaleuca trees, up to 6 m in height.



Photo ID: 3.00



Photo ID: 3.01



Photo ID: 3.01



Photo ID: 3.03



Photo ID: 3.04



Photo ID: 3.05

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Plot 3	
 **Photo ID:** 3.06	 **Photo ID:** 3.07
 **Photo ID:** 3.08	 **Photo ID:** 3.08
 **Photo ID:** 3.10	

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Plot 4		
Vegetation classification	**Pre-development**	Class G Grassland
	Post-development	Combination of Class G Grassland and areas within residential cells and POS modified to a low threat state.

Description / justification

Unmanaged grassland vegetation greater than 10 cm in height at maturity. Includes properties where grassland management is not enforceable under the firebreak notice.



Photo ID: 4.00



Photo ID: 4.01



Photo ID: 4.02



Photo ID: 4.03

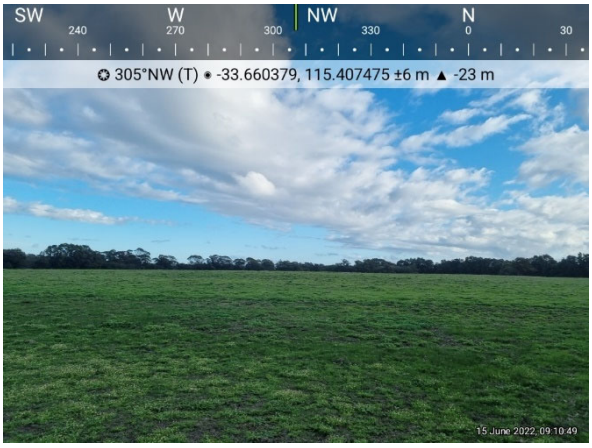


Photo ID: 4.04



Photo ID: 4.05

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Plot 4	
 **Photo ID:** 4.06	 **Photo ID:** 4.07
 **Photo ID:** 4.08	 **Photo ID:** 4.09
 **Photo ID:** 4.10	 **Photo ID:** 4.11

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Plot 4	
	
Photo ID: 4.12	**Photo ID:** 4.13
	
Photo ID: 4.14	**Photo ID:** 4.15
	
Photo ID: 4.16	**Photo ID:** 4.17

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Plot 4	
	
Photo ID: 4.18	**Photo ID:** 4.19
	
Photo ID: 4.20	**Photo ID:** 4.21
	
Photo ID: 4.22	**Photo ID:** 4.23

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Plot 5		
Vegetation classification	**Pre-development**	Excluded – Non-vegetated and Low threat (Clause 2.2.3.2 [e] and [f])
	Post-development	Choose an item.

Description / justification

Existing non-vegetated areas (i.e., cleared vacant lots, roads, driveways, buildings, footpaths) and low threat managed vegetation (i.e. mowed lawns, managed gardens, existing dam, slashed road verges, managed POS, street trees).



Photo ID: 5.00 (grassland management enforceable)



Photo ID: 5.01



Photo ID: 5.02



Photo ID: 5.03



Photo ID: 5.04



Photo ID: 5.05

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Plot 5



Photo ID: 5.06



Photo ID: 5.07



Photo ID: 5.08



Photo ID: 5.09



Photo ID: 5.10

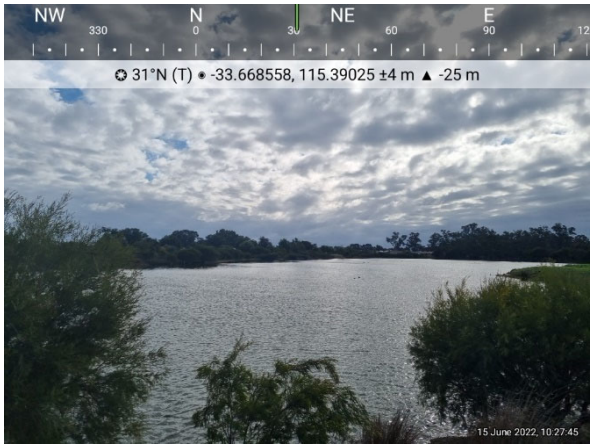


Photo ID: 5.11

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Plot 5	
 **Photo ID:** 5.12	 **Photo ID:** 5.13
 **Photo ID:** 5.14	 **Photo ID:** 5.15

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Appendix C City of Busselton Firebreak Notice

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PERMITS TO BURN

Permits to Burn are required for the whole of the Restricted Burning Times and can only be obtained from the Fire Control Officer for your area

A list of Fire Control Officers is available on the **Fire and Emergency Services** page on the City's website

Most of our Fire Control Officers are volunteers, make sure you **plan ahead** if you intend to apply for a Permit to Burn

A Permit to Burn must be obtained before any burning takes place and the permit holder **must be in possession** of the permit throughout the duration of the burn

The permit holder shall ensure **all conditions** of the permit, as shown on the permit, are **fully complied** with

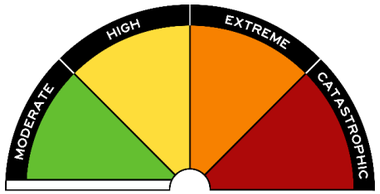
NOTIFY DFES COMMUNICATIONS CENTRE

DFES Communications Centre (9395 9209) are to be advised whenever the holder of a permit **commences burning**; and/or whenever a person is carrying out burning activities **outside of the Prohibited and Restricted Burning Times**

HARVEST VEHICLE MOVEMENT BANS

The City may declare **Harvest Vehicle Movement Bans** (HVMBs) at any time. For further information or to receive notification of HVMBs please visit the **Fire and Emergency Services** page on the City's website

The new Australian Fire Danger Rating System



Moderate: plan and prepare

High: be ready to act

Extreme: take action now to protect life and property

Catastrophic: for your survival, leave bushfire risk areas

GENERAL INFORMATION

Burning of Garden Refuse: pursuant to section 24G(2) of the *Bush Fires Act 1954*, the burning of garden refuse is prohibited throughout the District during Prohibited Burning Times, and prohibited in urban areas of the District during Restricted Burning Times

During Restricted Burning Times, a Permit to Burn is required for the burning of garden refuse in Rural Residential or Rural areas

Camping and/or Cooking Fires: pursuant to section 25(1a) of the *Bush Fires Act 1954*, the lighting of fires in the open for the purpose of camping and/or cooking is prohibited throughout the District during Prohibited Burning Times

The lighting of fires in the open for the purpose of camping and/or cooking is prohibited at all times when the **Fire Danger Rating** for the District is ***High or above** without the written approval of the City

Fire Pits, Chimineas, and/or Braziers: the lighting of fire pits, Chimineas and/or braziers is prohibited during Prohibited Burning Times, and otherwise prohibited if the **Fire Danger Rating** for the District is ***High or above**

Conditions for the Lighting and Extinguishing of Fires in the Open: when burning garden refuse; or lighting camping and/or cooking fires; or when lighting fire pits, Chimineas and/or braziers the space of ground around the site of the fire, having a radius of at least 3 metres from the site at the centre, shall be clear of all vegetation and other flammable materials

The person who lit the fire, or a person left in attendance at the fire as the case may be, shall completely extinguish the fire by the application of water and/or earth before that person leaves the site unattended

**The new Australian Fire Danger Rating System (AFDRS) will go live on 1 September 2022. The Australia wide system uses current science that significantly improves the ability to predict fire behaviour*

Work is underway at a State level to amend legislation to reflect the new AFDRS. Importantly, these changes will not affect the requirement for landowners or occupiers of land to fully comply with this Notice

For more information about the AFDRS visit

www.afac.com.au/initiative/afdrs

KEY DATES

Dates **may change due to seasonal fire conditions** in which case details will be published in local newspapers and on the City's website

PROHIBITED BURNING TIME
(BURNING IN THE OPEN IS PROHIBITED)

1 December 2022 to 28 February 2023

RESTRICTED BURNING TIMES
(BURNING PERMITS ARE REQUIRED)

15 October 2022 to 30 November 2022
and 1 March 2023 to 30 April 2023
(Burning on Public Holidays Prohibited)

COMPLIANCE DATES

Rural Residential / Urban / Industrial Land

Compliance with this Notice must be achieved no later than 15 November 2022 and maintained until 30 April 2023

Rural Land

Compliance with this Notice must be achieved no later than 15 December 2022 and maintained until 30 April 2023

FIREBREAK INSPECTIONS AND RIGHT OF ENTRY

The City will commence its annual firebreak inspection program on 15 November 2022

Rangers are appointed Bush Fire Control Officers under the provisions of the *Bush Fires Act 1954* and carry out annual inspections

Under the provisions of the Act, Bush Fire Control Officers may in the performance of their duties, enter any land or building including private property

FIREBREAK VARIATIONS

Where there are valid environmental and/or on-ground considerations that prevent full compliance with this Notice, landowners may apply to the City for a firebreak variation. A variation must be lodged in writing on an Application for Variation form that is available on the City's website.

Applications for variation must be submitted by 31 October 2022

City of Busselton
Geographe Bay

FIREBREAK AND FUEL HAZARD REDUCTION NOTICE

2022/2023 BUSH FIRE SEASON

FIRST AND FINAL NOTICE

Take notice that pursuant to Part 3 Division 6 Section 33 of the ***Bush Fires Act 1954***, landowner(s) or occupier(s) of land shall construct firebreaks and carry out fire prevention work in accordance with this Notice

Failure to comply with this Notice may result in a fine of up to

$5,000

This year the City will be prioritising the inspection of properties that were issued Work Orders during the 2021/2022 bush fire season

Should you require assistance or clarification of the requirements of this Notice, please contact the City's Ranger Services on 9781 0444

FIREBREAK CATEGORY CODE AND SUMMARY OF REQUIREMENTS



ALL REQUIREMENTS IN THIS NOTICE ARE TO BE MAINTAINED THROUGHOUT THE ENTIRE DURATION OF THE FIRE SEASON

FAILURE TO COMPLY MAY RESULT IN A $5,000 FINE

PLEASE BE ADVISED THAT YOUR PROPERTY MUST COMPLY WITH CATEGORY REQUIREMENTS AS NOTED BY A TICK IN COLUMN A, B, C OR D



CATEGORY	A	B	C	D
It is the land owner's responsibility to identify the category that relates to their property and to ensure the necessary fire prevention works are completed on time. Please contact the City if you are unsure of your category.				
CATEGORY 1 **RURAL** Except plantations and vineyards (for tourist chalets, refer to Estate Fire Management Plan or Individual Fire Management Plan) Sections A, C and D apply to this category.	✓		✓	✓
CATEGORY 2 **URBAN RESIDENTIAL & INDUSTRIAL - COMMERCIAL** Sections A, B, D and E1 Trees, apply to this category. Refer to section E - Interpretation and Additional Requirements (E1 Trees).	✓	✓		✓
CATEGORY 3 & 4 **PLANTATIONS** Fire Management Plan applies	N/A	N/A	N/A	N/A
CATEGORY 5 **PROTEA PLANTATIONS / VINEYARDS** (For tourist chalets, refer to Estate Fire Management Plan or Individual Fire Management Plan) Sections A, B, C and D apply to this category.	✓	✓	✓	✓
CATEGORY 6 **RURAL RESIDENTIAL - LOTS WITH INDIVIDUAL (MINERAL EARTH) BOUNDARY BREAKS** Sections A, B, C and D apply to this category unless the property is subject to Estate Fire Management Plan or Individual Fire Management Plan	✓	✓	✓	✓
CATEGORY 7 **RURAL RESIDENTIAL - LOTS WITH A STRATEGIC FIREBREAK ON ONE OR MORE BOUNDARIES** Sections A, B, C and D apply to this category unless the property is subject to Estate Fire Management Plan or Individual Fire Management Plan	✓	✓	✓	✓
CATEGORY 8 **RURAL RESIDENTIAL - LOTS WITHIN A STRATEGIC FIREBREAK AREA WITH NO STRATEGIC FIREBREAKS ON THE LOT BOUNDARIES** Sections B, C and D apply to this category unless the property is subject to Estate Fire Management Plan or Individual Fire Management Plan		✓	✓	✓

A - Firebreak – The term firebreak includes a mineral earth firebreak. A mineral earth firebreak means a 3 metre wide area of the owner(s)/occupiers(s) land, cleared and maintained totally clear of all vegetation material (living or dead) so there is only mineral earth left. Any overhanging trees and other vegetation must be pruned to a height of 5 metres above the ground level of a mineral earth firebreak.

Category 1 – Rural: A mineral earth **FIREBREAK** shall be constructed **3 metres** wide, except in pasture or crop areas where a **FIREBREAK** shall be **2 metres** wide. **FIREBREAKS** shall be located adjacent to all external boundaries of the land. Where the land area exceeds 120 hectares, an additional **FIREBREAK** must divide the land into areas of not more than 120 hectares with each part completely surrounded by a **FIREBREAK.**

Category 2 - Urban Residential and Industrial-Commercial: Where the area of land exceeds 2024m² (½ acre) a mineral earth **FIREBREAK** shall be constructed and maintained at least **3 metres** wide and within **6 metres** of the inside of all external boundaries of the land. Where the area of land is 2024m² (½ acre) or less, hazardous material must be removed in accordance with section **B - Fuel Reduction (refer to B1).**

Category 5 - Protea Plantations/Vineyards: A mineral earth **FIREBREAK** shall be 3 metres wide. A low fuel area is to be maintained in accordance with section **B - Fuel Reduction (refer to B2).**

Category 6 and 7 - Rural Residential: A mineral earth **FIREBREAK** shall be constructed **3 metres** wide. On Category 6 Rural Residential land with pasture or crop, a **FIREBREAK** shall be **2 metres** wide and located within **6 metres** of all external boundaries of the land. For Category 7 Rural Residential land, free access along a Strategic **FIREBREAK** is to be maintained at all times and including across the boundary of a lot, by means of a **3.5 metres wide field gate** in the adjoining lot boundary fence.

B - Fuel Reduction

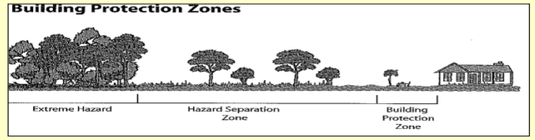
1) **Category 2 - Urban Residential and Industrial-Commercial:** Where the area of land is 2024m² (½ acre) or less, **ALL HAZARDOUS MATERIAL** must be removed from the whole of the land except living trees. In the area remaining, vegetation is to be maintained to a height of no greater than **10 centimetres**; this includes piles of timber, branches and other vegetation. Trees shall be pruned in accordance with section **E – Interpretation and Additional Requirements (refer to E1).**
2) **Category 5 - Protea Plantations/Vineyards:** A **5 metre** low fuel area is to be maintained between the **3 metre FIREBREAK** and the plantation/vineyard area. In this area, vegetation is to be maintained to a height of no greater than **10 centimetres**; this includes piles of timber, branches and other vegetation.
3) **Category 6, 7 and 8 - Rural Residential:** Parkland clearing must be carried out in all open paddocks and along the boundary of the property. Clearing means that all dead vegetation and dry grasses (excluding approved crops, pasture areas and living trees/shrubs) including piles of timber and disused materials must be maintained to a height of no greater than **10 centimetres**.

C - Building Protection Zones (BPZ) - This is a modified area of reduced fuel immediately surrounding a building

BPZ's starve the fire by reducing the fuel levels around your house. These requirements are designed to reduce the fire's intensity and minimise the likelihood of flame contact with buildings. The BPZ gives more protection to families should a fire threaten suddenly and they cannot leave. It also provides extra protection for fire fighters and property owners who may decide to stay with their property.

A BPZ shall be provided for buildings in bush fire prone areas. The surroundings of buildings must comply with the following requirements:

1) The BPZ for existing buildings must be at least 20 metres from any external wall of the building unless varied under an approved Fire Management Plan (FMP) in accordance with section **E - Interpretation and Additional Requirements (refer to E4).**
2) The minimum BPZ for buildings constructed after 1 November 2011, in all cases shall be 25 metres.
3) The BPZ must be located within the boundary of the lot that the building is situated on.
4) Hazardous/flammable materials must not exceed the maximum fuel load specified in Point 5 below with grass areas not exceeding a height greater than 10 cm.
5) Fuel loads must be reduced and maintained at 2 tonne per hectare.
6) Isolated trees and shrubs may be retained, however, the first 5 metres around all buildings is to be clear of all hazardous/flammable materials.
7) Reticulated gardens in the BPZ shall be maintained to a height of no greater than 500 millimetres.
8) Wood piles must be at least 10 metres away from habitable dwellings.
9) Trees in the BPZ must comply with section **E - Interpretation and Additional Requirements (refer to E1).**
10) Where the land has an approved FMP, compliance must be achieved in accordance with the FMP. The FMP may vary the above BPZ requirements.
11) A Hazard Separation Zone (HSZ) is also recommended in the absence of a Fire Management Plan. **Section E - Interpretation and Additional Requirements (refer to E3).**



D – Fuel Storage & Haystack Protection Zones

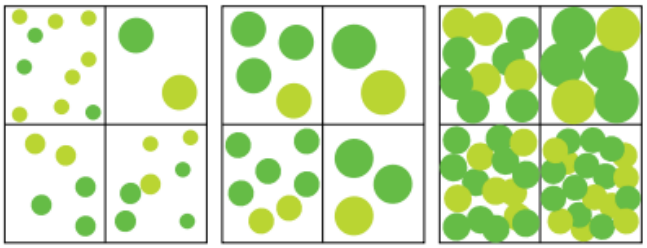
A **3 metre** mineral earth **FIREBREAK** shall be located within **6 metres** of fuel storage tanks, sheds, gas cylinders and haystacks. The mineral earth firebreak shall be maintained so that it is totally clear of all material (living or dead).

E – Interpretation and Additional Requirements

1) **Trees** On **Urban, Industrial, Rural,** and **Rural Residential** land, all tree branches must be removed or pruned to ensure a clear separation of at least **3 metres** back from the eaves of all buildings and **5 metres** above the top of the roof. Branches that may fall on the house must also be removed. In the **BPZ** the following is 'recommended'; the spacing of individual or groups of trees should be 15 metres apart to provide for a 5 metres separation between tree crowns. There is also a requirement of 2.5 metres between trees and power lines so they do not come into contact and start a fire or bring down a power line.
2) **Hazardous and Flammable Materials** means the accumulation of fuel including burn piles (living or dead) such as leaf litter, twigs, trash, bush, dead trees and scrub capable of carrying a running fire, but excludes standing living trees and isolated shrubs. **NOTE**: All remaining vegetation, piles of timber, branches and other living vegetation must be maintained to a height of no greater than 10 centimetres. To measure and determine fuel loads use DFES's *Visual Fuel Load Guide* at http://www.dfes.wa.gov.au/safetyinformation/fire/bushfire/pages/publications.aspx#5 and select *Visual Fuel Load Guide Swan Coastal (Part 1 & 2)*. Surface bush fire fuels should be kept low to the ground.
3) **Hazard Separation Zones (HSZ)** A HSZ is a modified area of reduced fuel load outside of the BPZ and is recommended to assist in reducing the fires intensity when flames are approaching buildings. Both the BPZ and the HSZ are essential strategies for the protection of buildings. A HSZ covers the area 75 metres outside the BPZ.
   The HSZ should be modified to have a maximum fuel load of 6-8 tonne per hectare. This can be implemented by fuel reduction methods such as burning, mowing and slashing to remove the hazard. This should not require the removal of living trees or shrubs. **REMEMBER:** reduce the fuel level of the fire to lower the intensity of the blaze. Further information on fuel loading can be found in the *Visual Fuel Load Guide* available by calling DFES or via their website at www.dfes.wa.gov.au
4) **Fire Management Plan (FMP)** A FMP is a comprehensive plan for the prevention and control of bushfires which may apply to individual land holdings. A notification, pursuant to the Transfer of Land Act 1893 (as amended) may be placed on the Certificate(s) of Title of the land for medium to long term fire management to reduce the occurrence and minimise the impact of uncontrolled bush fires, thereby reducing the threat to life, property and the environment. The land owner must comply with the FMP. **Building in bush fire prone areas**, new dwellings and other forms of accommodation, as well as additions to existing buildings are to be constructed in accordance with in *Australian Standard 3959-2009.* In designated bush fire prone areas, the minimum BPZ in all cases shall be 25 metres. Further information on this and other information relating to fire safety issues can be found on the City's website www.busselton.wa.gov.au

Appendix D Asset Protection Zones – Standards (Schedule 1) and explanatory notes from the Guidelines

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Schedule 1: Standards for Asset Protection Zones	
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 <6 millimetres in thickness)	• Should be managed and removed on a regular basis to maintain a low threat state. • Should be maintained at <2 tonnes per hectare (on average). • Mulches should be non-combustible such as stone, gravel or crushed mineral earth or wood mulch >6 millimetres in thickness.
Trees* (>6 metres 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 <15 per cent of the total APZ area. • Tree canopies at maturity should be at least five metres apart to avoid forming a continuous canopy. Stands of existing mature trees with interlocking canopies may be treated as an individual canopy provided that the total canopy cover within the APZ will not exceed 15 per cent and are not connected to the tree canopy outside the APZ. **Figure 19:** Tree canopy cover – ranging from 15 to 70 per cent at maturity 
Shrub* and scrub* (0.5 metres to six metres in height). Shrub and scrub >6 metres 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 >5 square metres in area. • Clumps should be separated from each other and any exposed window or door by at least 10 metres.
Ground covers* (<0.5 metres in height. Ground covers >0.5 metres in height are to be treated as shrubs)	• 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 >100 millimetres in height.
Grass	• Grass should be maintained at a height of 100 millimetres or less, at all times. • Wherever possible, perennial grasses should be used and well-hydrated with regular application of wetting agents and efficient irrigation.

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Schedule 1: Standards for Asset Protection Zones	
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 covers, grass and non-combustible mulches as prescribed above.
LP Gas Cylinders	• Should be located on the side of a building furthest 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.

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Element 2 Explanatory Notes
E2 Landscaping and design of an Asset Protection Zone
Landscaping, design, and maintenance of an APZ in a bushfire prone area can significantly improve the bushfire resilience of a building. An APZ should not be seen as an area entirely cleared of vegetation, but as a strategically designed space that gives holistic consideration to how existing or proposed vegetation or non-combustible features interact with, or affect the building's bushfire resilience. A well designed APZ provides a greater level of vegetation management within the first few metres of a building with, for example, less vegetation or inclusion of non-combustible materials. The vegetation within the remainder of an APZ can increase further away from the building with carefully considered plant selection and landscaping techniques. Strategic landscaping measures can be applied, such as replacing weeds with low flammability vegetation (refer to E2 Plant Flammability) to create horizontal and vertical separations between the retained vegetation. The accumulation of fine fuel load from different plants is an important consideration for ongoing maintenance in accordance with Schedule 1. For example, when planting ground covers under deciduous trees within an APZ, the total fine fuel load prescribed in Schedule 1 will include any dead plant material from ground covers and leaf litter from the trees. Plant density and final structure and form of mature vegetation should be considered in the initial landscaping stages. For example, clumps of sapling shrubs planted at a density without consideration of future growth, may increase the bushfire risk as a clump will quickly grow to exceed 5m2. It should be noted that in some cases, a single shrub in a mature state may be so dense as to fill a 5m2 clump alone. The location of plants within an APZ is a key design technique. Separation of garden beds with areas of low fuel or non-combustible material, will break up fuel continuity and reduce the likelihood of a bushfire running through an APZ and subjecting a dwelling to radiant heat or direct flame contact. It is important to note, where mature trees are separated from a building by six metres, but the canopy has grown to extend or overhang a building, maintenance and pruning to remove the overhanging branches should be undertaken without the entirety of the tree being removed. Mulches used within the APZ should be non-combustible. The use of stone, gravel, rock and crushed mineral earth is encouraged. Wood mulch >6mm in thickness may be used, however it is recommended that it is used in garden beds or areas where the moisture level is higher by regular irrigation. These materials could be sourced from non-toxic construction and demolition waste giving the added benefit of reducing the environmental impact of any 'hard landscaping' actions. Combustible objects, plants, garden supplies such as mulches, fences made from combustible material, should be avoided within 10 metres of a building. Vines or climbing plants on pergolas, posts or beams, should be located away from vulnerable parts of the building, such as windows and doors. Non-flammable features can be used to provide hazard separation from classified vegetation, such as tennis courts, pools, lawns and driveways or paths that use inorganic mulches (gravel or crushed rock). Consider locating firewood stacks away from trees and habitable buildings. Incorporation of landscaping features, such as masonry feature walls can provide habitable buildings with barriers to wind, radiant heat and embers. These features can include noise walls or wind breaks. Use of Appendix F of AS 3959 for bushfire resistant timber selection within areas of 29kW/m² (BAL-29) or below, or the use of non-combustible fencing materials such as iron, brick, limestone, metal post and wire is encouraged.

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Element 2 Explanatory Notes

In addition to regular maintenance of an APZ, further bushfire protection can be provided at any time by:

- ensuring gutters are free from vegetation;
- installing gutter guards or plugs;
- regular cleaning of underfloor spaces, or enclosing them to prevent gaps;
- trimming and removing dead plants or leaf litter;
- pruning climbing vegetation (such as vines) on a trellis, to ensure it does not connect to a building, particularly near windows and doors;
- removing vegetation in close proximity to a water tank to ensure it is not touching the sides of a tank; and/or
- following the requirements of the relevant local government section 33 fire break notice, which may include additional provisions such as locating wood piles more than 10 metres from a building.

Preparation of a property prior to the bushfire season and/or in anticipation of a bushfire is beneficial even if your plan is to evacuate. As embers can travel up to several kilometres from a bushfire and fall into small spaces and crevices or land against the external walls of a building, best practice recommends that objects within the APZ are moved away from the building prior to any bushfire event. Objects may include, but are not limited to:

- door mats;
- outdoor furniture;
- potted plants;
- shade sails or umbrellas;
- plastic garbage bins;
- firewood stacks;
- flammable sculptures; and/or
- playground equipment and children's toys.

E2 Plant flammability

There are certain plant characteristics that are known to influence flammability, such as moisture or oil content and the presence and type of bark. Plants with lower flammability properties may still burn during a bushfire event, but may be more resistant to burning and some may regenerate faster post-bushfire.

There are many terms for plant flammability that should not be confused, including:

- Fire resistant – plant species that survive being burnt and will regrow after a bushfire and therefore may be highly flammable and inappropriate for a garden in areas of high bushfire risk.
- Fire retardant – plants that may not burn readily or may slow the passage of a bushfire.
- Fire wise – plants that have been identified and selected based on their flammability properties and linked to maintenance advice and planting location within a garden.

Although not a requirement of these Guidelines, local governments may develop their own list of fire wise or fire retardant plant species that suit the environmental characteristics of an area. When developing a recommended plant species list, local governments should consult with ecologists, land care officers or environmental authorities to ensure the plants do not present a risk to endangered ecological communities, threatened, or endangered species or their habitat.

When selecting plants, private landholders and developers should aim for plants within the APZ that have the following characteristics:

- grow in a predicted structure, shape and height;
- are open and loose branching with leaves that are thinly spread;
- have a coarse texture and low surface-area-to-volume ratio;
- will not drop large amounts of leaves or limbs, that require regular maintenance;
- have wide, flat, and thick or succulent leaves;
- trees that have bark attached tightly to their trunk or have smooth bark;
- have low amounts of oils, waxes, and resins (which will often have a strong scent when crushed);
- do not produce or hold large amounts of fine dead material in their crowns; and/or
- will not become a weed in the area.

Refer to the WAPC Bushfire and Vegetation Fact Sheet for further information on clearing and vegetation management and APZ landscaping, design and plant selection reference material.

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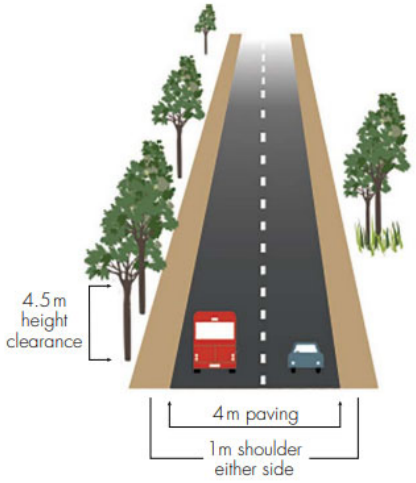
Element 2 Explanatory Notes

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

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Appendix E Vehicular access – Explanatory notes from the Guidelines

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Acceptable Solution A3.1 – Public Roads
Explanatory Note E3.1
These Guidelines do not prescribe values for the trafficable (carriageway/pavement) width of public roads as they should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area. The IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards do not prescribe a horizontal clearance. However, it is recommended that a traversable verge is provided to allow for emergency services vehicles to stop and operate on the side of the public road, specifically where the public road may traverse large areas of classified vegetation. Where local government roads are proposed to be widened by the proponent, they must obtain approval from the local government.  **Figure 20:** Example of a public road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2a – Multiple access routes
Explanatory Note E3.2a

Acceptable Solution A3.2a – Multiple access routes
Explanatory Note E3.2a

Two-way public road access is public road access from a lot in at least two different directions to two suitable destinations, and provides residents and the community, as well as emergency services, with access and egress from both the subdivision and individual habitable buildings/development in the event of a bushfire emergency. A single road provides no alternative route if the access becomes congested or is unable to be traversed due to smoke and/or fallen trees during a bushfire.

Two-way public road access applies to access/egress routes leading into a subdivision, as well as those within a subdivision. A road that loops back onto itself does not constitute the option of two different directions.

Two-way public road access should always be the first option. Where the site is not able to achieve two-way access within 200 metres of the lot boundary, due to demonstrated site or environmental constraints, the proponent should identify options for an emergency access way from the subject site to a suitable destination. Where an emergency access way cannot be provided, the proponent should demonstrate compliance with the performance principle.

Subject sites or proposed lots greater than 200 metres from an intersection, which provides two-way access, do not satisfy the requirement for two-way access unless they meet the provisions which allow for no-through roads greater than 200 metres in A3.2a.

To demonstrate compliance with the performance principle for two-way access, the bushfire planning practitioner may have regard to:

a. the extent of the bushfire hazard, location and vegetation classification, the likelihood, potential severity and impact of bushfire to the subject site and the road network;
b. time between fire detection and the onset of conditions in comparison to travel time for the community to evacuate to a suitable destination;
c. available access route(s) travelling towards a suitable destination; and
d. turn-around area for a fire appliance for no-through roads.

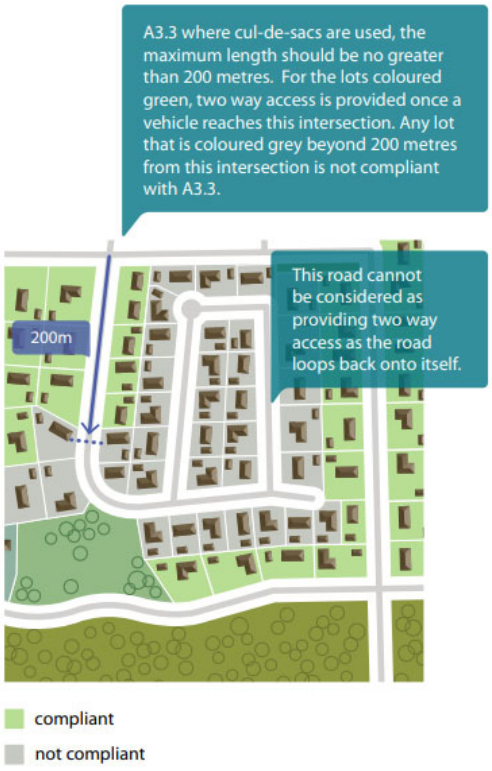


Figure 21: Example of compliant and non-compliant two-way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.2b – Emergency access way
Explanatory Note E3.2a

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Acceptable Solution A3.2b – Emergency access way
Explanatory Note E3.2a
An emergency access way is not a preferred alternative to through public road access and should only be considered acceptable where it has been demonstrated that it will provide the safety and performance needs of emergency services and the community, including consideration for future needs, and that public road access to satisfy A3.2a cannot be achieved due to site constraints, such as an established road network with no opportunity to provide a public road for secondary access. Acceptance of an emergency access way should also consider the ability to accommodate reasonable worst-case vehicle volumes. The principal function of the emergency access way is to provide a contingency (second) community evacuation route and simultaneously provide access for emergency services, in the event of a bushfire emergency. Where an emergency access way traverses classified vegetation, which has the potential to create a bushfire hazard, an emergency access way performs the secondary function of providing access by emergency services to this vegetation. Emergency access ways should connect to a public road to allow alternative two-way through access. An emergency access way should not exceed 500 metres in length as they may not be as safe for road-use due to not being designed or constructed to the full requirements of a public road and may present uncertainties to emergency service personnel and the public as they are not part of the daily road network and not identified on Maps. **Permanent public emergency access way** An emergency access way can be provided as either a public easement in gross or a right-of-way. In both approaches, the management of the emergency access way is by the local government as the grantee of the easement or management body of the right-of-way. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the easement or right-of-way; this must be provided to the decision-maker prior to granting planning approval. The approach taken is at the discretion of the decision-maker and/ or the local government and is also dependent on whether the land is to remain in private ownership or be ceded to the Crown. Consultation with Land Use Management at the Department of Planning, Lands and Heritage should also be considered if the land is to be ceded to the Crown or if the local government is uncertain of which approach to take. If the emergency access way is provided as an easement, it should be provided as a public easement in gross under sections 195 and 196 of the Land Administration Act 1997 in favour of the local government and/or public authority, to ensure accessibility for emergency services and the public at all times. To be provided as a right-of-way the emergency access way should be vested in the Crown under section 152 of the Planning and Development Act 2005 as a right-of-way and such land to be ceded free of cost and without any payment or compensation by the Crown. If gates are used to control traffic flow during non-emergency periods, these will be managed by the local government and must not be locked. Gates should be double gates wide enough to access the full pavement width and accommodate Type 3.4 fire appliances with the design and construction to be approved by the relevant local government. **Temporary public emergency access way** A temporary emergency access way may be proposed to facilitate the staging arrangements of a subdivision. The provision of two public roads may not be possible in the first stage of the subdivision and an emergency access way can be provided as an interim access route until the second public road is developed and gazetted in a subsequent stage of the subdivision (see figure 22). The emergency access way should be provided in the same manner as a permanent emergency access way, but it should be removed from the certificate of title once the public road is developed and gazetted. Where an emergency access way is proposed as an alternative to a public road, the Bushfire Management Plan should provide thorough justification for its use. **Restricted public emergency access way** There may be some instances where a restricted emergency access way is proposed as a performance principle based solution where access is only available to the public in the event of a bushfire emergency. This option can only be considered where the local government or Main Roads WA have advised that vehicular access on the emergency access way is not allowed during non-emergency periods, as it provides an additional thoroughfare and entry point on a local or State road. In this scenario, the emergency access way can be provided as an easement under section 195 of the Land Administration Act 1997, as public access in the event of a bushfire emergency or vested in the Crown as a reserve under section 152 of the Planning and Development Act 2005. Such land is to be ceded free of cost without any payment or compensation by the Crown. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the proposed reserve and agree to the terms of the Management Order Conditions (if applicable); this must be provided to the decision-maker prior to granting planning approval. The purpose of the reserve should be for a public purpose specified in the condition related to the subdivision, for example for emergency access only, or for emergency access and recreation. A reserve for emergency access and recreation can optimise the land-use as a dual purpose where it provides vehicular access in the event of a bushfire

Acceptable Solution A3.2b – Emergency access way
Explanatory Note E3.2a

emergency, but can be accessed by the public (on foot) on a day-to-day basis as a recreation link. Appropriate signage can ensure the general public is aware of the purpose of the reserve. The approach taken is at the discretion of the decision-maker and/or local government.

Right-of-carriageway emergency access way

There may be some instances where a right-of-carriageway easement is proposed as a performance principle-based solution. This may be where particular landowner(s) and emergency services, but not the public, require access over a neighbouring lot(s). A right-of-carriageway easement should be provided under section 195 of the Land Administration Act 1997. The easement is to provide alternative access for the particular landowner(s) in the event of a bushfire emergency and not for use by the public. In this scenario, support will be necessary from the adjoining lot owner(s). The easement is to be granted to the local government and it is to agree with the landowner on the arrangements of the management of the easement area by deed. These management arrangements will be at the discretion of the local government. If gated, the easement area can be locked to restrict day-to-day vehicular access.

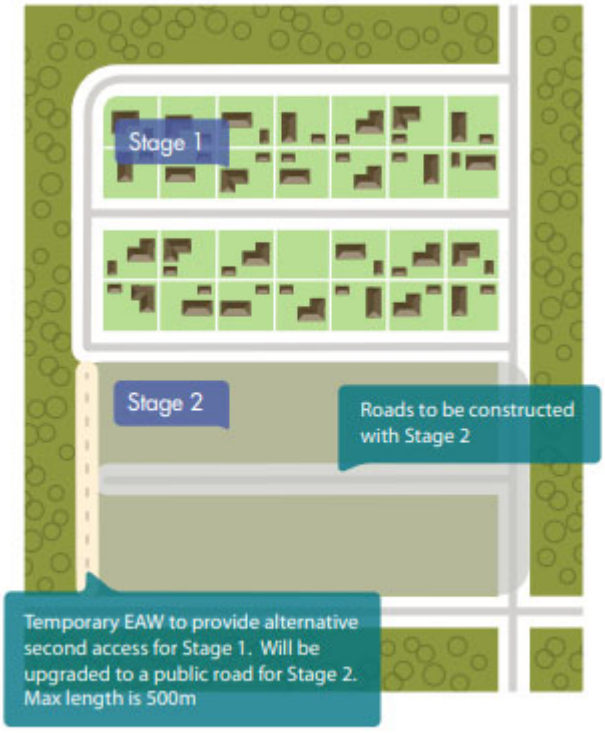


Figure 22: Example of an emergency access way

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.3 – Through roads
Explanatory Note E3.3

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Acceptable Solution A3.3 – Through roads

Explanatory Note E3.3

In bushfire prone areas, a proposed structure plan or subdivision that incorporates no-through roads should be avoided because they do not provide a connected and legible design that allows for easy access and egress by the community, residents and emergency services in the event of a bushfire. No-through roads also reduce the options available for access and egress in the event of a bushfire emergency.

There will however be situations where a subject site is accessed via an existing or proposed no-through road and alternative access cannot be provided. In these situations, the proponent should demonstrate to the decision-maker, that all efforts have been made with the local government and/or adjoining landowners to secure alternative public road access or an emergency access way and that a redesign has been explored. The bushfire planning practitioner may need to develop a performance principle-based solution or address the non-compliance and demonstrate to the decisionmaker why discretion should be exercised in accordance with section 2.6 of these Guidelines.

No-through roads will only be considered an acceptable solution where it is demonstrated by the proponent, to the satisfaction of the decision maker, that a no through-road cannot be avoided due to site constraints. For example, the internal road design of a structure plan or subdivision where site constraints, such as a water body or Bush Forever, prevent the ability to create a through-road and a no-through road may be a more appropriate road layout.

No-through roads should be a maximum of 200 metres from the lot(s) boundary to an intersection where two-way access is provided and may only exceed 200 metres if it meets the provisions which allow for no-through roads greater than 200 metres in A3.2a.

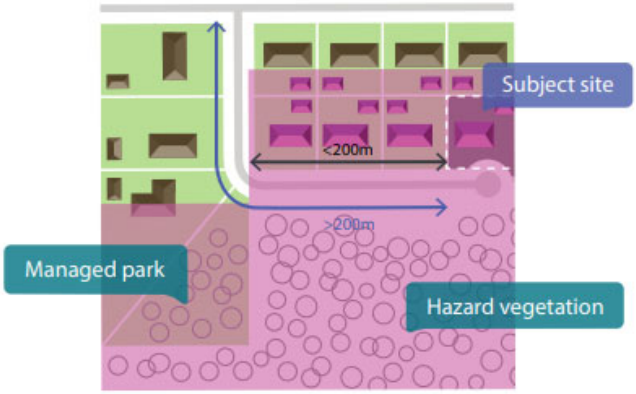


Figure 23: Example of a site on a no-through road greater than 200 metres from the intersection, but within 200 metres of BAL-LOW

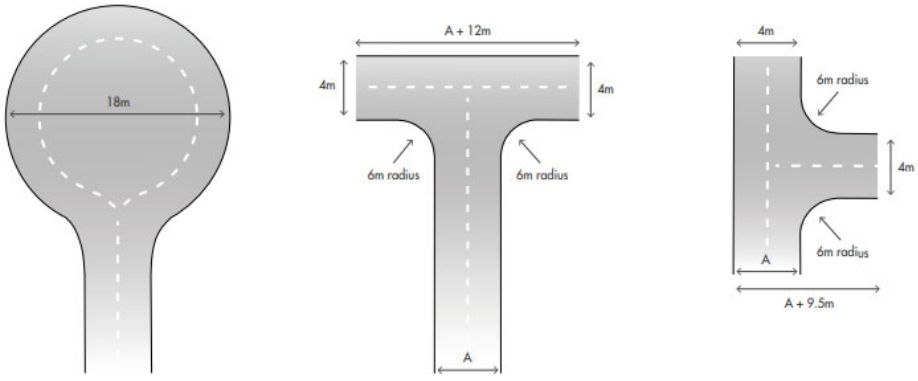


Figure 24: Turn-around area dimensions for a no-through road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

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Acceptable Solution A3.4a – Perimeter roads
Explanatory Note E3.4a

Where a planning proposal includes the creation of 10 or more lots adjacent to each other, which adjoin classified vegetation under AS 3959 with the exception of Class G Grassland, as part of a greenfield development or large urban infill site, hazard separation and defendable space should be provided in the form of a perimeter road. Greenfield is 'undeveloped or minimally developed areas that have been identified for urban development'; and urban infill is 'the redevelopment of existing urban areas at a higher density than currently exists'. The creation of 10 or more lots includes cumulative subdivision applications where the subdivision application may be part of a staged subdivision.

A perimeter road should be in accordance with the class of road as specified in the IPWEA Subdivision Guidelines, Liveable Neighbourhoods, Austroad Standards and/or any applicable standard in the local government area as per the requirements of a public road in Table 6, Column 1.

As the road is likely to function as a key neighbourhood distributor, or similar, consideration should be given to the provision of additional width to allow for emergency services vehicles to stop and operate on the side of the perimeter road, whilst simultaneously proving for the evacuation of the community (Figure 20).

When designing a strategic planning proposal and/or subdivision, creating a large setback between classified vegetation and proposed lots with a perimeter road, and orientating habitable buildings to front onto (rather than back onto) areas of vegetation has many benefits, including:

- passive surveillance;
- defendable space for firefighting and emergency management purposes;
- reducing the potential radiant heat that may impact a habitable building in a bushfire event;
- reducing the need for battle-axe lots; and
- unconstrained public access/egress for the community in the event of a bushfire.

In developments where no perimeter road exists, property defence in a bushfire event is difficult and can be impossible. Where proposed lots have frontage to an existing public road and abut the hazard at the rear or side, it may be an undesirable planning outcome to create lots which front the existing public road and back onto a perimeter road. In this instance, consideration should be given to a fire service access route. Refer to E3.4b below.

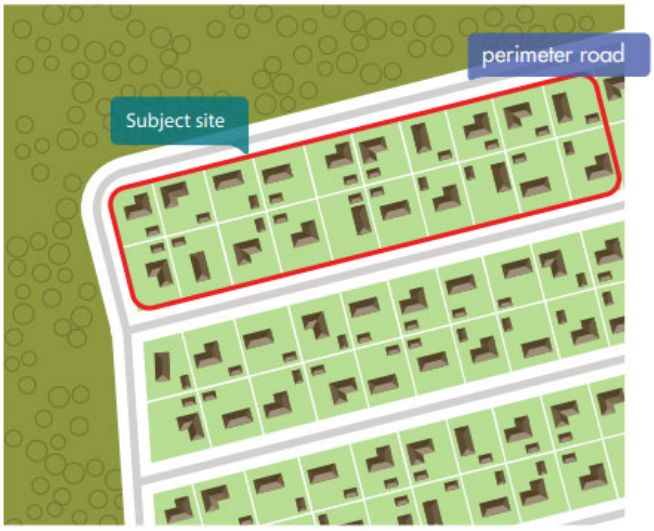


Figure 25: Example of a perimeter road

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.4b – Fire service access route
Explanatory Note E3.4b

Acceptable Solution A3.4b – Fire service access route
Explanatory Note E3.4b

Where a subdivision adjoins classified vegetation and where A3.2a has been satisfied, hazard separation and defendable space across multiple lots may be required in the form of a fire service access route.

A fire service access route is not intended to provide residents and the general public with emergency egress and therefore is not a suitable second access or substitute for a public road. A fire service access route is to provide access for emergency services to classified vegetation for firefighting and fire management purposes.

A fire service access route can be provided as either an easement in gross over private or Crown land, or ceded to the Crown as a reserve. In both approaches, the management of the fire service access route is by the local government as the grantee of the easement or management body of the reserve. Determining which approach to take is dependent on what the intended tenure of the fire service access route is, which is explained further below. The proponent must obtain written consent from the local government that the local government will accept care, control and management of the easement or reserve and agree to the terms of the Management Order Conditions (if applicable); this must be provided to the decision-maker prior to granting planning approval. The approach taken is at the discretion of the decision-maker and/or the local government. Consultation with Land Use Management at the Department of Planning, Lands and Heritage should also be considered if the land is to be ceded to the Crown or if the local government is uncertain of which approach to take.

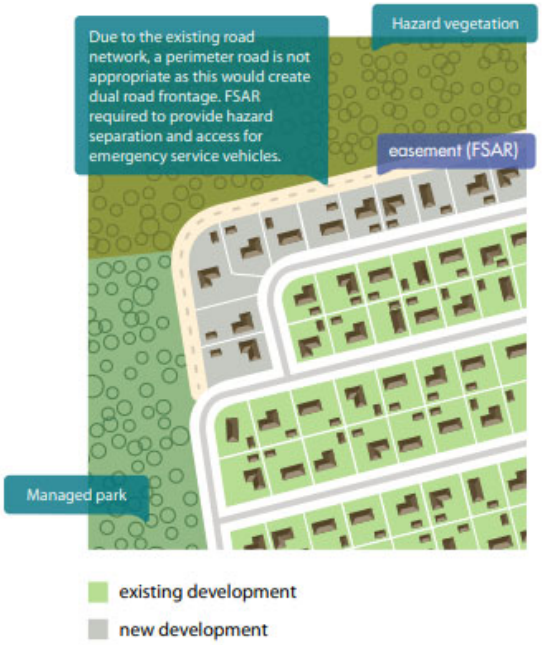


Figure 26: Example of a fire service access route

Where gates are used, these should be double gates wide enough to access the full required horizontal clearance and accommodate type 3.4 fire appliances with the design and construction to be approved by the relevant local government. Gates on fire service access routes may be locked to restrict access, provided a common key system is used, and such keys are made available for emergency services and designated fire officers within the local government area and/or surrounding district. Gates should be installed where fences cross fire service access routes. If an easement in gross is proposed, such arrangements for gates should be included in the deed of easement and be agreed to by the local government.

Fire service access route to remain in private ownership of multiple landowners

Where a fire service access route is proposed to traverse multiple private lots and they are intended to remain in the private ownership of the multiple landowners, it should be provided as an easement in gross under section 196 of the Land Administration Act 1997, to ensure accessibility for fire emergency services and not for use by the public. The easement is to be granted to the local government and/or public authority for firefighting and emergency management purposes.

Fire service access route to be created under State ownership

Where a fire service access route is proposed to traverse multiple private lots, but the decision-maker and/or local government prefer for the fire service access route to remain in one ownership under the State for management purposes, the fire service access route can be vested in the Crown under section 152 of the Planning and Development Act 2005 as a reserve, such land to be ceded free of cost without any payment or compensation by the Crown. The purpose of the reserve should be for a public purpose specified in the condition related to the subdivision, for example for vehicular access for emergency services and the local government only, or for vehicular access for emergency services and the local government and recreation. A reserve for emergency services access and recreation can optimise the land-use as a dual purpose, where it provides vehicular access for emergency services, but can be accessed by the public (on foot) on a day-to-day basis as a recreation link. Appropriate signage will ensure the general public is aware of the purpose of the reserve. The approach taken is at the discretion of the decision-maker and/or local government.

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

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Acceptable Solution A3.5 – Battle-axe access legs
Explanatory Note E3.5

In bushfire prone areas, lots with battle-axe access legs should be avoided because they:

- do not enable the habitable building to be located close to a public road where it is visible to emergency services;
- result in longer than necessary access routes for evacuation and the response of emergency services;
- may be blocked by falling trees or debris; and
- may not provide certainty for emergency services regarding the width, length and ability to turn emergency services vehicle around.

In some instances, it may be appropriate for battle-axe access legs to be used to overcome specific site or design constraints created by the existing road networks or lot layout. The Bushfire Management Plan should provide justification for proposed battle-axe access leg(s), including exploration of a redesign of the proposal, and the decision-maker should determine whether the justification is valid.

The measurement of the battle-axe access leg should be from the edge of the public road to where the access leg joins the effective area of the lot. Effective lot area means that part of the battle-axe lot that is capable of development and excludes the access leg and associated truncations for vehicle manoeuvrability. Where a proposed battle-axe lot has an existing habitable building that will be retained, the private driveway requirements and/or the battle-axe requirements (as appropriate) should be satisfied.

Battle-axe access should be 6 metres in width where the battle-axe is more than 50m in length or for lots serviced by a water source within the property, such as a water tank. It is acceptable for a single battle-axe to have a trafficable width of 4 metres with a traversable edge of 1 metre on either side of the carriageway.

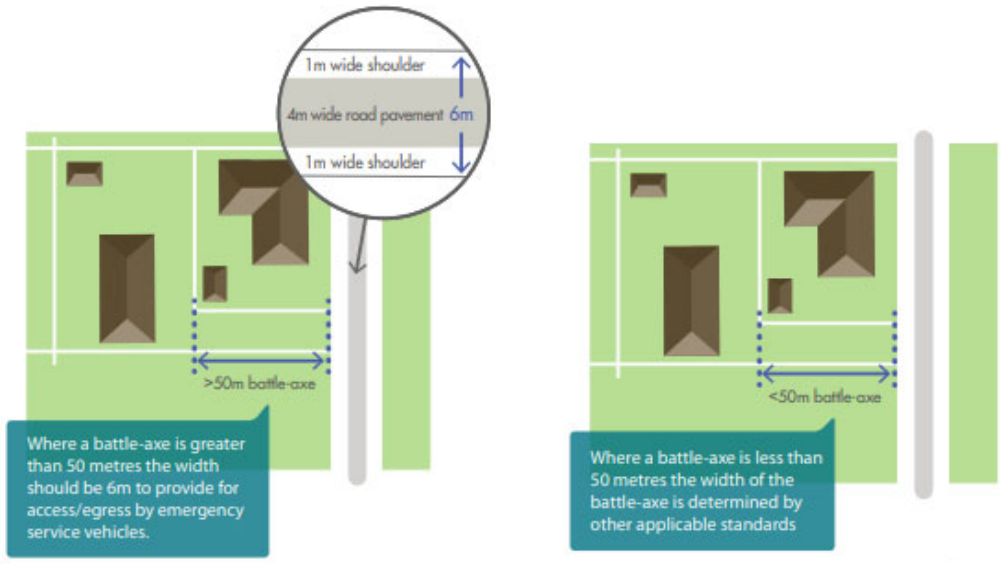


Figure 27: Battle-axe design requirements where required under A3.5

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Acceptable Solution A3.6 – Private driveways
Explanatory Note E3.6

Acceptable Solution A3.6 – Private driveways

Explanatory Note E3.6

In areas serviced by reticulated water, where the road speed limit is not greater than 70 km/h, and where the distance from the public road to the further part of the habitable building is no greater than 70 metres, emergency service vehicles typically operate from the street frontage.

In the event the habitable building cannot be reached by hose reel from the public road, then emergency service vehicles will need to gain access within the property. Emergency service vehicles will also need to gain access within the property, where access to reticulated water (fire hydrants) is not possible. In these situations, the driveway and battle-axe (if applicable) will need to be wide enough for access for an emergency service vehicle and a vehicle to evacuate.

Turnaround areas should be available for both conventional two-wheel drive vehicles of residents and Type 3.4 fire appliances. Turn-around areas should be located within 30 metres of habitable buildings. Circular and loop driveway design may also be considered. Note that the design requirements for a turn-around area for a private driveway or battle-axe differ to a cul-de-sac.

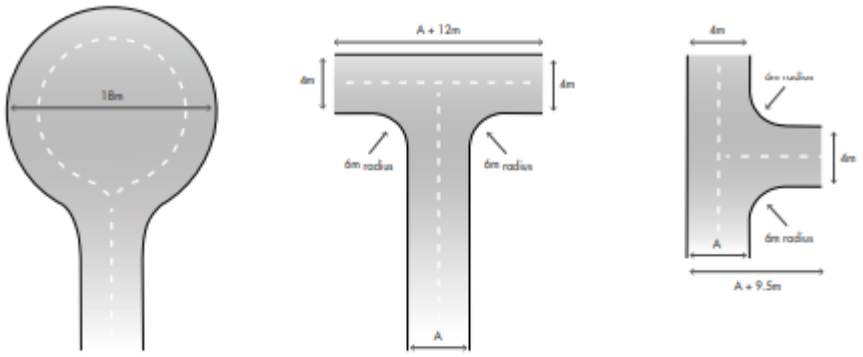


Figure 28: Design requirements for a turn-around area for a private driveway or battle-axe

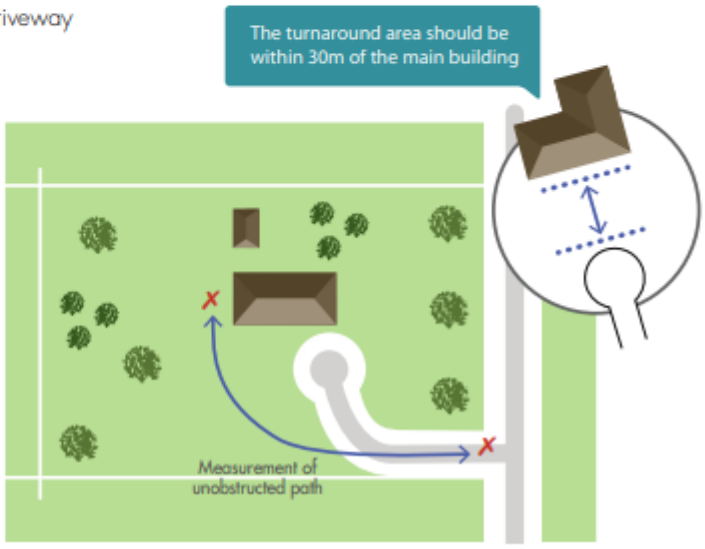


Figure 29: Design requirements for a private driveway where required under A3.6

Source: *Guidelines for Planning in Bushfire Prone Areas (WAPC 2021)*

Technical requirement	1	2	3	4
	Public road	Emergency access way[1]	Fire service access route[1]	Battle-axe and private driveways[2]
Minimum trafficable surface (m)	In accordance with A3.1	6	6	4
Minimum horizontal clearance (m)	N/A	6	6	6
Minimum vertical clearance (m)	4.5	4.5	4.5	4.5
Minimum weight capacity (t)	15	15	15	15
Maximum grade unsealed road[3]	As outlined in the IPWEA Subdivision Guidelines	1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Maximum grade sealed road[3]		1:7 (14.3%, 8°)	1:7 (14.3%, 8°)	1:7 (14.3%, 8°)
Maximum average grade sealed road		1:10 (10%, 6°)	1:10 (10%, 6°)	1:10 (10%, 6°)
Minimum inner radius of road curves (m)		8.5	8.5	8.5

[1] To have crossfalls between 3 and 6%

[2] Where driveways and battle-axe legs are not required to comply with the widths in A3.5 or A3.6, they are to comply with the Residential Design Codes and Development Control Policy 2.2 Residential Subdivision

[3] Dips must have no more than a 1 in 8 (12.5% -7.1 degree) entry and exit angle.

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Document Status

Report version	Rev No.	Purpose	Author	Reviewed and Approved for Issue	
				Name	Date
Draft Report	Rev A	For client review	Louisa Robertson (BPAD 36748, Level 3)	Louisa Robertson (BPAD 36748, Level 3)	14 December 2022
Final Report	**Rev 0**	**For use to accompany the Structure Plan amendment application**	**Louisa Robertson (BPAD 36748, Level 3)**	**Louisa Robertson (BPAD 36748, Level 3)**	**22 December 2022**
Final Report	**Rev 1**	**Revised as per feedback from City of Busselton**	**Louisa Robertson (BPAD 36748, Level 3)**	**Louisa Robertson (BPAD 36748, Level 3)**	**17 May 2023**



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Lot 2, 9032 & 9034 Bussell Highway, Busselton

Local Water Management Strategy

October 2026



Client: Yolk Property Group

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Disclaimer

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Hyd2o recognise site conditions change and contain varying degrees of non-uniformity that cannot be fully defined by field investigation. Measurements and values obtained from sampling and testing in this document are indicative within a limited timeframe, and unless otherwise specified, should not be accepted as conditions on site beyond that timeframe.

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In making this declaration, I am aware that section 491 of the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) makes it an offence in certain circumstances to knowingly provide false or misleading information or documents to specified persons who are known to be performing a duty or carrying out a function under the EPBC Act or the Environment Protection and Biodiversity Conservation Regulations 2000 (Cth). The offence is punishable on conviction by imprisonment or a fine, or both. I am authorised to bind the approval holder to this declaration and that I have no knowledge of that authorisation being revoked at the time of making this declaration.

Signed:



Full name: Alexander (Sasha) Martens

Position : Principal Hydrologist / Managing Director

Organisation: Hyd2o

Date: 01 September 2025

Document History

Rev	Document Version No.	Description	Date	Author	Reviewer	Approver
1	H22018Dv2	Issued for Review	27/4/2023	S Martens/ S O'Sullivan	S Martens	S Martens
2	H22018Dv3	Issued for Review (DWER Review Amendments)	16/1/2025	S O Sullivan	S Martens	S Martens
3	H22018Dv4	Issued For DCCEEW Approval (DCCEEW Review Amendments DWER Review Amendments)	6/4/2025	S Martens/ S O'Sullivan	S Martens	S Martens
4	H22018Dv5	Issued For DWER Approval (DWER Review Amendments)	01/9/2025	S Martens/ S O'Sullivan	S O'Sullivan	S Martens
5	H22018Dv6	Issued for Review	18/12/2025	S Martens/ S O'Sullivan	S O'Sullivan	S Martens
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8	H22018Dv10	Issued for Review	07/10/2026	S Martens/ S O'Sullivan	S O'Sullivan	S Martens

Executive Summary

Hyd2o was commissioned by Yolk Property Group to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan (LSP) addendum for Lot 2, 9032 and 9034 Bussell Hwy, Busselton.

The LSP addendum has been prepared by Taylor Burrell Barnett (TBB), consisting of residential lots, commercial land uses, roads, public open space, retirement village and an education facility. It is important to note that this LWMS requires consideration of a wider area than that covered by the LSP addendum to provide an overarching integrated water management strategy. It is therefore this wider area that is referred to in this document as the site.

The site is located approximately 4 km south east of the Busselton City Centre and within the City of Busselton (Figure 1). The site has an approximate area of 217 ha and is bound by existing residential development to the west, Bussell Hwy to the north and existing rural lots to the east and south. The site has low relief, has surface sandy soils over much of its area and has a high regional groundwater table. The site contains no mapped watercourses, and is mainly located within the catchment of the Sabina River which drains through Reinscourt to the Vasse Wonnerup estuary.

The site is located in an area covered by the conditions of approval of EPBC 2004/1878, and this document therefore addresses the EPBC approval and conditions and provides the additional specific information requested to provide compliance with water related development conditions above typical LWMS reporting requirements set by the Commonwealth Minister for the Environment and Water through the Department of Climate Change, Energy, the Environment and Water (DCCEEW). These water related conditions aim to ensure development of the site does not negatively impact the Vasse Wonnerup wetlands and contribute to long term water quality improvements.

Understanding key hydrological considerations has informed the development of the structure plan addendum and this LWMS for the site. A summary of the key elements of the water management strategy are detailed in the following table.

Stormwater management within the site will be undertaken using water sensitive design practices. A treatment train approach to water quality management will be implemented to improve water quality outcomes for the site in comparison to current use, including:

- Soakwells to manage and infiltrate lot runoff at source where possible,
- A series of pipes, swales, and road reserves to convey local and regional flows,
- Localised biofiltration areas comprising vegetation and for water quality treatment,
- Landscaped POS areas with multiple use characteristics to assist with flood management during larger storm events.
- Use of appropriate density urban residential zonings and POS landscaping to reduce nutrient input.

A further key consideration of this report is to ensure that the site does not discharge more flow (rate and volume) than predevelopment towards Reinscourt.

This LWMS has been prepared adopting a considered approach to previous water management plans prepared for the site, the East Busselton 'Provence' Estate Development, Busselton, WA (EPBC No 2004/1878) Draft Conditions (Department of Climate Change, Energy, the Environment and Water, 2025), overarching City of Busselton approach to Water Sensitive Urban Design (WSUD), Institute of Public Works Engineering Australasia guidelines, Stormwater Management Manual for WA (Department of Water and Environmental Regulation, 2022), and State Planning Policy 2.9 Water (Western Australian Planning Commission, 2025).

Implementation of the strategy will be undertaken in accordance with BUWM through the development and implementation of Subdivision and Development Water Management Reports for individual stages of development within the site. A copy of the WAPC (2008) LWMS submission checklist is contained as Appendix A.

Local Water Management Strategy Summary

Water Use Sustainability	
Water Efficiency	• Use of water efficient fixtures and fittings at lot scale. • Use of native plantings in landscaped areas. • Maximise infiltration of stormwater at source.
Water Supply	• Reticulated water supply system for lots via connection to existing Busselton Water water supply system. • Encouraged use of rainwater tanks (non-mandated). • POS irrigation via existing DWER groundwater licence.
Wastewater	• Reticulated sewerage via connection to existing Water Corporation system.
Stormwater Management	
Ecological Protection (15 mm Event)	• Land use change to reduce nutrient input compared to existing. • Implement both structural and non-structural controls. • Retention and management of small events (15mm) at lot scale, where design limitations permit. • Road runoff for the initial 15mm event for piped systems to be treated and managed in vegetated biofiltration storage areas, with swales and distributed infiltration to manage runoff at source determined at SDWMR stage.
Serviceability: 20% AEP Event	• Road drainage designed so that roads will be passable in the 20% AEP event. • Provision of 20% AEP storage for management and attenuation of local stormwater within identified POS areas.
Flood Protection: 1% AEP Event	• Ensure that the site does not discharge more flow (rate and volume) than predevelopment towards Reinscourt. • Additional more direct flow path to Vasse Wonnerup via easement for estate and downstream landowner protection. • Overland flows paths provided within road reserves identified for safe conveyance of flows exceeding pipe drainage system capacity. • Provision of 1%AEP storage for management and attenuation of local stormwater within POS areas.

	• Habitable building floor levels to be established at a minimum of 0.5 m above the 1% AEP flood level if no overflow relief present.
Groundwater Management	
Fill & Subsoil Drainage	• Use of a combination of fill and subsoil to provide suitable clearances above groundwater for development. • Subsoil inverts set at the average annual maximum groundwater level (AAMGL) or above to protect site wetlands and conservation areas, and downstream Vasse Wonnerup wetlands. • Subsoil to be free draining and have appropriate treatment prior to discharge.
ASS & Contamination	• Minor contaminated site within LWMS area. Remediated classification does not preclude development. • Where required, ASS management to be conducted consistent with agency requirements as a separate process.
Implementation	
Monitoring & Process	• Compliance targets based on predevelopment monitoring and Vasse Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan (WQIP) (DoW, 2010) • Contingency Management Plan to be implemented to inform post development monitoring and compliance reporting requirements, and data provision to agencies. • Future stages of planning consistent with Better Urban Water Management (WAPC, 2025) process including preparation of SDMWR's for individual subdivision areas.

1 Introduction

Hyd2o was commissioned by Yolk Property Group to prepare this Local Water Management Strategy (LWMS) to support the proposed local structure plan (LSP) addendum for Lot 2, 9032 and 9034 Bussell Hwy, Busselton.

The LSP addendum has been prepared by Taylor Burrell Barnett (TBB). The proposed development consists of residential lots, commercial land uses, roads, public open space, retirement village and an education facility. It is important to note that this LWMS requires consideration of a wider area than that covered by the LSP addendum to provide an overarching integrated water management strategy. The area covered by this LWMS is shown in Figure 1 (herein referred to as the site).

The site is located in an area covered by the conditions of approval of EPBC 2004/1878, and this document therefore addresses the EPBC approval and conditions and provides the additional specific information requested to provide compliance with water related development conditions above typical LWMS reporting requirements set by the Commonwealth Minister for the Environment and Water through the Department of Climate Change, Energy, the Environment and Water (DCCEEW). These water related conditions aim to ensure development of the site does not negatively impact the Vasse Wonnerup wetlands and contribute to long term water quality improvements.

The site is located approximately 4 km south east of the Busselton City Centre and within the City of Busselton (Figure 1). The site has an approximate area of 217 ha and is bound by existing residential development to the west, Bussell Hwy to the north and existing rural lots to the east and south.

This document provides an integrated total water cycle management approach to the development, with an assessment of the pre-development environment, development of water use sustainability initiatives, a stormwater management strategy, a groundwater management strategy and a plan for implementation of subdivision plans.

This LWMS has been prepared adopting a considered approach to previous water management plans prepared for the site, the East Busselton 'Provence' Estate Development, Busselton, WA (EPBC No 2004/1878) Draft Conditions (Department of Climate Change, Energy, the Environment and Water, 2025), overarching City of Busselton approach to Water Sensitive Urban Design (WSUD), Institute of Public Works Engineering Australasia guidelines, Stormwater Management Manual for WA (Department of Water and Environmental Regulation, 2022), and State Planning Policy 2.9 Water (Western Australian Planning Commission, 2025).

A copy of the Better Urban Water Management (WAPC, 2008) LWMS Checklist for Developers is included as Appendix A to assist the Department of Water and Environmental Regulation (DWER) in review of this document.

Chapter 10 and Table 18 provide details of compliance with DCCEEW water related development conditions to assist DCCEEW in its assessment.

1.1 Planning Background

The urban water management planning process for the site is shown in Table 1. The site is currently zoned Urban under the Metropolitan Region Scheme and zoned as Urban Development under the City of Busselton Local Planning Scheme No. 21.

The site has previously had a number of overarching water management strategies as detailed in Table 1. It is important to note the most recent JDA (2019) LWMS did not receive final agency approval. It is understood the JDA (2019) LWMS was not updated to address several remaining comments from the Department of Water and Environmental Regulation (DWER) and City of Busselton (CoB) at that time. An LWMS Addendum report was therefore prepared (Hyd2o, 2022) in consultation with agencies as a bridging document to support the Stage 1 development area in advance of the LSP addendum process and its supporting technical documents.

The LWMS Addendum was solely to satisfy the progression of Stage 1, and was not intended for supporting future subdivision stages until the structure plan addendum was completed together with the supporting studies and reports including a revised LWMS.

This document represents the revised LWMS for the site and supersedes previous LWMS planning documents.

Table 1: Integrated Planning and Urban Water Management Process

Planning Phase	Planning Document	Urban Water Management Document
District	Busselton Airport District Structure Plan	Busselton Airport Structure Plan District Water Management Strategy (JDA, 2009)
Local	Local Structure Plan	Provence Drainage & Nutrient Management Plan (JDA, 2005) Provence Water Management Strategy (JDA, 2008) Provence Local Water Management Strategy (JDA, 2019) Lots 9032 and 9034 Joseph Drive Yalyalup, WAPC Subdivision 162371 JDA (2019) Local Water Management Strategy Addendum Report (Hyd2o, 2022a). Lot 2, 9032 & 9034 Bussell Highway Busselton LWMS **THIS DOCUMENT**
Subdivision	Subdivision Application	Embark Stage 1 Urban Water Management Plan (Hyd2o, 2023a) Lot 9034 Joseph Drive Yalyalup Urban Water Management Plan (Hyd2o, 2023b) SDWMRs for Future Stages **FUTURE PREPARATION**

1.2 EPBC Approval

The site is located in an area covered by the conditions of approval of EPBC 2004/1878. The previous conditions for the site were most recently agreed and signed in July 2008 which was before the Western Australian Planning Commission (WAPC) Better Urban Water Management (BUWM) framework was released and implemented.

Since 2008, significant local changes in alignment of water management with the planning process have occurred in WA, which ensures greater alignment of water management and implementation of water sensitive urban design to the planning process. These documents include Better Urban Water Management (WAPC, 2008), DWER monitoring guidelines, and the recently released Draft State Planning Policy 2.9 Planning for Water and Planning for Water Guidelines.

The EPBC approvals are currently being revised to update these in accordance with the LSP addendum, and as part of this process modification to the relevant water management provisions are also being undertaken.

The revised conditions provided by the Department of Climate Change, Energy, the Environment and Water are included in Appendix B and are used to inform this LWMS.

This document addresses the EPBC approval and conditions and provides the following additional information above typical LWMS reporting requirements:

• specific information requested to provide compliance with water related development conditions set by the Commonwealth Minister for the Environment and Water through the Department of Climate Change, Energy, the Environment and Water

• a table of compliance, detailing where and how conditions are addressed in the LWMS

This LWMS maintains consistency with local requirements and previously approved EPBC water management strategies for the site (JDA, 2008). The LWMS aims to ensure development at the site does not negatively impact the Vasse Wonnerup Ramsar Wetland.

1.3 Key Documents and Previous Studies

This LWMS uses the following key documents and previous water management plans for the site to define its principles, criteria, and objectives:

- State Planning Policy 2.9 Water (WAPC, 2025)
- East Busselton 'Provence' Estate Development, Busselton, WA (EPBC No 2004/1878) Draft Conditions (Department of Climate Change, Energy, the Environment and Water, 2025)
- Hyd2o (2022), Lots 9032 and 9034 Joseph Drive Yalyalup, WAPC Subdivision 162371 JDA (2019) Local Water Management Strategy Addendum Report August 2022.
- Stormwater Management Manual for WA (Department of Water and Environmental Regulation, 2022)
- Provence Local Water Management Strategy (JDA, 2019)
- Decision Process for Stormwater Management in WA (Department of Water, 2017)
- Specification, Separation Distances for Groundwater Controlled Urban Development, Prepared by the Land Development in Groundwater Constrained Landscapes Steering Group (Institute of Public Works Engineering Australasia Western Australia, 2016)

- Local Planning Policy No. 6.1 Stormwater Management (City of Busselton, 2015)
- Water Sensitive Urban Design Guidelines for Individual Lots, Infill Development and Subdivision (City of Busselton, 2014).
- Engineering and Works Services Standards and Specifications Section 6 Property Development Technical Requirements and Guidelines Earthworks, Drainage and Parking (City of Busselton, 2013)
- Vasse Wonnerup Wetlands and Geographe Bay WQIP (Department of Water, 2010)
- Busselton Airport Structure Plan District Water Management Strategy (JDA, 2009)
- Provence Water Management Strategy (JDA, 2008)
- Better Urban Water Management (WAPC, 2008)
- Provence Drainage and Nutrient Management Plan (JDA, 2005)

2 Proposed Development

The LSP addendum for the site is shown in Figure 2 within the context of the wider structure plan area and existing developed areas of Provence Estate.

Note that the areas specified as excluded from the LSP addendum are included within the site for this LWMS to enable a complete water management strategy for the area to be developed consistent with previous water management documented for the area.

Development within the addendum area will consist of:

1. Residential Areas
2. Local Centre (including retail, shops, restaurants/cafes, commercial)
3. Public Open Space (including stormwater management areas)
4. School Site
5. Special Use Precinct (intended to accommodate a lifestyle village for older persons)

Many of the POS areas are to have multiple use characteristics and include both a public use, landscaped drainage function, and vegetation conservation areas.

Areas excluded from the LSP Addendum are predominately residential areas, including larger sized rural residential lots to the west.

The proposed development of the site has considered the predevelopment environment, key environmental factors, and the constraints posed by previous water management planning and used this together with additional data and local scale information to inform and guide the structure plan addendum development.

A copy of the proposed staging plan for the LSP Addendum area is included in Appendix C.

3 Pre-Development Environment

3.1 Site Conditions

A site conditions plan is included as Figure 3.

The site is currently a rural lot of approximately 271 ha in size. The site is largely cleared with some retained vegetation in the central western portion of the site. Historically, the southern region of the site has been mined for mineral sands before being used for grazing pasture.

The site is relatively flat, with site topography typically ranging in elevation between approximately 3 mAHD near Bussell Highway to 7 mAHD at its southern extent, with some higher elevations in parts. DWER 1m Lidar topographic contours are shown on Figure 3.

3.2 Geotechnical

Environmental geology mapping on the Busselton 1:50,000 Environmental Geology sheet (Belford, S. M, 1987) is shown in Figure 4. The site is characterised as:

- LS7 (Limestone: Tamala Limestone) – Light yellowish brown, fine to coarse grained, sub-angular to well-rounded quartz, of marine origin, overlain by S7.
- S7 (Sand: Derived from Tamala Limestone) – pale and olive-yellow, medium to coarse grained, sub-angular quartz, moderately sorted, of residual origin, modified by marine inundation.
- Spc1 (Clayey Peaty Sand): Swamp Deposits – grey to black quartz sand with variable organic content, minor clays, of lacustrine origin.
- MS2 (Sandy Silt: Guildford Formation) – strong brown to mid-grey, mottled, blocky, disseminated fine sand, of alluvial origin.
- S27 (Calcareous Sand : Overlying Estuarine Silts) – relatively thin layer over variably thick estuarine silts, clays, of estuarine and eolian origin.

A geotechnical field investigation was undertaken by Golder Associates across the wider Provence estate area which included the site in 2006 and 2007 (Golder Associates, 2007). A copy of the report is included in Appendix D.

The report summarised previous investigations conducted by Coffey Partners in 1995, Golder in 2004 and the additional two investigations in September 2006 and April/June 2007. This investigation included 272 backhoe excavated test pits, Electric Friction Cone Penetrometer tests (EFCPT) at 101 locations, Dynamic Cone Penetrometer tests (DCP) and or Perth Sand Penetrometer tests.

The investigation identified three separate geological zones, with the LSP Addendum area shown as within Zone 1 and Zone 2. Zone 1 consisted predominately of natural sands overlying limestone, and Zone 2 included ground conditions consistent with Zone 1 with reworked sands and sand residues from previous mining activities within the site.

Further geotechnical investigations for the site undertaken by Structerre are also included in Appendix D. Structerre conducted field investigations in March 2022 and assessed the existing natural sand materials in the northern region of the site for suitability for reuse as structural (sand) fill.

The assessment used soil retrieval probing to determine the thickness of the sand cover in the northern section of the site. Six boreholes were installed to a depth of 2.5 m indicating a thickness of insitu sand ranging from 0.6 m in the south to 2m near the northern boundary of the site. Test locations are shown in Figure 4. Based on the visual assessments the natural sand materials were considered suitable for use as free draining sand fill in the upper soil profile for residential development.

A number of bores have also been installed within and in proximity to the site and data from these bores also informs an understanding of the sites geological conditions. Bore locations are shown in Figure 4, with logs of the bores installed by JDA contained as Appendix E.

3.2.1 Acid Sulphate Soils

Acid Sulphate Soil (ASS) mapping in the vicinity of the site is shown in Figure 4. Published acid sulphate risk mapping for the site indicates the majority of the site is located within an area of moderate to low risk of acid sulphate soils occurring within 3.0 m of natural soil surface. In the northern portion of the site, there is a small portion of moderate to high risk of ASS occurring within 3.0m of natural surface, associated with an area mapped as clayey peaty sand in Environmental Geology mapping.

ASS management will be undertaken consistent with the previously developed ASS management plan for the site (Coffey Environments, 2010). All future assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series documentation (Department of Environmental Regulation, 2015a & b).

3.3 Contaminated Sites

According to the DWER's Contaminated Sites Database dataset (2022) the site contains a remediated contaminated site near the northern boundary. As per documented recommendations this remediation classification (classified 10/09/2024) has made the associated land suitable for proposed residential land use.

3.4 Wetlands

According to the Department of Biodiversity Conservation and Attractions (DBCA) Geomorphic Wetlands of the Swan Coastal Plain dataset, most of the site is not a mapped wetland, and no Conservation Category or Resource Enhancement wetlands are present. The site does however contain a linear multiple use wetland toward its northern boundary and a further multiple use wetland along its southern border (Figure 5). This does not preclude development of this area.

The Vasse-Wonnerup estuarine system, located approximately 700m north of the site, ultimately receives discharge from the site. It is listed under the Ramsar Convention as a wetland of International Importance due to its significance as a habitat for water birds, and is also an important fish habitat supporting commercial and recreational fisheries taking place within Geographe Bay.

The Vasse Wonnerup wetlands are one of the most important waterbird habitats in WA, with more than 30 000 waterbirds comprising 90 different species using the habitat provided by the wetlands each year (DoW,2010). These include a range of migratory and resident species in addition to the largest breeding colony of black swans.

The wetlands currently cover approximately 1115 ha and include the non-freehold and seasonally inundated floodplains and marshes of the Vasse and Wonnerup estuaries and Wonnerup Inlet. The Lower Vasse, Lower Sabina and Abba rivers flow into the Vasse estuary, while the Ludlow River flows into the Wonnerup estuary.

Floodgates were installed in the estuaries during the early 1900s to prevent flooding of land with salt water and these floodgates have enabled the Busselton town site to expand into otherwise inundated land. The floodgates maintain fresh–brackish water within the system for longer periods than would have occurred naturally. Large areas of the wetland dry out during summer, though some water is retained that provides a waterbird refuge.

The wetlands have experienced symptoms of nutrient enrichment for many years largely as a result of the surrounding rural land use. Protection of the Vasse Wonnerup estuarine system is a key consideration of the EPBC approval conditions for the site (DCCEEW, 2025).

3.4.1 Vasse Wonnerup Wetlands and Geographe Bay WQIP (DoW,2010)

This Vasse Wonnerup Wetlands and Geographe Bay Water Quality Improvement Plan (WQIP) was developed by the then Department of Water (DoW) in 2010 to detail a strategic approach to reducing nutrients and manage and improve water quality being discharged to the Vasse-Wonnerup estuarine system and Geographe Bay.

The management practices described in the plan were selected using models and decision-support tools based on current data and understanding, with the plans aim being to provide clear and achievable advice about the best practice management approaches for the catchment to meet reduction targets for total nitrogen and total phosphorus.

DoW (2010) provided much of its assessment information at a subcatchment level to aid its implementation at local scale. Key relevant extracts from the WQIP for the site are included as Appendix F. The site is identified as located in the Lower Sabina River reporting catchment (~7000 ha), which is classified as a Recovery Catchment. A Recovery Catchment is defined in the WQIP (DoW, 2010) as a waterway that does not meet either of the nitrogen or phosphorus criteria.

Targets in DoW (2010) for the Lower Sabina River Reporting Catchment are contained in Appendix F and summarised in Table 2. While nutrient load reduction targets are provided in DoW(2010), a median concentration criteria for Recovery Catchmetns of 0.1 mg/L for total phosphorus and 1 mg/L for total nitrogen are specified to achieve the load objectives.

Existing water quality in relation to these concentration targets are discussed in Sections 3.5.1 and 3.6.2, with an assessment of nutrient loads as a result of land use change detailed in Section 6.3 on the basis of applying DWER's UNDO model to the site.

Table 2: Lower Sabina Reporting Catchment Nutrient Targets (DoW, 2010)

Timeframe	TN Load tonnes/yr	TP Load tonnes/yr	TN Load kg/yr/ha	TP Load kg/yr/ha	TN Conc mg/L	TP Conc mg/L
Current Load	39.5	3.57	5.6	0.51	3.5	0.38
10 Year Target	26.9	2.61	3.8	0.37	1.0	0.10
Long Term Target	11.3	0.94	1.6	0.13		

3.5 Surface Water

Catchment boundaries for the site are shown in Figure 6. The site is part of the Vasse-Wonnerup Estuary catchment, and lies across Sabina, Wonnerup and Vasse subcatchments. The total area of the Vasse Wonnerup Estuary catchment is 96,000 ha meaning the site takes up approximately 0.2% of its total catchment area.

The site largely exists across a Sabina subcatchment which drains through the existing Reinscourt rural residential area to the Sabina River via a set of culverts under Bussell Hwy on the sites northern boundary. This connectivity is provided by a shallow largely cleared depression running west to east win the northern region of the site toward the 2 x 600 mm diameter culverts under Bussell Hwy. These culverts are reflected as PSW1 on Figure 6. JDA (2019) reported detailed modelling of this Sabina subcatchment (Sabina4) which provided flow rates and parameters to inform water management planning.

JDA (2019) extracts are included as Appendix G. Key modelling outcomes are presented in Figure 7 which define the peak flow and volume criteria for this subcatchment post development as a peak flow for the 1% AEP of 0.492 m^3/s and total volume of 35,600 m^3, and a peak flow for the 20% AEP of 0.10 m^3/s and total volume of 6,500 m^3.

With regards to flow from the Sabina4 catchment to Reinscourt it is important to note that although the predevelopment catchment is identified as 189.6 ha in JDA (2019), previous stages of development at Provence have reduced this catchment. As such flows to Reinscourt would therefore currently be reduced when compared to estimated predevelopment flows. This is consistent with anecdotal evidence provided by landowners in Reinscourt during field investigations by Hyd2o that flows into the subdivision have significantly reduced since the Provence development. Landowner feedback reflected a negative sentiment toward this reduction. This advice is considered likely to be related to base flows rather than during flooding events.

As shown on Figure 6 a 450 mm diameter culvert exists on Bussell Hwy approximately 100m east of the culverts detailed above (PSW6). Based on recent pipe survey data it is understood that this culvert also connects through to the Reinscourt flowpath.

Wonnerup subcatcments within the site include northern regions of the site that also direct flow to existing culvert crossings across Bussell Highway. As shown on Figure 6 crossing PSW4 discharges Wonnerup1 (4.6 ha) and crossing PSW5 discharges Wonnerup2 (32.4 ha).

With respect to the far western portion of the site, this flows to the west and is located within the Vasse River catchment. JDA (2019) reports an allowable discharge rate of approximately 5 l/s/ha from this area. This area drains through a broad flat vegetated depression flowing westward toward the Sir Stewart Bovell Sports Complex and Vasse River behind the exiting Willow Grove rural residential subdivision west of the site.

3.5.1 Reinscourt Flow Path Considerations

It is noted that the flow path through Reinscourt does not exist within an easement and potential landowner inference in the downstream system can occur. Based on consultation with the City of Busselton is understood that across the winter of 2025 there were observations of long-standing water in the watercourse to suggest modifications have taken place to impact the baseflow condition and the draining of groundwater. This is supported by historical aerial imagery captured over time. It is considered that the unregulated nature of the water course introduces an element of risk for ultimate drainage planning. Downstream

landowners have shared concerns regarding an increased risk of flooding as stages of the development area are brought online. It is also considered that apparent modification of the watercourse is a key contributor to reduction of flow being experienced by landowners.

Based on discussions with the City of Busselton, the baseflow condition current to 2025 is considered to be constrained by an elevation of 3.4 mAHD which is 0.3m higher than that reported and allowed for in design in the JDA (2019) LWMS.

Opportunity for an alternative pathway for ultimate flows through Reinscourt is considered the best avenue to mitigate risk and ease landowner concerns. Ideal stormwater management would be ongoing minor event flow through Reinscourt for landowner consideration and an additional more direct flow path to the Vasse-Wonnerup Estuary to provide flood risk mitigation against any further modification of the Reinscourt flowpath.

Such alternatives have been investigated by Hyd2o with a summary of potential flow paths provided in Appendix H. Bussell Hwy exists between the site and the estuary and as such any option would require consideration of governance of infrastructure. Based on discussions with the City and Main Roads WA it is understood that the preferred option would involve independent flow management. As such the landowner of the rural lot to the north of Bussell Hwy (Lot 243) has been engaged with agreement in principle reached in acquiring a 11m wide drainage easement to facilitate Option B as shown in Appendix H. This would provide potential of a secondary outlet to the drainage easement with flow directed west adjacent to Bussell Hwy and then north to the estuary. DWER has been consulted and do not object to, and acknowledges this as a lower risk outfall option pending proof of implementation and agreement across all relevant parties.

Per CoB requirements the proposed drainage easement will require a 4m maintenance track (with turnaround) and such as the secondary outlet discharge will be limited to the remaining easement capacity for drainage. Based on an indicative 6m wide swale cross section (0.5m deep, 3m base width, 1:3 batters) is estimated that a flow of 0.93 m^3/s can be conveyed with a balance of 1m remaining in the easement. This was estimated via a standard mannings calculator provided in Appendix H. This flow is considered a conservative estimate for the purposes of estimating stormwater management requirements for this LWMS (as swale may ultimately be deeper or wider) which will allow for flexibility in detailed design at the SDWMR stage.

3.5.2 Surface Water Quality

Surface water quality monitoring was previously undertaken for the site and reported in JDA (2019) having been undertaken from November 2005 to October 2011 at 5 outlets from the wider development Provence development area to the receiving environment.

Detailed monitoring data graphs and results for individual sites (PSW1 to PSW5) are presented in Appendix I, with aggregated data summarised in Table 3. Results in Table 3 are compared against Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) guidelines for protection of aquatic ecosystems in south-west Australia. Summarising the results:

- Median and mean pH was found to be consistent with ANZECC (2000) guideline values, with all EC samples above the ANZECC (2000) guideline
- Both TN (median 2.1 mg/L) and TP (median 0.15 mg/L) were higher than ANZECC (2000) guideline levels.

With respect to Vasse Wonnerup WQIP (DoW, 2010) targets, both TN and TP were above the concentration criteria of 0.1 mg/L for TP and 1 mg/L for TN.

Table 3. Surface Water Quality Summary

Parameter and Unit	ANZECC Guideline	Aggregated Monitoring Results 2005- 2011						
		Total Samples	Min	20 %ile	Mean	Median	80 %ile	Max
pH	6.5-8.0	33	6.40	7.05	**7.49**	**7.49**	7.97	8.90
EC (mS/cm)	0.12-0.30	33	0.66	0.95	**1.28**	**1.15**	1.61	2.67
TDS (mg/L)	-	15	0.0	19.2	**430.6**	**489.5**	588.5	950.0
TSS (mg/L)	-	36	1.00	1.00	**8.33**	**3.50**	12.00	43.00
TN (mg/L)	1.2	40	0.24	0.96	**2.00**	**2.10**	2.90	4.10
TKN (mg/L)	-	36	0.21	0.94	**1.73**	**1.80**	2.40	4.10
Ammonia-N(mg/L)	0.90	34	0.01	0.01	**0.12**	**0.06**	0.11	0.91
NOx (mg/L)	0.15	28	0.01	0.01	**0.25**	**0.03**	0.37	3.10
TP(mg/L	0.065	34	0.01	0.06	**0.20**	**0.15**	0.27	1.10
FRP (mg/L)	0.04	31	0.01	0.01	**0.07**	**0.04**	0.10	0.38

ANZECC (2000a) guideline values shown for Lowland River South West Australia

3.6 Groundwater

3.6.1 Groundwater Levels

A total of 19 groundwater monitoring bores were installed across the wider Provence development area during the 2002-2004 period by 75 mm hand auger. Bore logs are contained in Appendix E. These bores were used to map the average annual maximum groundwater level (AAMGL) as detailed in JDA (2008), and this groundwater mapping was later updated in JDA (2019).

Hyd2o have updated this mapping to reflect more recent DWER data at nearby bores 18s and 19s, and to consider additional bores located within and in close proximity to the site as shown in Figure 7. More recent data from bores across the wider Provence development area was also considered in the analysis.

DWER bore hydrographs are shown in Appendix J together with site specific groundwater data and hydrographs for these bores contained ion Appendix K.

Revised groundwater mapping relative to previous JDA (2019) mapping is shown in Figure 7, showing a marginally lower AAMGL than previous mapping. This is largely due to improvement in the accuracy of the mapping due to DWER bores now being monitored every 2 months by DWER and not 6 monthly was the case when initial groundwater mapping for the site was undertaken. The average annual maximum groundwater level at the site was found to vary between 3.0 mAHD and 3.8 mAHD with flow toward the north. The Maximum Groundwater Level for the site (MGL) is estimated to be 0.5m above the AAMGL.

Calculation of the revised AAMGL at individual bores is detailed in Table 4. A depth to groundwater map is provided as Figure 9.

Table 4: Groundwater Levels

Bore	Easting	Northing	Natural Surface (mAHD)	AAMGL (mAHD)	Depth to AAMGL (m)	Data Adopted for Use in AAMGL Calculation
DWER Bores						
18s	348950	6273759	-	3.67	-	2000-2022 Dataset
19s	352718	6274798	-	3.90	-	2000-2022 Dataset
JDA Western Bores						
BA3	350696	6273985	4.50	4.10	0.40	JDA 2009 Data
BA7	349960	6273673	5.61	4.70	0.91	JDA 2004 Data
BA8	350185	6273234	5.61	5.69	at surface	JDA 2009 Data
BA11	349932	6274018	4.03	3.76	0.27	JDA 2004 Data
BA12	350171	6274144	4.30	3.80	0.50	JDA 2004 Data
BA13	350054	6274156	4.35	3.68	0.67	JDA 2004 Data
BA17	349556	6273827	3.91	4.11	at surface	JDA 2009 Data
BA18	349095	6273642	4.37	3.92	0.45	JDA 2004 Data
BA19	349488	6273218	6.10	4.72	1.38	JDA 2004 Data
BA20	349881	6273365	6.20	5.28	0.92	JDA 2004 Data
BA21	349780	6272908	6.07	5.77	0.30	JDA 2004 Data
JDA Eastern Bores						
BA4	351599	6273883	6.08	4.68	1.40	JDA 2004 Data
BA5	351588	6274288	5.78	2.93	2.83	JDA 2004 Data
BA6	351557	6274834	4.75	2.80	1.95	JDA 2004 Data
BA14	352047	6274342	6.94	3.64	3.30	JDA 2004 Data
BA15	351793	6274905	4.94	2.75	2.19	JDA 2004 Data
JDA Footprint Lake Bores						
FP02	350839	6273607	6.41	4.89	1.52	JDA 2019 Data
FP04	350819	6273423	5.83	5.51	0.32	JDA 2019 Data
RPS Bores						
MB5	350722	6274521	4.20	3.18	1.02	JDA 2019 Data
MB10	350686	6274598	3.87	3.00	0.87	RPS 2016 Data
MB14	350691	6274764	3.33	2.28	1.05	RPS 2016 Data

3.6.2 Groundwater Quality

Predevelopment groundwater water quality sampling for the wider Provence development area was initially undertaken in November 2002 and February 2004, with more regular quarterly monitoring then undertaken from September 2005 to October 2011. Further monitoring was then conducted between June 2015 and October 2019.

Samples were analysed for physical parameters and nutrients. Physical parameters were measured in the field and nutrients were analysed at a NATA-approved laboratory.

Detailed monitoring data graphs and results for individual bores via Hyd2o's FieldDAE database are presented in Appendix I, with aggregated data summarised in Table 5. Results in Table 5 are compared against Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000) guidelines for protection of aquatic ecosystems in south-west Australia and results from surface water quality (Section 3.5.1).

Note that while results for minimum, 20%ile, mean, median, 80%ile , and maximum values are shown in Table 5 as indicators of the distribution and variability of pre development data, median values are used to establish targets in Section 9.3 for post development monitoring and performance assessment. The use of medians to establish targets rather than means is considered preferable to reduce the impact of outlier values in target establishment.

Summarising the results:

- Median and mean pH was found to be consistent with ANZECC (2000) guideline values, and only marginally lower than the pH of surface water
- Median and mean EC was found to be above with ANZECC (2000) guideline values, and also above the EC of surface water.
- Median (2.9 mg/L) and mean (7.44 mg/L) TN was found to be above with ANZECC (2000) guideline values, and also above the TN of surface water. The large difference between mean and median indicated a higher variability in results than that of surface water.
- Median (0.14 mg/L) and mean (0.24 mg/L) TP was found to be above with ANZECC (2000) guideline values, but similar to that of surface water.

With respect to Vasse Wonnerup WQIP (DoW,2010) targets, both TN and TP were above the concentration criteria of 0.1 mg/L for TP and 1 mg/L for TN.

It is important to note that the high predevelopment nutrient conditions at the site are a result of its historical rural land use and that of the surrounding area in proximity to the site.

While high relative to target values, these nutrient levels are not uncommon in historically rural areas of the Swan Coastal Plain.

Table 5. Groundwater Quality Summary

Parameter and Unit	Aggregated Monitoring Results 2005- 2011							
	ANZECC Guideline	Total Samples	Min	20 %ile	Mean	Median	80 %ile	Max
pH	6.5-8.0	166	5.68	6.69	**7.06**	**7.10**	7.37	8.90
EC (mS/cm)	0.12-0.30	166	0.04	0.78	**3.77**	**1.51**	8.20	17.63
TDS (mg/L)	-	30	225.5	464.8	**3212.7**	**1400.0**	6000.0	11000.0
TN (mg/L)	1.2	159	0.10	1.06	**7.44**	**2.90**	9.46	100.00
TKN (mg/L)	-	135	0.05	0.56	**3.03**	**1.70**	4.00	26.00
Ammonia-N(mg/L)	-	127	0.01	0.02	**0.23**	**0.10**	0.32	2.70
NOx (mg/L)	0.15	116	0.01	0.04	**4.26**	**0.33**	6.50	82.00
TP (mg/L)	0.065	154	0.01	0.04	**0.24**	**0.14**	0.33	3.10
FRP (mg/L)	0.04	85	0.01	0.01	**0.07**	**0.01**	0.05	0.84

ANZECC (2000a) guideline values shown for Lowland River South West Australia

3.7 Opportunities and Constraints

Based on the assessment of site conditions, the following key constraints and opportunities are identified to guide the development of the water management strategy:

- There are no conservation category wetlands, resource enhancement wetlands, multiple use wetlands, or natural waterways within the site.
- The site generally has sandy soils at surface indicating the opportunity to use infiltration to minimise off site runoff post development.
- The majority of the site is located within the catchment of the Sabina River and the site generally falls from south to north toward the existing culverts at under Bussell Hwy, which drain through the downstream suburb of Reinscourt. Other culverts across Bussell Highway exist with these currently servicing a lesser extent of the site. All these routes form part of the greater Vasse-Wonnerup Estuary catchment.
- The watercourse within the Reinscourt area to which the site drains is not within an managed easement and is subject to landholder modification. The City of Busselton considers the topographical constraint has evidently risen since JDA conducted pre-development 2D modelling to guide development will all flow to previously go down Reinscourt. This prompts implementation of alternative flow paths downstream of Bussell

Hwy post development for additional flood risk management. Continued flow contribution down Reinscourt remains a point to landowner consideration.

- The western region of the site generally has a shallow depth to groundwater, with groundwater generally with 2m of the existing natural surface, and fill is therefore likely to be required to facilitate development. A larger clearance to groundwater generally exists over the eastern region of the site.
- Water quality reflects the previous rural use of the site. Given the proximity to the Vasse Wonnerup Estuary, the change in land use provides an opportunity to improve existing stormwater management and water quality treatment outcomes from the area.

Based on this assessment and given the timeframe over which the proposed development will ultimately occur, it is considered the water management process of State Planning Policy 2.9 Water (WAPC, 2008) with reference to Better Urban Water Management (WAPC, 2008) is suitable for guiding the implementation of future water management measures within the site.

4 Design Criteria

Table 6 summarises the key urban water management design objectives, based on the previous water management planning documents for the site and other key reference documents detailed in Section 1.3.

These design criteria are used in Sections 5, 6 and 7 together with the identified constraints and opportunities of the predevelopment environment (Section 3) to establish the water management strategy for the site.

Table 6: Key Water Management Design Objectives

Management Elements	Objectives
Water Use Sustainability	
Water Efficiency	▪ Reduce consumptive use through adoption of waterwise practices.
Water Supply	▪ Apply a "fit for purpose" water supply strategy, and minimise potable water use where drinking quality water is not essential.
Wastewater	▪ Provide a wastewater system which meets agency requirements.
Stormwater	
Ecological Protection	• Retention and management of small events (15mm) at lot scale where possible. ▪ Road runoff for the initial 15mm event for piped systems to be treated and managed in vegetated biofiltration storage areas, with swales and distributed infiltration to manage runoff at source for non-piped areas adjacent to POS. Use of swales for flow management/conveyance where possible.
Serviceability	▪ Design road drainage system for roads to be passable in the 20%AEP event. ▪ Provide 20%AEP (5 year) event storage areas to attenuate local stormwater runoff post development.
Flood Protection	▪ Overland flows paths provided within road reserves identified for safe conveyance of flows exceeding pipe drainage system capacity. ▪ Provide 1% AEP (100 year) local flood storage to attenuate post development flow to predevelopment levels (flows rates and quantity). ▪ Provide additional site outlet flow path more direct to Vasse-Wonnerup Estuary to protect estate and downstream landowners in Reinscourt. ▪ Establish minimum habitable floor levels at 0.5m above the 1% AEP flood levels.
Groundwater	
Fill Requirement & Subsoil Drainage	▪ Use of a combination of fill and subsoil to provide suitable clearances above groundwater for development. ▪ Subsoil inverts set at the average annual maximum groundwater level (AAMGL) or above to protect wetland and conservation areas. ▪ Subsoil to be free draining and have appropriate treatment prior to discharge.

5 Water Use Sustainability Initiatives

5.1 Water Efficiency Measures

Development of the site will lead to an increased demand of potable water for residential use and irrigation of gardens and landscape areas.

Water conservation measures will be implemented to reduce scheme water consumption within the development and will be consistent with Water Corporation's "Waterwise" land development criteria, and include:

- Use of high density residential zoning and smaller lots to reduce garden (ex-house) use.
- Promotion of use of waterwise practices including water efficient fixtures and fitting (taps, showerheads, toilets and appliances, rainwater tanks, waterwise landscaping).
- All houses to be built to 6 star building standards.
- Use of native plants in POS areas and retention of existing trees and vegetation areas, with landscape design based on "Waterwise" principles
- Use of groundwater bores for irrigation of POS.
- Maximising on site retention of stormwater.

5.2 Wastewater Management

Wastewater will be reticulated sewerage connected to the existing Water Corporation network.

5.3 Water Supply

Domestic water supply will be provided via extension of Busselton Water's integrated local water supply system.

Rainwater tanks will not be implemented/mandated at estate scale to supplement the domestic water supply scheme. Residents who wish to supplement scheme water supply with rainwater tanks will be provided for by individual builders during the building application process.

With respect to POS irrigation, the site has an existing Yarragadee aquifer licence (GWL 157168) to abstract water for POS irrigation and maintaining lake levels (Table 7). This licence has an allocation of 168,300 kL/yr, and covers irrigation requirements for the whole site.

Landscape master planning for the site prepared by LD Total is shown in Appendix L detailing the integration of stormwater within the proposed POS areas. This planning also provides estimates of the overall irrigation water requirements for POS and streetscape irrigation inclusive of turf and planting establishment. This estimate of 108,490 kL/yr is well within existing licencing. Note that this irrigation estimate does not include the propose primary school. Based on a 4.5 ha school and assuming 60% of area is irrigated at 6750 kl/ha/yr this equates to a further 18,225 kL/yr being required. Even with this additional use, total irrigation remains well within the licenced allocation for the site.

Irrigation licences required to sustain POS areas will be ultimately transferred to the City of Busselton on handover.

Licence extracts from DWER's online Water Register for the site are included as Appendix M. Note the site also has a licence in the Leederville aquifer (GWL 160990) for an annual abstraction of 34,300 kL/yr for dust suppression, and earthworks and construction purposes.

Table 7: Groundwater Resource and Licenced Allocations

Groundwater Area	Subarea	Aquifer	Parties	Allocation Limit (kL)	Expiry Date
Busselton-Capel	Busselton-Yarragadee	Perth-Yarragadee South	Almond Lake Pty Ltd	168300	07/08/2032
Busselton-Capel	Busselton-Capel	Perth-Leederville	Almond Lake Pty Ltd	34300	07/08/2032

5.3.1 Footprint Lake Water Quality & Irrigation

Footprint Lake is an existing unlined lake repurposed from a mining void. The lake is currently used as part of the irrigation system for the wider development area, storing irrigation water abstracted from a production bore in the Yarragadee Aquifer. The lake precipitates out the dissolved iron from the groundwater, prior to pumping to Almond Parkway Lake for irrigation.

The lake bathymetry ranges from 4.5 mAHD to -5.5 mAHD, containing a volume of approximately 154,000 m^3 and having a surface area of 3.2 ha. The lake depth extends to 10 m toward the centre of the lake, with shallow areas at gentle grades along its edges. It is an expression of the local superficial aquifer, and therefore has a seasonal water table variation broadly commensurate with that of the superficial aquifer.

The lake receives inflow from a range of sources. According to JDA (2019), approximately 57% of inflow to Footprint Lake comes from the Yarragadee Aquifer bore, 24% from direct rainfall, 17% from catchment stormwater runoff, and 2% from the superficial aquifer as groundwater throughflow.

Algal blooms occur periodically within Footprint Lake and a review of historical Landgate aerial photography indicates blooms have occurred in at least 7 of the past 20 years, including prior to urban development of the area. In this context the algae blooms are not therefore not considered to be an outcome of urbanisation of the area, but rather due to legacy land use and water quality conditions.

Blooms appear to predominately occur in the late summer/autumn period, and are a result of nutrients causing excessive growth of algae under a combination of suitable environmental conditions. Algae growth favours elevated nutrient concentrations, warm temperatures (20 and 30° C), prolonged thermal stratification (stable water column with minimal turbulence), long water retention times, low turbidity, and conditions with intermittent exposure to high intensity light.

JDA undertook detailed water quality monitoring within Footprint Lake in 2019, collecting samples and undertaking testing at various depth of the lakes water column at different times of the year. Additional monitoring was undertaken at the surrounding superficial bores (up-gradient and down-gradient of the lake) and at the new Yarragadee production bore.

Table 8: Footprint Lake and Surrounds Water Quality Summary 2019

Parameter	Shallow Lake Water Quality	Deep Lake Water Quality	Superficial Bores Around Lake	Yarragadee Irrigation Bore
TN Mean (mg/L)	0.87	1.15	0.25	0.27
TP Mean (mg/L)	0.09	0.14	0.47	0.46
PO_4-P Mean (mg/L)	0.02	0.02	0.31	0.02

The JDA (2019) monitoring and nutrient balance results are summarised as follows with mean results presented in Table 8.

- The lake exhibited a defined thermal stratification from October to March, with mean lake temperatures rising approximately 5 °C during this period. In March lake temperatures varied from 20 °C at depth to 25 °C at surface, with temperature condition at surface ideal for algal growth. In August the lake temperature was approximately 15 °C and not stratified.
- With respect to nutrients, shallow lake samples had lower concentrations of nutrients than deeper samples, and groundwater from the superficial and Yarragadee Aquifers had broadly similar concentrations of TN, TP, and PO_4-P.
- With respect to the production bore, the TN concentration of the Yarragadee bore was lower than within the lake, however the TP and PO_4-P concentrations were higher.
- The nutrient balance undertaken by JDA (2019) indicated that the Yarragadee inflow from the pump bore is decreasing lake salinity and TN, however TP is increasing. Phosphorus is not remaining in the water column however but precipitating and being bound in lake sediments. Recent sampling by Hyd2o of the Yarragadee bore inflow in January 2023 provided broadly similar nutrient levels to previous JDA sampling.
- Due to soil types and groundwater gradients JDA (2019) found shallow superficial groundwater throughflow to be only a minor contribution of inflow to the lake (2 %) and overall nutrient input (2.2 % TP, 1.4 % TN) annually compared to other sources.

Further monitoring of the lake has been undertaken periodically by Hyd2o since 2021 to observe seasonal algae behaviour (Hyd2o, 2022b-g, Hyd2o, 2023c). Based on these results, a range of potential options for lake management and water quality improvement were derived as summarised in Table 9. The measures are considered a best practice management approach to achieve better water quality within the lake.

These options continue to be actively explored with ongoing liaison and consultation with the City and DWER. To date a trial has been undertaken incorporating a filtration system (SPEL Stormwater filtration system) to treat bore water from the Yarragadee bore and remove TP prior to discharging water to Footprint Lake. The trial was unsuccessful, with limitations found in the systems performance with this application.

A series of 3 x 5 hp surface aerators have since been installed in the lake to assist in reducing stratification and aerate the lake, which has achieved better success. No algal bloom was detected across the summer of 2024/25 which was notably the first observed seasonal absence under the current tenure of private ownership. A copy of the Water Quality Solutions product brochure is contained in Appendix N together with a plate of an installed aerator.

A further 3 subsurface aerators have been installed in 2025 and as an additional measure, the application of Biostim has also occurred to reduced sludge build up and consume nutrients. Manufacturers details of Biostim are also contained in Appendix N. Monitoring of the lake in November and December 2025 found no cyanobacteria present at any of the sampled sites which is a notable improvement to monitoring outcomes at the same time of year in 2021.

Sampling data current to December 2025 with results and field photos is provided in Appendix O. Across the sampling timeline algae and toxin levels haven generally tested low with reference to National Health and Medical Research Council (NHMRC) (2008) guidelines.

Rock pitching to aerate Yaragadee Bore inflow has most recently been installed to build upon observed water quality improvement performance. An image capture showing its installation and function is provided in Appendix N. Monthly monitoring of water quality management performance is set to occur across summer in early 2026.

5.3.2 Footprint Lake Management and Handover

A Heads of Agreement and subsequent Deed (satisfactory to Council, DWER, DPLH and Landowner) associated with the Footprint Lake is to be agreed and executed within 6 months from the LWMS approval, covering the options and monetary contributions detailed below.

Within the next 6 months, approvals and lake trust payments will be issued in accordance with the LWMS. In the absence of an executed Deed, beyond 6 months from LWMS approval no residential child lot subdivision clearance will be issued over the subject land by Council.

To cover the interim period whilst lake works are undertaken to inform the preparation of the LMP, a financial mechanism via a Deed is proposed, providing Council with security and ensuring the landowner continues to pursue investigations towards finalisation of the LMP.

A Lake Management Plan is to cover ongoing management and implementation of the lake in perpetuity and will detail the final preferred option, stemming from those being explored currently and over the coming years. The measures/actions to be undertaken to inform the LMP will take a significant period and does not enable an LMP to be prepared and finalised in the coming 2-3 years.

As Council is aware the landowner has implemented several initiatives (aerators / filters / chemical) over the past 3 years, in accordance with the DWER recommended staged implementation approach, to ascertain their viability. With the successfulness of each option taking several years of monitoring (summer periods) to determine their viability and effectiveness, the decision on a final preferred option to be embedded within an LMP cannot accurately be made for some time.

5.3.2.1 Lake Management Plan

A LMP is to be prepared by the Landowner and approved by Council, DPLH, DWER and the Landowner. In preparing the LMP, long-term, sustainable management options for the Lake will be investigated, include but are not limited to:

- Partial infilling of the Lake to reduce depth, nutrient storage capacity, and long-term water quality risks.
- Engineering the Lake into a constructed, reshaped waterbody using passive (non-mechanical) water quality management measures such as shoreline regrading, wetland plantings, and controlled inflow/outflow design.
- Retention of the Lake as private open space managed by an adjoining survey strata development, with public access maintained to the northern side.
- Removal of first-flush stormwater inflows entering the Lake to reduce nutrient and contaminant loading.
- Deviation of the bore reticulation supply, which currently flows into the Footprint Lake before passing through to the northern lake, so that it instead flows directly to the northern lake, bypassing the Footprint Lake entirely.

5.3.2.2 Assessment Criteria

Each option will be assessed against the following criteria:

- Long-term water quality outcomes and risk profile.
- Capital and ongoing operational costs, including the maintenance burden relative to standard open space.
- Environmental suitability and regulatory compliance.
- Amenity outcomes for residents of the Embark Estate.

5.3.2.3 Lot Delivery Milestone

The Landowner has approximately 800+ residential lots remaining to deliver within the Embark Estate. The parties agree that implementation of measures for the long-term management of Footprint Lake will take a period of time to finalise, with the final LMP (preferred implementation option) to be completed no later than the registration of the next 400 lots on and from 1 April 2026 (being 50% of the remaining lot yield).

This milestone provides sufficient time for Landowner to:

- Commission and finalise the LMP.
- Undertake environmental testing, monitoring, and technical investigations.
- Undertake a staged implementation strategy of management, which is currently occurring.
- Explore all management options and obtain any required regulatory approvals.
- Develop detailed design and implementation documentation for the preferred option.
- Liaise with the Council in relation to all of the above.

5.3.2.4 Steering Committee

A Lake Management Steering Committee will be established to oversee the LMP and its implementation, comprising:

- Chairperson - to be nominated from steering committee members (inaugural Chair Yolk Property Group)
- DWER — Member
- Council — Member
- Landowner — Member

The Steering Committee is an advisory body only. Its recommendations are not binding on any party.

5.3.2.5 Developer Contribution

To facilitate ongoing development whilst actions are being undertaken to inform the LMP prior to approval, the Landowner will pay $12,500 per residential lot created as a refundable financial security contribution (Contribution) to be held in Trust by Council. Each lot payment is due in the timing of the relevant residential child lot seeking Council clearance.

5.3.2.6 Timeframe

• HOA / Deed	6 months from LWMS Approval
• Interim Contribution Payments	As per executed deed.
• Investigation Works to inform LMP	Present – 400 lots (inform LMP)
• Final LMP Approval	Prior to 401 lot being titled.
• Steering Committee	Bi-annually

Table 9: Lake Water Quality Improvement Options

Approach	Description	Key Outcomes and Considerations
Reduced Stratification, Increased Mixing & Oxygenation		
Aeration: Diffuser	Addition of bed diffusers at the bottom of the lake. The diffusers inject compressed air to the lake bed, increasing aeration.	• Increased circulation and reduced stratification. • Effective aeration to lower depths of lake. • Improves natural decomposition of organic material. • Minimal impact on nutrient input reduction.
Aeration: Fountain	Increases natural aeration by floating a pump at surface, drawing in lake water, and spraying it above surface. Water at lake surface is circulated, increasing oxygenation.	• Effective aeration at shallow depths. • Aerates water at the surface which is often already oxygenated. • Unable to prevent stratification as fountain doesn't aerate the bottom of the lake. • Minimal impact on nutrient input reduction. • Adds aesthetic value to development.
Temperature and Light Exposure Reduction		
Increased fringe vegetation	Increasing vegetation planted along the banks of Footprint Lake.	• Increased sun cover for shallow exposed areas. • Improved bank stability, limiting organic matter mobilisation into lake waters. • Increase nutrient absorption. • Adds aesthetic value to development by increasing greenery.
Lake Nutrient Concentration Reduction		
Recirculation of lake water through swale with biofiltration media	Water from Footprint Lake is pumped into a vegetated swale containing high PRI material and filtration with recirculation of water back to the lake.	• Biofiltration media adsorbs phosphorus and reduces concentrations prior to discharge into lake • Recirculation of water within the swale increases water aeration. • Potential use of solar pump • Increased public awareness as the swale is a visual indicator that the lake is being actively treated.
Treatment of Yarragadee bore prior to Footprint Lake via swale with biofiltration media	Water from the Yarragadee Bore passes through a vegetated swale containing high PRI material and filtration prior to entering the lake.	• As above
Treatment of Yarragadee bore prior to Footprint Lake via inline filtration system	Particulate nutrients are filtered out of the water pumped from the Yarragadee bore prior to discharge into Footprint Lake.	• Decrease nutrient discharge into the lake. • Typically applied for irrigation systems to prevent blockage rather than water quality improvement

6 Stormwater Management Strategy

Stormwater management within the site will be undertaken consistent with DWER and City of Busselton water sensitive design practices. This LWMS seeks to remain consistent with the previous overall stormwater management planning approach presented in previous water management planning for the area, while being refined to suit current structure planning and consider the opportunities and constraints detailed in Section 3.7.

Key elements of the overall stormwater management system for the site are as follows, with the design based on achieving an ultimate discharge from combined catchments to the Vasse-Wonnerup Estuary via the Reinscourt flow path consistent with a predevelopment peak discharge rate of 2.3 L/s/ha for the 1% AEP event and discharging at 0.93 m^3/s via an additional more direct drainage easement flow path as per Section 3.5.1:

- First 15mm on lots retained via soakwells.
- First 15mm of road runoff for piped systems treated and managed in vegetated biofiltration storage areas, with further opportunities for swales and distributed infiltration to manage runoff at source for non-piped areas adjacent to POS designed at SDWMR stage.
- As per the JDA (2019) LWMS, where groundwater levels are the controlling factor in establishing a storage invert, biofiltration areas and storage inverts are designed to be underlain by subsoil at the AAMGL (controlled groundwater level (CGL) post development), with the biofilter areas underlain by 0.3m of biofilter material to provide water quality treatment of inflows.
- Flood storage areas sized within POS to allow for detention of up to the 1% AEP event.
- Where flood storage basins are to be integrated into turfed POS areas, 0.6m clearance to the CGL should be provided.

Post development catchments for the site are shown in Figure 10.

These catchments have been refined from those in the JDA (2019) LWMS based on consultation with the projects engineering consultants and reflect the revised local structure plan for the site. Note than these catchment boundaries also reflect already constructed areas outside of the site which will contribute flows to the storages designed in this LWMS. The catchments consider areas outside of the proposed structure plan addendum area to provide an overall stormwater strategy for the site. In addition, this LWMS extends over the LSP area and as such is inclusive of land areas which have approved UWMP's. This includes Embark Stage 1 (Hyd2o, 2023a), Lot 9034 Joseph Drive Yalyalup (Hyd2o, 2023b) and land which covers Catchment H.

6.1 Water Quality Management

Consistent with DWER requirements, a treatment train approach to water quality management will be implemented which includes structural and non-structural controls:

- **Non Structural Controls**
  Planning: POS locations and configurations (including multiple use characteristics).
  Landscape: Maintain Conservation Areas, Vegetation (use of native plantings) and soil selection, WSUD integration.

Maintenance: POS areas, Street sweeping, Access chamber eduction.
Monitoring: Post development program and review.

- **Structural Controls**
  Bioretention Storages: 15mm Treatment Areas in POS, and streetscape opportunities to be identified at SDWMR Stage.
  Detention Storages: 20%AEP and 1%AEP Storage Areas.

Stormwater management measures adopted for the site represent best practice as detailed in the Stormwater Management Manual for Western Australia (DWER, 2022) and have been selected and designed with consideration of the sites environment. The sites strategy has been informed through consultation with key agencies and is underpinned by monitoring outcomes. While DWER (2022) does not provide expected pollutant removal efficiencies for all BMP's, application of a treatment train approach with a combination of the measures detailed will therefore achieve the design objectives for water quality as detailed in State Planning Policy 2.9 Water (WAPC, 2025).

Bioretention areas will be sized to retain treat and infiltrate 15mm in accordance with DWER requirements (DWER, 2017). Required biofiltration areas and volumes to achieve this outcome are detailed in Table 12.

All biofiltration systems will be designed considering DWER Biofilter guideline and the Adoption Guidelines for Stormwater Biofiltration Systems (CRC for Water Sensitive Cities, 2015), with planting and biofilter media requirements to be specified at SDWMR stage.

Table 10 details a summary from DWER's Stormwater Management Manual for Western Australia (2023) of expected pollutant removal efficiencies for various WSUD measures in relation to water quality design criteria.

Table 10: BMP Water Quality Performance In Relation to Design Criteria

Parameter	Design Criteria based on BUWM (WAPC, 2008) (as compared to a development with no WSUD)	Structural Controls Nutrient Output Reduction [1]	
		Vegetated Swales/ Bioretention Systems	Detention/ Retention Storages
Total Suspended Solids	80%	60-80%	65-99%
Total Phosphorus	60%	30-50%	40-80%
Total Nitrogen	45%	25-40%	50-70%
Gross Pollutants	70%	-	>90%

1. Typical Performance Efficiencies via DoW (2023)

6.2 Flood Management

Stormwater modelling for storage areas was performed using XP Storm.

The design rainfall storms modelled in XP-Storm were based on methodology in Australian Rainfall and Runoff (AR&R) (Ball et al, Australia, 2016). All design rainfall and temporal patterns where imported into the model using the ARR Data Hub. Rainfall was assumed to be spatially uniform across the catchment. Storm durations modelled ranged from 10 minutes to 168 hours and all ensembles were run for each storm to determine critical design events.

Recent updates to Australian Rainfall and Runoff (Ball et al, 2016) have resulted in changes in terminology to describe design rainfalls. Generally, Exceedance per Year (EY) terminology is recommended to be used for very frequent design rainfalls, Annual Exceedance Probability (AEP, %) used for frequent and infrequent design rainfalls, and AEP (1 in x) used for rare design rainfalls. These replace previous ARI terminology as follows:

- 1 Year Average Rainfall Interval (ARI) – replaced with 1 EY
- 5 Year ARI – replaced with 0.2 EY
- 100 Year ARI – replaced with 1% AEP

Key stormwater modelling runoff parameters for individual land use types are shown in Table 11. These rates have been refined from the JDA (2019) LWMS based on further consideration of post development site characteristics and have been based on Hyd2o's CURRV Runoff Calculator (Appendix P). Hyd2o's CURRV runoff calculator is a standardised approach used by Hyd2o across all development projects to estimate runoff rates. In estimating runoff rates CURRV considers rainfall IFD's, land use breakdown, percentages of impervious and pervious areas within land use type and likely initial and continuing loss of soil types. Importantly it also considers Book 5 Chapter 3 of Australian Rainfall and Runoff (Ball, et al 2106), which details the relationship between Effective Impervious Area (EIA) and Total Impervious Area (TIA) and considers the different behaviour in runoff that occurs from areas which are directly connected and those impervious areas which are only indirectly connected. Research has found the Effective Impervious Area is typically in the range of 55-65% of TIA for Australian catchments.

Increased runoff for lot connections has been accounted for in western regions of the site as a legacy to previous versions of the LWMS. While accounted for in modelling the City of Busselton have advised that lot connections will not be approved at the SDWMR stage on the basis of concerns regarding larger pipes sizes on low grade in a high groundwater environment. It is however recognised that modelling with lot connections represents a conservative estimate in determining that maximum storage area requirements can be serviced by the LSP. As such it is considered appropriate that requirements can be refined accordingly at SDWMR stage. It should be noted that City's position on lot connections has been accounted for in ongoing background works for next SDWMR Stages (3 and 4) with the use of soakwells for associated area in the western region reflected in Figure 10.

Note that with respect to the commercial and retirement village while these sites are designed in accordance with CoB's Engineering and Works Services Standards and Specifications Section 6 Property Development Technical Requirements and Guidelines Earthworks, Drainage and Parking (2013) which states

> *"The City will require on-site retention equivalent of at least 15 minutes time of concentration on commercial and industrial and group dwelling areas as this is the approximate design minimum run-off times allowed for in road drainage design"*

which equates to 18mm (20% AEP, 15min event). Recent discussion with the City have indicted this requirement may be conservative and a lesser on site requirement than the standard of 15mm may be acceptable. This will be considered during refinement of individual storage volumes at SDWMR stage.

Modelling has considered geotechnical conditions and clearance to groundwater in applying nominal design permeability rates. Based on findings discussed in Section 3 and for the purposes of this LWMS the western region of the site has been generalised as lesser permeability with groundwater closer to surface, with a nominal design rate of 0.5 m/d applied. The eastern region has been generalised as higher permeability with greater clearance to groundwater, with a nominal design rate of 2 m/d applied.

Modelled flood protection storage volumes, areas, and flood rises are detailed in Table 11 and Figure 10 shows the indicative extent of inundation within the development for flood management events up to 1% AEP. Key inverts and levels of the stormwater system to inform future engineering design and meet key design requirements are detailed in Figure 11.

Connection to the site outfall location to Reinscourt occurs via two separate connections, with one generally servicing the western region and the other the eastern region of the site. The modelled network has also considered logistical stormwater management across multiple landowners. As such discharge from Basin A, M and K has been set to generally align with the 2.3 L/s/ha pro-rata discharge rate with respect to cumulative catchments. A similar rate has been adopted for the Lot 31 site (not part of the LWMS area) equating to a permissible discharge of 37 L/s when developed. Any drainage design in the development of Lot 31 to achieve attenuation to this rate is considered to be independent. On this basis, the outfall condition for the site for the LWMS has been set with a permissible discharge of 455 L/s.

As discussed in Section 3.5 an additional culvert crossing exists approximately 100m east of the main site outlet on Bussell Hwy with connection through to the Reinscourt flow path. This is considered to have potential as an additional outlet location to service the eastern region of the site and Lot 31. Use of this connection will still require restriction in accordance with the pro-rata discharge to satisfy the overall predevelopment flow criteria. Information on the additional culvert is limited and would require further investigation at later stages of planning should it be explored as an option in design.

Connection to the additional new drainage easement pathway will occur via Basin A via a new culverting crossing across Bussell Hwy. To enhance estate drainage it is proposed that the new system outlet be set at an invert of 2.8 mAHD and the culvert crossing and easement be designed to suit. A Basin A engineering concept has been devised in consultation with the City and is provided in Appendix Q. The City have given approval in principle of the proposed concept on the basis that the design of the easement through Lot 243 can be further refined at the detailed design stage (SDWMR), to incorporate an access track with a track width and turnaround which is adequate for operational requirements.

Modelling and design for this LWMS has accounted for a tailwater condition of 3.4 mAHD in Reinscourt consistent with City of Busselton advice. Further to the development of the proposed outlet concept in Appendix Q, design opportunities have been discussed to allow

redistribution of flow between Basin A outlets by way of configuration modification (orifice plates, stopboards etc.). This is to allow for reactive stormwater management based on flow observations down Reinscourt. Dual outlet connection at Basin A will provide protection of the estate and downstream landowners in Reinscourt should the watercourse become further modified. A such allowing for additional capacity down the new drainage easement pathway will be an added consideration in detailed design at SDWMR stage.

It is important to note the areas for flood storage shown in this LWMS have been produced with reference to basin design concepts accommodating tree retention in POS allocations. For SDWMR stage integrated design concepts include those which flood storage basins are kept separate to existing vegetated areas as well as utilising existing seasonally inundated vegetated areas to provide effective flood storage post development within natural form. Available engineering concepts for Basins A, B, F and G considering retention are provided in Appendix Q.

In order to facilitate connection through Catchment A from the southern region of the catchment to the basin it is likely a drainage swale will be required with the most viable location currently travelling along the inside of the retirement village eastern boundary as shown on Figure 10. Should this infrastructure be implemented it will be required to be located within a drainage reserve or easement consistent with City requirements. It is understood the City's clear preference is for a drainage reserve with an easement only to be utilised should no feasible alternative exist.

Modelled storage volumes, areas, flood rise and inverts are detailed in Table 11 for the 20% and 1% AEP event. The total area required for the 20% and 1% AEP event is 5.14 ha and 6.62 ha respectively, equating to a land area requirement of 2.4% and 3.1% respectively.

Storm volumes for ecological protection based on the 63% AEP 1 hour (15mm) event are provided in Table 12, indicating a volume of 3,834 m^3 as being required. Based on an integrated nested 0.3m deep shape, the total area required equates to 1.51 ha.

Figure 12 provides a hydrograph comparison between peak volumes and discharge rates post development down Reinscourt to those provided for predevelopment in the JDA (2019) LWMS. Flow characteristic values are also provided pro-rata for the LWMS site for comparison. It should be noted that if the JDA model was required to consider the latest baseflow condition (3.40 mAHD), and the predevelopment site inundated as such as an antecedent condition, it would be expected that predevelopment flow characteristics would be larger.

In meeting the 1% AEP criteria of 455 L/s the indicative stormwater management system discharges less total volume comparatively. The resulting 20% AEP peak flow rate is comparatively higher however the increase in the 20% AEP peak flow relative to the 1% AEP peak flow is considered a reflection of the urbanisation of the catchment with the critical event durations shorter and total outflow volumes less as shown in Figure 12.

Comparable flows for pre and post development down either Reinscourt or the new easement flow path are also provided in Table 13. For the purposes of comparison Reinscourt flows post development have included pro-rata allocations for Lot 31. As detailed previously the development of detailed Basin A design at SDWMR stage should allow for the redistribution of flow between these tabulated outlets based on future flow behaviour in Reinscourt.

Subsoil inverts in indicative basin design have been set consistent with the stormwater management criteria. Indicative subsoil inverts underlaying biofiltration areas for the western site region are provided in Table 12.

As specified in the criteria turfed areas will require a nominal 0.6m separation to subsoil inverts within drainage POS areas. This is to provide a basis for subsoil design at SDWMR stage so that mounding maintains a 300mm capillary fringe in winter and allow for seasonal use of these areas.

Similar to stormwater management Basin A will act as an ultimate discharge point for subsoil for the western region of the estate. To allow for an overall integrated free draining groundwater control system Basin A design at SDWMR stage will require consideration of the downstream environment. This includes the identified constraints in Reinscourt and the baseflow condition to the additional proposed drainage easement flow path. New WAter Ways (2018) provides general guidance that subsoil outlets are to be located 150mm above either the estimated 50% AEP event base flow or the surveyed winter base flow level.

Given the clearance to groundwater over the eastern region, subsoil is considered unlikely to be required in storage design.

XP-Storm modelling outputs are contained in Appendix R.

The final storage area configuration (side slopes, treatments etc), location, and elevations will be documented in the SDWMR and will be dependent on final earthworks, drainage, road design levels for the development, and interfacing requirement with existing developed stages and infrastructure. It is noted that greater potential for infiltration may be realised at the SDWMR stage to inform final basin design. Minor refinements to catchment areas shown in this report may occur as detailed design proceeds, and stormwater modelling will be updated accordingly if required during the SDWMR process.

Engineering drawings at SDWMR stage will be required to comply with requirements for a minimum habitable floor level clearance of 0.5 m above the 1% AEP flood level within stormwater storage areas where no overflow relief is present.

As shown in Figure 11 the proposed stormwater management network represents a series of distributed basins and linkages that provide shared attenuation to the downstream environment. As an outcome of fragmented land ownership this requires the discharge and acceptance of flow across property boundaries to be recognised in detailed design at the SDMWR stage. As such with recognition of differing landowner arrangements and development timeframes the drainage routes shown are to be considered as indicative only with shown alignments not to be assumed. Based on consultation with the City of Busselton and DWER there are two notable regions in the network that are recognised to require design coordination in future:

- The western flow path from Basin M to the Bussell Hwy crossing to Reinscourt will require the provision of a series of drainage pipes or otherwise to facilitate a connection for discharge. It has been identified that the most practical location for this location is along the interface of Lot 31 and Bussell Hwy. This location is external to the LWMS site boundary and the implementation of this drainage strategy is dependant on securing an agreed pathway through third-party land. The City of Busselton expects that the relevant landowners will secure the necessary landowner arrangements though an appropriate legal agreement/easement prior to any affected development proceeding in the event that POS/drainage reserve has not been created. The final alignment of this

required connection will be determined through future detailed design and approvals at SDWMR stage.

- The flow path connection between Basin K and Basin M occurs within the LWMS site boundary however development of each respective drainage POS will occur under separate landownership. As there is potential for Basin K to be developed ahead of Basin M there may be the need for the consideration of an alternative or interim drainage solution depending on the ultimate downstream connection being available. Any ultimate drainage connection in this regard will be subject to future detailed design and approvals at the SDWMR stage.

Table 11: Stormwater Modelling & Infrastructure Sizing

Catchment	A	B	F	G	H	Total
Total Catch Area (ha)	44.43	16.46	8.79	20.19	31.70	121.57
Land Use Breakdown						
Residential - Soakwells (ha) IL 15mm, 45% Runoff	3.92	8.70	2.19	4.68	7.45	26.94
Residential – Modelled Lot Connections (ha) 71% Runoff	8.52	-	1.68	2.85	-	13.05
Road (ha) 85% Runoff	7.19	4.72	1.70	4.07	4.25	21.93
Road w Median (ha) IL 15mm, 85% Runoff	-	0.52	-	-	-	0.52
Commercial (ha) IL 18mm, 90% Runoff	2.81	-	-	-	-	2.81
POS/Landscape (ha) 20% Runoff	7.32	2.52	3.22	4.08	9.21	26.35
Retirement Village IL 18 mm, 70% Runoff	14.67	-	-	-	-	14.67
Rural Residential (ha) IL 15mm, 20% Runoff	-	-	-	-	10.80	10.80
Primary School IL 15mm, 20% Runoff	-	-	-	4.51	-	4.51
Storage Parameters						
AAMGL (mAHD)	2.8	3.8	5.1	3.8	4.4	-
Basin Invert (mAHD)	3.3	4.3	5.6	4.2	4.7	-
Base Area (ha)	0.7	0.21 @ 4.3 mAHD 0.44 @ 4.5 mAHD	0.1 @ 5.6 mAHD 0.22 @ 5.7 mAHD	0.13 @ 4.2 mAHD 0.35 @ 4.5 mAHD	0.19 @ 4.7 mAHD 0.35 @ 5.0 mAHD	-
Side Slopes	1:6	1:6	variable	1:6	1:6	-
Design Perm. (m/d)	0.5	0.5	0.5	0.5	-	-
Outlet Pipe Invert (mAHD)	3.6	4.5	5.9	4.5	5.0	-
20% AEP Event - Minor Event						
Flood Rise (m)	0.58	0.46	0.33	0.65	0.47	-
Volume (m^3)	4388	2463	947	2332	1824	12262
Area (ha)	0.82	0.81	0.83	0.60	0.42	3.48
Peak Outflow (m^3/s)	0.208 to Rein 0.442 to MRE	0.167	0.005	0.077	0.068	-
Critical Storm (hr)	12	12	6	6	12	-
1% AEP Event - Major Event						
Flood Rise (m)	1.16	0.80	0.36	1.13	1.18	-
Volume (m^3)	9527	5382	2263	5556	5199	28057
Area (ha)	0.96	0.93	1.34	0.74	0.54	4.51
Peak Outflow (m^3/s)	0.299 to Rein 0.909 to MRE	0.246	0.014	0.122	0.077	-
Critical Storm (hr)	3	6	6	6	12	-

Table 11: Stormwater Modelling & Infrastructure Sizing (cont)

Catchment	I	J	K	L	M	Total
Total Catch Area (ha)	3.16	5.02	8.77	15.40	37.41	69.76
Land Use Breakdown						
Residential - Soakwells (ha) IL 15mm, 45% Runoff	1.51	3.15	5.16	9.84	19.32	38.99
Road (ha) 85% Runoff	0.93	1.36	1.93	3.82	10.53	18.58
POS/Landscape (ha) 20% Runoff	0.72	0.51	1.67	1.74	7.55	12.19
Storage Parameters						
AAMGL (mAHD)	3.6	3.7	2.9	3.5	2.8	
Basin Invert (mAHD)	5.4	5.3	4	4.6	3.8	-
Base Area (ha)	0.04	0.08	0.16	0.39	0.79	-
Side Slopes	1:6	1:6	1:6	1:6	1:6	-
Design Perm. (m/d)	2	2	2	2	2	-
Outlet Pipe Invert (mAHD)	5.7	5.6	4.3	4.9	4.1	-
20% AEP Event - Minor Event						
Flood Rise (m)	0.53	0.44	0.35	0.23	0.35	-
Volume (m^3)	272	424	634	931	2876	5137
Area (ha)	0.07	0.11	0.20	0.42	0.86	1.66
Peak Outflow (m^3/s)	0.011	0.011	0.002	-	0.005	-
Critical Storm (hr)	3	6	6	6	6	-
1% AEP Event - Major Event						
Flood Rise (m)	1.07	1.08	0.91	0.84	1.08	-
Volume (m^3)	753	1337	1968	3788	9785	16431
Area (ha)	0.11	0.17	0.28	0.52	1.03	2.11
Peak Outflow (m^3/s)	0.013	0.012	0.054	0.029	0.162	-
Critical Storm (hr)	6	6	6	6	6	-

Table 12: Stormwater Quality Infrastructure Sizing

Catchment	A	B	F	G	H	Total
Contributing Land Use						
Residential – Modelled Lot Connections (ha) 61% Runoff	8.52	-	1.68	2.85	-	13.05
Road (ha) 69% Runoff	7.19	5.24	1.70	4.07	4.25	22.45
15mm EIA (ha)	10.16	3.62	2.20	4.55	2.93	23.45
Nested Biofiltration Area Parameters						
Subsoil Invert (mAHD)	3	3.8	5.1	3.9	4.4	
Basin Invert (mAHD)	3.3	4.3	5.6	4.2	4.7	-
Base Area (m^2)	3050	2070	1000	1334	1900	-
Side Slopes	1:6 & 1:0	1:6	1:3	1:6	1:0	-
Outlet Pipe Invert (mAHD)	3.6	4.5	5.9	4.5	5.0	-
15mm Event						
Flood Rise (m)	0.3	0.16	0.30	0.30	0.3	-
Volume (m^3)	951	370	320	433	564	2638
Area (m^2)	3346	2633	1160	1551	1900	10590

Table 12: Stormwater Quality Infrastructure Sizing (cont)

Catchment	I	J	K	L	M	Total
Contributing Land Use						
Road (ha) 69% Runoff	0.93	1.36	1.93	3.82	10.53	18.57
15mm EIA (ha)	0.64	0.94	1.33	2.64	7.27	12.82
Nested Biofiltration Area Parameters						
Basin Invert (mAHD)	5.4	5.3	4	4.6	3.8	-
Base Area (m^2)	180	273	384	864	2100	-
Side Slopes	1:6 with 1:0 interface to remaining flood storage					-
Outlet Pipe Invert (mAHD)	5.7	6.6	4.3	4.9	4.1	-
15mm Event						
Flood Rise (m)	0.29	0.29	0.30	0.28	0.29	-
Volume (m^3)	64	93	130	247	644	1196
Area (m^2)	266	362	491	942	2334	4464

Table 13. Pre and Post Development Flows

Parameter	Predevelopment		Post Development	
	Reinscourt	New Drainage Easement	Reinscourt	New Drainage Easement
Total Catchment Area (ha)	189.6	-	215.1 (Embark)	
20% AEP Estimated Flow (l/s)	100	-	217	443
1% AEP Estimated Flow (l/s)	492	-	490	909

6.3 Post Development Nutrient Input & Export Assessment

The Urban Nutrient Decision Outcomes (UNDO) model is a conceptual decision support tool developed by DWER that evaluates nutrient reduction decisions for urban developments on the Swan Coastal Plain in south-west Western Australia. It is designed for ease-of-use by urban development proponents and for assessment by local and state government authorities.

The tool was developed to assess the nutrient impacts of urban development on the Swan Coastal Plain in a consistent and scientifically rigorous manner, and improve scientific understanding relating to nutrient issues, and efficiencies in the investment to manage nutrients. The tool is web-based and provides users with the ability to implement a range of structural or non-structural design options to evaluate and reduce nutrients exported from an urban development.

Modelling outputs of the site's existing land use using UNDO are detailed in Appendix S and summarised in Table 14. UNDO modelling was performed over the modelled catchments, detailed in Table 11.

The results indicate nutrient inputs of 15,533 kg/yr of TN and 2,753 kg/yr of TP to the environment annually based on typical nutrient application rate estimates. The resultant nutrient export was 1543 kg/yr of TN and 24 kg/yr of TP. These export estimate considers soil types, groundwater gradients, and depth to groundwater in its calculation.

Post development UNDO modelling of the site is detailed in Appendix S, showing the positive impact land use change will have with respect to nutrient application within the site. Modelling outputs of the site's existing land use using UNDO are detailed in Appendix S and summarised in Table 14. UNDO modelling was performed over the modelled catchments, detailed in Table 11 and included already developed LWMS areas (Catchment C and E). Land use details used to inform UNDO modelling for individual catchments are contained in Appendix P.

The results indicate nutrient inputs of 17,702 kg/yr of TN and 3,137 kg/yr of TP to the environment annually based on typical nutrient application rate estimates. The resultant nutrient export was 1759 kg/yr of TN and 28 kg/yr of TP. These export estimate considers soil types, groundwater gradients, and depth to groundwater in its calculation.

Post development UNDO modelling of the site is detailed in Appendix S, showing the positive impact land use change will have with respect to nutrient application within the site.

Modelling was performed based on the proposed local structure plan and stormwater modelling outcomes in Figure 9 & Table 11. Table 14 show the indicated nutrient inputs and exports of TN and TP post development compared to the predevelopment results under existing land use.

The post-development nutrient input values reduced to 6,445 kg/yr for input TN and 1,108 kg/yr input TP for site. This represents a considerable reduction in nutrient input within the site as a result of land use change, with a 63% reduction in TN and a 65% reduction in TP input annually compared to current existing land use.

The resultant nutrient export, inclusive of water sensitive urban design, was 349 kg/yr export TN, and 18.4 kg/yr for export TP kg/yr following development. This represents a significant 80% reduction in TN export and a 34% reduction in TP export to the environment post development.

In summary the above modelling outcomes indicate export rates of 1.5 kg/ha/yr of TN and 0.08 kg/ha/yr of TP from the site following development.

These rates are below both the 10 year and long term target loads for the Lower Sabina River catchment detailed in the Vasse Wonnerup Wetlands and Geographe Bay WQIP (DoW, 2010), with the long term load targets detailed in DoW (2010) equating to 0.13 kg/ha/yr for Phosphorus and 1.6 kg/ha/yr for Nitrogen (Table 2).

Post development monitoring and annual reporting is detailed in Section 9.3. As part of this process monitoring data will also be provided to agencies to assist in the continuous improvement of the UNDO model.

Table 14: Site Nutrient Inputs and Outputs for Existing & Proposed Land Use

Nutrient	Input	Export (without Treatment	Load Removed (via WSUD)	Export (after WSUD)
Predevelopment (Existing Land Use)				
Total Nitrogen (TN) (kg/yr)	17,702	1,759	-	1,759
Total Phosphorus (TP) (kg/yr)	3,137	28	-	28
Post Development (Proposed LSP)				
Total Nitrogen (TN) (kg/yr)	6645	610	261	349
% Change (compared to existing land use)	-63%			-80%
Total Phosphorus (TP) (kg/yr)	1108	27	8.3	18.4

% Change (compared to existing land use)	-65%	-34%
Total Nitrogen (TN) (kg/yr/ha) DoW (2010) WQIP Long Term Target (1.6 kl/yr/ha)		1.5
Total Phosphorus (TN) (kg/yr) DoW (2010) WQIP Long Term Target (0.13 kl/yr/ha)		0.08

7 Groundwater Management Strategy

7.1 Fill & Subsoil Drainage

Minimum separation between building floor levels for development and groundwater will be achieved by a combination of fill and subsoil drainage (where required) to provide protection against any post development groundwater rise.

While detailed finished lot levels, fill requirements, and subsoil drainage design are a detailed civil engineering design issue which will be addressed during preparation of the SDWMR and submitted for council approval at that stage, the following criteria and information is provided to inform the future design.

The requirement for groundwater control to facilitate development was identified in JDA (2019) with development levels to be established with similar principles. It is recognised that development across the wider estate area may result in up to a 0.5m groundwater rise post development (without subsoil control). As such subsoils are to be installed where clearance to groundwater is less than 2m. With the controlled groundwater level (CGL) to be set to best maintain the predevelopment AAMGL, design levels and requirements are to be set in accordance with the controlling subsoil levels.

Fill level and subsoil design at the SDWMR stage will be required to comply with separation specifications as per CoB (2013) guidelines and the Institute of Public Works Engineering Australasia (Western Australia) (IPWEA) (2016), Specification, Separation Distances for Groundwater Controlled Urban Development guideline. Relevant extracts from these documents to guide design at SDWMR stage are detained in Appendix T. Key requirements include a minimum 1.2m clearance from CGL to lot level (CoB) and a minimum 0.3m clearance from lots to the mounding 50% AEP phreatic surface between subsoils (IPWEA).

Interface between lots and roads will account for a minimum subsoil depth of 0.9m in road reserves and additional clearance requirements for raised lot levels. The subsurface profile may be open to variation in providing effective drainage with consideration of existing soil conditions and imported fill. Minimising large scale trucking and importation of fill will be a key consideration in final design. Indicative cross sections in Appendix T provided by project engineers JDSI show a step fill design for efficient fill application. It should be noted that these sections are indicative only and do not reflect fixed designs to be implemented at the SDWMR stage.

Preliminary subsoil and fill modelling using DRAINMOD for a 30 year daily rainfall sequence modelled for soakwells, 1.2m fill above subsoil at an 80m spacing within road reserves is shown Appendix T, to provide some context to mounding and clearances in design. This modelling indicates a clearance of 0.87m from surface to 50% AEP phreatic and shows that there is scope for fill application efficiency to achieve requirements detailed above. Minimising large scale trucking and importation of fill should be a key consideration in final design. For the purposes of conservative design, it is recommended that a clearance of 0.5m to the 50% AEP phreatic between subsoils be provided to lots for additional protection.

Consistent with the approved Stage 1 SDWMR (Hyd2o, 2023a) the implementation of subsoils at the rear of lots to minimise fill requirements has been accepted by the City of Busselton for Stage 1. Based on City requirements, engineering design accounts for easements with a minimum 3m width to contain and manage lengths of rear subsoil.

For future development however, the City has indicated rear of lot subsoils with easements are not permitted in design beyond the Stage 1 area unless otherwise approved by the City.

To satisfy agencies permeability testing will be required between site development and housing construction to ensure sand fill achieves the design permeability. Testing will need to be addressed between the developer and agencies at SDWMR stage.

To improve subsoil and soakwell function the developer will mandate that soakwells are installed at the front of lots nearest road reserve subsoil lines consistent with best practice. This will be carried out via a restrictive covenant placed on the title of each lot. This is considered to be to the benefit of the council and residents.

Where implemented, subsoil design throughout the estate is proposed to be installed at the existing AAMGL where possible so that the post development controlled groundwater level (CGL) maintains a similar groundwater environment. It should be noted that there are areas where this is not possible due to other engineering design considerations and some localised groundwater rise may be expected in these areas. This includes the Basin A location where groundwater levels will continue to be controlled by the baseflow condition in Reinscourt.

Subsoils will be permitted to outflow to estate drainage basins to provide treatment prior to site discharge. To provide a free draining system subsoils will daylight as required.

7.2 Acid Sulphate Soils

Dewatering may be required for sewer installation. Should any licencing be required based on the quantity of groundwater abstraction during dewatering, this will be the responsibility of the construction contractor.

ASS management will be undertaken consistent with the ASS management plan (Coffey Environments, 2010) and will be undertaken as a separate process to this SDWMR. All assessment and management of ASS will be conducted in accordance with the Acid Sulphate Soil Guideline Series documentation (Department of Environmental Regulation, 2015a & b).

8 Subdivision and Development Water Management Reports

Consistent with processes defined in WAPC (2025), Subdivion and Development Water Management Reports (SDWMR's) will be developed and submitted to support subdivision applications for various stages of development within the site. SDWMR's will address:

- Demonstrated compliance with LWMS criteria and objectives to the satisfaction of local government and DoW.
- Agreed/approved measures to achieve water conservation and efficiencies of water use.
- Detailed stormwater management design including the size, location and design of public open space areas, integrating major and minor flood management capability. This will include the design of additional local scale stormwater management measures where appropriate as well as temporary downstream drainage if required.
- Management of groundwater levels including proposed fill levels and subsoil drainage inverts.
- Specific structural and non-structural BMPs and treatment trains to be implemented including their function, location, maintenance requirements, expected performance and agreed ongoing management arrangements.
- Management of subdivisional works including development of a strategy for sediment control during construction.
- Implementation plan including roles, responsibilities, funding and maintenance arrangements.
- Specific monitoring and reporting to be undertaken for each SDWMR area consistent with the monitoring program defined in the LWMS. Sites for each subdivision/stage area to be defined as SDWMR stage in consultation with agencies.
- Contingency plans (where necessary).

More detail on stormwater storage integration with POS areas will be provided during the development of the SDWMR, including refinement of stormwater modelling, preparation of detailed landscape plans and sections (species selection and treatments), and detailed engineering design drawings.

Preparation of the SDWMR will be the developer's responsibility.

9 Contingency Management Plan

9.1 Maintenance

The stormwater and groundwater management systems will require ongoing maintenance to ensure efficient operation. Operating and maintenance practices and frequencies are shown in Table 15. The effectiveness of the system and maintenance practices will be assessed via visual assessments conducted as part of regular monitoring.

Annual reporting will include a review of the maintenance schedule and its adequacy in relation to system performance.

Table 15: Maintenance Schedule for Stormwater Infrastructure

Item	Maintenance Interval			
	Monthly	Quarterly	Biannually	As Required
Local Drainage				
Street sweeping		✓		
Removal of sediment and rubbish in manholes			✓	
Assess and Remove sediment and rubbish in GPT's			✓	
Subsoil Drainage				
Check on function (via groundwater level monitoring)		✓		
Bioretention Systems and Swales				
Inspection for erosion			✓	
Mowing of grassed areas and clipping removal	✓			
Vegetation maintenance (remove dead plants, replace if needed)				✓
Inspect for standing water after rainfall events (as part of water quality monitoring)		✓		
Remove excessive sediment build-up				✓
Detention Storages / POS Areas				
Removal of debris to prevent blockages				✓
Remove excessive sediment build-up				✓
Use slow-release / low-P fertilisers in turf areas			✓	
Community Education Campaigns				
Leaflets promoting source control practices				✓
Online / social media campaigns				✓

9.2 Monitoring & Reporting

9.2.1 Pre-Development Monitoring

Pre-development monitoring for the site has been previously completed, with results reported in this LWMS and previous water management strategy documents for the site. No further predevelopment monitoring is required or proposed.

9.2.2 TSS Construction Monitoring & Exceedance Notification

With respect to construction activities, previous water management planning for the site (JDA, 2019) specified TSS will require ongoing management review by the contractor to minimise concentrations. Monitoring which provides readings in excess of target concentrations will be subject to immediate corrective action using engineering controls and stopping work where necessary.

When undertaking TSS monitoring, should target values be exceeded (or be predicted to exceed), DWER and DCCEEW will be notified within 2 business days and advise of measures that have been taken to mitigate or prevent that exceedance. Within 14 days of notifying DWER and DCCEEW of the exceedance (or predicted exceedance), DWER and DCCEEW will then be notified that measures have been taken to mitigate or prevent that exceedance, and the effectiveness of those measures. DWER and DCCEEW will also be advised of measures to be taken to prevent and/or minimise the likelihood of similar future exceedances.

Note that while TSS monitoring will be undertaken by the contractor, the responsibility for assessing and reporting to agencies will be with the proponent and their consultant.

Table 16: Construction Monitoring Program

Monitoring	Parameter	Location [1]	Method	Frequency/Timing
Surface Water	TSS	6 outflow locations as needed (PSW1,2,3,4,5,6)	Outflow grab sample & hand held meter	Daily when flowing and during periods when site outflow is impacted by construction activity

1. Refer Figure 13 for specified locations

9.2.3 Post Development Monitoring & Reporting

JDA (2019) detailed a proposed monitoring program for the site. The monitoring program was designed to allow quantitative assessment of hydrological impacts of proposed development, in particular the monitoring of surface water discharges and groundwater quality, with monitoring to be performed for 2 years post practical completion per stage of development.

This program has been used as the basis to establish a post development monitoring program for the site as detailed in Table 17 and Figure 13 showing proposed sites with consideration of future development areas, POS locations, and a representative sampling distribution. The program considers the extent of existing developed areas which have already been subject to post development monitoring and no further monitoring of these areas is proposed.

Surface water monitoring includes both quality and quantity parameters at accessible points of reference within the stormwater management network and ultimate discharge point of the wider development area to the downstream environment. The key location for surface monitoring will be the Bussell Highway culverts to Reinscourt and a monitoring station with a data logger will be established at this location to provide continuous flow record. Monitoring of the alternative outlet location (PSW6) will be dependent on its utilisation at design stage.

Water quality sampling will be undertaken monthly (when flowing) during winter for analysis by a NATA registered laboratory, with the frequency to be reviewed following the first 12 months of sampling. Monitoring of the following parameters will be required:

- In situ - pH, EC and Temperature
- TP, TN (with components including FRP, TKN, Nitrate/Nitrite), TSS

Groundwater monitoring is proposed at 7 locations, undertaken quarterly for the same parameters as for surface water. Post development sites are aligned with POS areas as shown in Figure 13.

Surface water quality sampling is also proposed to be undertaken at Footprint Lake and Almond Parkway Lake as a continuation of monitoring reported in JDA (2019) with sampling and frequency detailed in Table 17. Collected data is intended to inform ongoing management works to improve lake water quality via additional measures discussed in Section 5.3.1. Additional lake monitoring specific to algae behaviour is expected to be undertaken in a responsive nature and as such has not been included as part of periodic monitoring proposed as part of this LWMS. Recent locations monitored by Hyd2o are provided in Appendix O and will be used to guide sampling site selection.

Ongoing tracking of environmental performance against targets will be undertaken as monitoring data becomes available through a consolidated database.

Reporting (including provision of monitoring data) will be annual, to be co-ordinated by the developer and submitted to CoB, DWER, and DCCEEW for review, with results compared to predevelopment conditions and established targets.

The report will compare the monitoring results with the target design criteria and performance objectives and determine what, if any, further actions may be necessary and provide ongoing assessment of the suitability of existing monitoring and reporting frequencies. The annual report will also include review of the maintenance schedule detailed in Table 15 in relation to system performance and provide a summary of any criteria exceedances and actions taken.

Monitoring concentration targets based on predevelopment site conditions and monitoring outcomes are shown in Table 18. Results will also be compared against DoW (2009), ANZECC (2000), and previous research outcomes of urban stormwater quality on the Swan Coastal Plain (Martens et al 2004). The assessment of performance compliance against water quality criteria will require careful consideration to account for inter seasonal and inter annual variability, particularly as both surface and groundwater quality will have legacy issues associates with historical land use practices.

The process for determining any contingency actions required following the assessment of overall performance compliance will be undertaken as follows:

- Notification authorities of any breach in compliance with required timeframes
- Assess if the occurrence is an isolated, development area or regional issue.
- Determine if due to the development or other external factors.
- Perform appropriate contingency actions as required, which may include:
  a) Identify and remove any point sources of pollution.
  b) Reinforce/conduct community education/awareness programs.
  c) Review constructional, operational and maintenance practices (eg fertilising)
  d) Consider alterations to POS areas (landscape regimes, soil amendment).
  e) Consider modifications to the stormwater system and storage/biofiltration areas.
  f) Consider initiation of community based projects.
- Assess any additional measures/controls required to minimise future likelihood of similar occurrence.

This approach is detailed in Table 19. Note that any breaches requiring action to be undertaken will be recorded and reported to authorities within required timeframes and annual reporting. With respect to the risks to the Vasse Wonnerup wetlands associated with breaches it is important to note:

- land use change is expected to considerably reduce nutrient inputs and outputs from the site compared to existing land use.
- the site is located in a low groundwater and surface water gradient environment so that any breaches will take considerable timeframes to reach the wetlands providing the opportunity for any intervention practices to be employed if necessary. The site is located ~700m to the wetland via groundwater flow and approximately 2 km from the wetland for the main surface water catchment flow path.
- the site is a staged development, and monitoring, analysis, and reporting outcomes will be used in a continual improvement capacity to review existing conceptual WSUD, and inform the planning and design approaches for subsequent stages.

The above aspects are considered in the development of the monitoring programs sampling and reporting frequencies.

While still considered low risk as stormwater is expected to be mainly retained and managed on site during construction periods, potential discharge of high TSS outflow is considered a higher risk during construction and this is reflected in the proposed sampling frequency during construction periods. The construction contractor will be responsible for preparing and implementing a site management plan detailing appropriate best management practices for the construction of the subdivision with management undertaken consistent with the Local Government Guidelines for Subdivision Development (Institute of Public Works Engineering Australia, 2017). Earthworks at the site will be carried out in accordance with AS 3798-2007 Earthworks for Residential and Commercial Developments. Temporary measures such as fences to locally control sediment and erosion during the construction phases of the project may require implementation. Any temporary storage requirements will be documented at SDWMR stage.

The monitoring program may need to be modified as data is collected to increase or decrease the monitoring effort in a particular area or to alter the scope of the program itself.

Any modification would be identified through review of collected data and would require the agreement of all parties (DWER, CoB, DCCEEW and the developer).

9.3 Responsibility and Duration

The Contingency Management Plan described in this Chapter is to be effective for the duration of the project, and for a period of five years following transfer of responsibility for the project to a land management authority.

The proponent will be required provide funds to that land management authority to implement the Contingency Management Plan for the first two years of that five year period.

Table 17: Post Development Monitoring Program

Monitoring	Parameter	Location [1]	Method	Frequency/Timing
Groundwater Level	Water Level (m AHD)	7 site bores (FP02, PM1,PM2, PM3,PM4,PM5,PM6) 2 DWER bores (18s,19s)	Electrical depth probe or similar	Quarterly (Jan, Apr, Jul & Oct) for 2 years at bores relevant to individual stage of development
Groundwater Quality	pH, EC Nitrogen Phosphorus, TSS	7 site bores (FP02, PM1,PM2, PM3,PM4,PM5,PM6)	Pumped bore samples	
Surface Water Flow	Flow Rate	6 Outflow locations (PSW1,2,3,4,5,6)	Water level recorder and data logger (PSW1), Visual estimate (PSW2-6)	Continuous at 1 site and Monthly during winter at other sites
Surface Water Quality	pH, EC TSS Nitrogen Phosphorus	6 Outflow Locations (PSW1,2,3,4,5,6)	Grab samples	Monthly during winter when flowing, typically April to November. Frequency to be reviewed following initial 12-month period for 2 years at outflow locations relevant to individual stage of development
		2 locations in Footprint Lake (North & South), 1 in Almond Parkway Lake		Quarterly (Jan, Apr, Jul & Oct)

1. Refer Figure 13 for Locations

Table 18: Monitoring Concentration Targets

Monitoring Type	Criteria for Assessment	Assessment Frequency
Construction		
Site Outflow 6 outflow locations as needed	**TSS : 32 mg/l** (based on Lower Vasse River 2001-2006 data) via previous site WMS (JDA, 200)	Daily (when flowing and during periods when site outflow is impacted by construction activity)
Post Development		
Groundwater	**Median TN** **2.9 mg/l** (pre development) 1.0 mg/l (WQIP long term) 0.75 mg/l (Estuaries-ANZECC, 2000) **Median NH4+** **0.04 mg/l** (Estuaries-ANZECC, 2000) **Median Nox-N** **0.33 mg/l** (pre development) 0.045 mg/l (Estuaries-ANZECC, 2000) **Median TP** **0.14 mg/l** (pre development) 0.10 mg/l (WQIP long term) 0.03 mg/l (Estuaries-ANZECC, 2000) **Median FRP** **0.01 mg/l** (pre development) 0.005 mg/l (Estuaries-ANZECC, 2000)	Ongoing data assessment & review following monitoring Annual Assessment Report & Data
Surface Water	**Median TN** **2.1 mg/l** (pre development) 1.0 mg/l (WQIP long term), 2010 0.75 mg/l (Estuaries-ANZECC, 2000) 1.1 mg/l (Martens et al, 2004) **Median NH4+** **0.04 mg/l** (Estuaries-ANZECC, 2000) **Median Nox-N** **0.03 mg/l** (pre development) 0.045 mg/l (Estuaries-ANZECC, 2000) **Median TP** **0.15 mg/l** (pre development) 0.10 mg/l (WQIP long term), 2010 0.03 mg/l (Estuaries-ANZECC, 2000) 0.21 mg/l (Martens et al, 2004) **Median FRP** **0.04 mg/l** (pre development) 0.005 mg/l (Estuaries-ANZECC, 2000) **Water Quantity and Flow** Water quantity and flow rates at culverts to Reinscourt exceeding estimated predevelopment flow rates.	Ongoing data assessment & review following monitoring Annual Assessment Report & Data

Table 19: Contingency Planning & Process

Contingency Assessment Frequency
• Immediately following monitoring occasion for field parameters & observations. • Following receipt of lab report for laboratory tested parameters. • Annual Reporting & Assessment Process.
Assessment Process
• Inform and provide monitoring data to DWER and DCCEEW upon breach of any trigger. • Assess if an isolated, development area or regional occurrence, and undertake additional monitoring as/if required to assist determination. • Determine if due to the development or other external factors. • Perform appropriate contingency action as required. • Record and report any breach and action taken. • Assess additional measures/controls to minimise future occurrence. • If necessary, inform residents of any required works and their purpose. • Inform and provide response measures implemented to DWER and DCCEEW, including additional performance monitoring if required.
Potential Actions / Remediation
Actions to be undertaken will be based on the assessment of site specific data to determine the appropriate course of action and possible remediation works. Potential courses of action include: • Identify and remove any specific point sources of pollution. • Review operational and maintenance practices (e.g. fertilising, lot construction practices) • Consider alterations to POS areas including landscape regimes, soil amendment • Consider modifications to the stormwater system. • Consider initiation of community based projects.
Notification & Reporting Frequencies
• Construction : Advice of any breaches within 2 business days and advise of measures taken to mitigate or prevent the exceedance. Within 14 days of notifying DWER and DCCEEW of the exceedance (or predicted exceedance), DWER and DCCEEW will be notified that measures have been taken to mitigate or prevent that exceedance, and the effectiveness of those measures, and measures implemented to avoid recurrence. • Post Development: Ongoing data assessment & review following monitoring to be undertaken on receipt of laboratory reports. Reporting to agencies as per construction requirements for readings outside the range of predevelopment data. Given highly variable predevelopment data, annual assessment report & data analysis to be used to assess overall performance in compliance with targets and assess actions required.

10 Compliance with DCCEEW Conditions

Table 20 details compliance of the strategy and action taken in response to the water related development conditions set by the Commonwealth Minister for the Environment and Water through the Department of Climate Change, Energy, the Environment and Water as detailed in the conditions of approval (Appendix B).

Table 20: Compliance with DCCEEW Water Related Development Conditions

DCCEEW Condition	Demonstrated Compliance/Action
4. The person taking the action must design and implement a Water Management Strategy (a Strategy) which is consistent with requirements of WAPC's Better Urban Water Management (BUWM) framework and implements water sensitive urban design principles and practices including,	
- a review of the **environmental values and water quality objectives** and **pollutant load targets** for the Vasse Wonnerup wetlands, including how those values, objectives and targets have informed the **environmental performance targets** developed in the Strategy;	- Description of Vasse Wonnerup estuarine system **(Section 3.4)** - Water quality objectives and management approach consist with the Vasse Wonnerup and Geographe Bay WQIP (DWER (2010) **(Section 3.4.1)** - Key extracts and targets relevant to the site included based on review of the Vasse Wonnerup and Geographe Bay WQIP (DWER (2010) **(Section 3.4.1, Appendix F)** - Review of export load targets in the Vasse Wonnerup and Geographe Bay WQIP (DWER (2010) for the site's catchment and assessment of land use change in relation to these targets **(Section 6.3)** - Targets established consistent with improving water quality within the Vasse Wonnerup estuary **(Section 9.3.2)**
- **environmental performance targets** in order for the activity to, as a minimum, contribute to attainment of those **water quality objectives** and load targets. **Environmental performance targets** are to be defined in a manner consistent with the BUWM;	- LWMS compliant with BUWM approach and process requirements (**Section 1.1, Section 8, Section 11)** - Determination of predevelopment surface water and groundwater conditions via assessment of predevelopment site water quality data **(Section 3.5.1, Section 3.6.2, Table 3, Appendix I)** - Approach to water quality target setting consistent with DWER requirements, ANZECC (2000), predevelopment monitoring data and Vasse Wonnerup and Geographe Bay WQIP (DWER (2010) (**Section 3.4.1, Section 3.5.1, Section 3.6.2, Table 18**) - Vasse Wonnerup and Geographe Bay WQIP (DWER,2010) targets relevant to the site reviewed and included for criteria establishment **(Section 3.4.1, Appendix F, Table 18)** - Concentration targets established consistent with achieving improvements in water quality for the Vasse Wonnerup estuary (**Section 3.4.1 & Table 18**)
- a commitment to supply surface and groundwater data, derived from implementation of the Strategy to the Western Australian **Department of Water and Environmental Regulation**;	- Commitment to supply all monitoring data to DWER provided (**Section 9.2.3, Section 6.3, Table 11**)
- the nature, location and maintenance requirements for structural and non-structural water sensitive urban design practices, including as they relate to achieving performance targets.	- General maintenance and operating requirements for the stormwater system provided (**Section 9.1, Table 14**)

DCCEEW Condition	Demonstrated Compliance / Action
The assumptions relating to pollutant removal efficiencies of those practices must be clearly documented for future verification and supplied to the **department** upon request;	- Expected pollutant removal efficiencies for key stormwater management measures provided based on DWER (2022) **(Table 10)**
- annual reporting to the **department**, via an **annual compliance report** which describes the status of the project, the results from monitoring and predictive modelling activities,	- Annual review and data assessment for long term compliance and performance assessment detailed **(Section 9.2.3, Tables 16-18)** - Monitoring data to be assessed against concentration targets based on predevelopment data and published water quality requirement for protection of the Vasse Wonnerup estuary (**Section 3.4.1, Section 9.2.3, Table 18)**
- assesses those results against attainment of environmental performance targets, and describes management interventions taken in response to any failure or anticipated failure to achieve the environmental performance targets; and	- Contingency Plan defines process and actions for a response to DWER and DCCEEW of any target breaches and the reporting process **(Section 9.2.2, Section 9.2.3, Table 19)** - As a staged development, monitoring, analysis, and reporting will be used in a continual improvement capacity to review existing WSUD, and inform planning and design approaches for subsequent stages of the development. **(Section 9.2.3)** - LWMS recognition of highly variable water quality spatially, seasonally and annually, and legacy impact of historical land use. Targets subject to annual review as part of the ongoing performance review process. **(Section 9.2.3).**
- The person taking the action must commence implementing the approved Strategy no later than when commencing **construction** and must continue to implement the approved Strategy at least until it has provided evidence to the **department** that a WA Government land management authority has assumed responsibility for the **project area** and that the WA Government land management authority is satisfied that the person taking the action has provided sufficient funds to that WA Government land management authority to implement the Strategy for at least the following two years.	- Commitment provided (**Section 11, Table 21)**
5. The Strategy is to include a Contingency Management Plan (CMP) which describes:	
- surface and groundwater monitoring pre, during and post development (for subdivision and **construction**) in order to track attainment of **environmental performance targets** for total suspended solids, and total and dissolved inorganic nitrogen and phosphorus. Monitoring regimes (including the nature, timing and frequency of monitoring activities, the relationship between monitoring activities and hydrologic conditions) are to be described;	- Predevelopment monitoring program completed and outcomes used to inform the site design and LWMS approach (**Section 3.5.1, Section 3.6, Section 9.2.1)** - Post development (including construction) monitoring program proposed for both surface and groundwater (**Section 9.2.2, Section 9.2.3, Section 9.3**) - Monitoring of surface and groundwater to be undertaken and assessed consistent with Tables 17 & 18 of this document (**Section 9, Tables 17 & 18)** - Ongoing tracking of performance against targets will be undertaken as monitoring data is available through a consolidated database (**Section 9.2.3**)

DCCEEW Condition	Demonstrated Compliance/Action
- management measures that will be taken by the proponent, and options for adjusting existing and proposed practices over the duration of the project, in response to measured or predicted failure to meet **environmental performance targets** during the period of the CMP. This is to include a description of circumstances where a stop work order will be issued by the proponent during **construction** due to failure to meet environmental performance targets.	- WSUD measures and BMP's consistent with DWER (2022) detailed and will be implemented with land use change based on DWER's recommended approach to urban water management to meet water quality objectives and targets **(Section 4, Section 5, Section 6.1)** - Contingency planning and process detailed including potential actions and approaches to remediation works assessment (Section 9.2.3, Table 19). - Basis for issue of stop work order detailed (**Section 9.2.2, Table 19)** - Monitoring, analysis and reporting outcomes to be used in a continual improvement capacity to review existing WSUD, and inform planning and design approaches for future stages of development **(Section 9.2.3).**
- The CMP is to be effective for the duration of the project, and for a period of five years following transfer of responsibility for the project to a land management authority. The proponent will provide funds to that land management authority to implement the CMP for the first two years of that five year period.	- Commitment to funding and CMP implementation **(Section 9.3)**
6. If any environmental monitoring performance target specified in the approved Strategy is exceeded or predicted by modelling to be exceeded, the person taking the action must:	
- within 2 **business days** of becoming aware of an exceedance or predicted exceedance notify the **department** of this and of the measures the person taking the action will take to mitigate any exceedance or to prevent an exceedance re-occuring; and	- Construction activities will be subject to ongoing management review to minimise TSS concentrations and any monitoring found in excess of the target concentrations will be subject to immediate corrective action and stopping works where necessary **(Section 9.2.2)** - Ongoing post development monthly surface water and quarterly groundwater monitoring undertaken with data assessment in terms of predevelopment data range. Annual review and data assessment for long term compliance and performance assessment **(Section 9.2.3, Tables 17-19)** - Establishment of Contingency Management Plan with notification of DWER and DCCEEW of any target breaches within reporting process in accordance with 2 business day requirement (**Section 9.2.2, Table 19)**
- within 14 days of notifying the **department** of an exceedance or predicted exceedance, notify the **department** of the measures that have been taken to mitigate or prevent that exceedance, and the effectiveness of those measures, and the measures the person will take to prevent and/or minimise the likelihood of any similar future exceedance.	- Commitment to notification of DWER and DCCEEW of measures taken to mitigate or prevent the exceedance, their effectiveness and measure to prevent/minimise future exceedances in accordance with 14 day requirement (**Section 9.2.2, Table 19)**

11 Implementation

Table 21 details the roles, responsibilities, and funding to implement the LWMS.

The LWMS will be implemented no later than when commencing construction and will be continued to be implemented until at least it has provided evidence to DCCEEW that:

- a WA Government land management authority has assumed responsibility for the project area; and
- that the WA Government land management authority is satisfied that the proponent has provided sufficient funds to that WA Government land management authority to implement the LWMS for at least two years.

Operation and maintenance of the stormwater management system will initially be the developer's responsibility, ultimately reverting to the City following handover. Details of maintenance responsibilities will be further outlined at SDWMR stage.

Long term maintenance of stormwater infrastructure and landscaping will be the responsibility of the City of Busselton. Maintenance will include but not be limited to street sweeping to reduce particulate build up, removal of sediment and rubbish in manholes and storage area, removal of debris to prevent stormwater blockages, checks on drainage function, and replacement of water quality treatment vegetation.

Table 21: Implementation Responsibilities

		Responsibility			
LWMS Section	**Implementation Action**	**Developer**	**City of Busselton**	**DWER**	**DCCEEW**
Strategy Implementation					
11	Implementation of LWMS	☑			
Subdivision and Development Water Management Reports					
8	Preparation of a SDWMR for Individual Development Stages	☑			
8	Review & Approval of SDWMRs		☑	☑	
Monitoring & Reporting					
9	Post Development Compliance Monitoring, Reporting & Data Provision	☑			
9	Review & Assessment of Compliance Reporting		☑	☑	☑
Stormwater System					
-	Construction	☑			
-	Operation & Maintenance a) Short Term (Prior to Handover)	☑			
	b) Long Term (After Handover)		☑		

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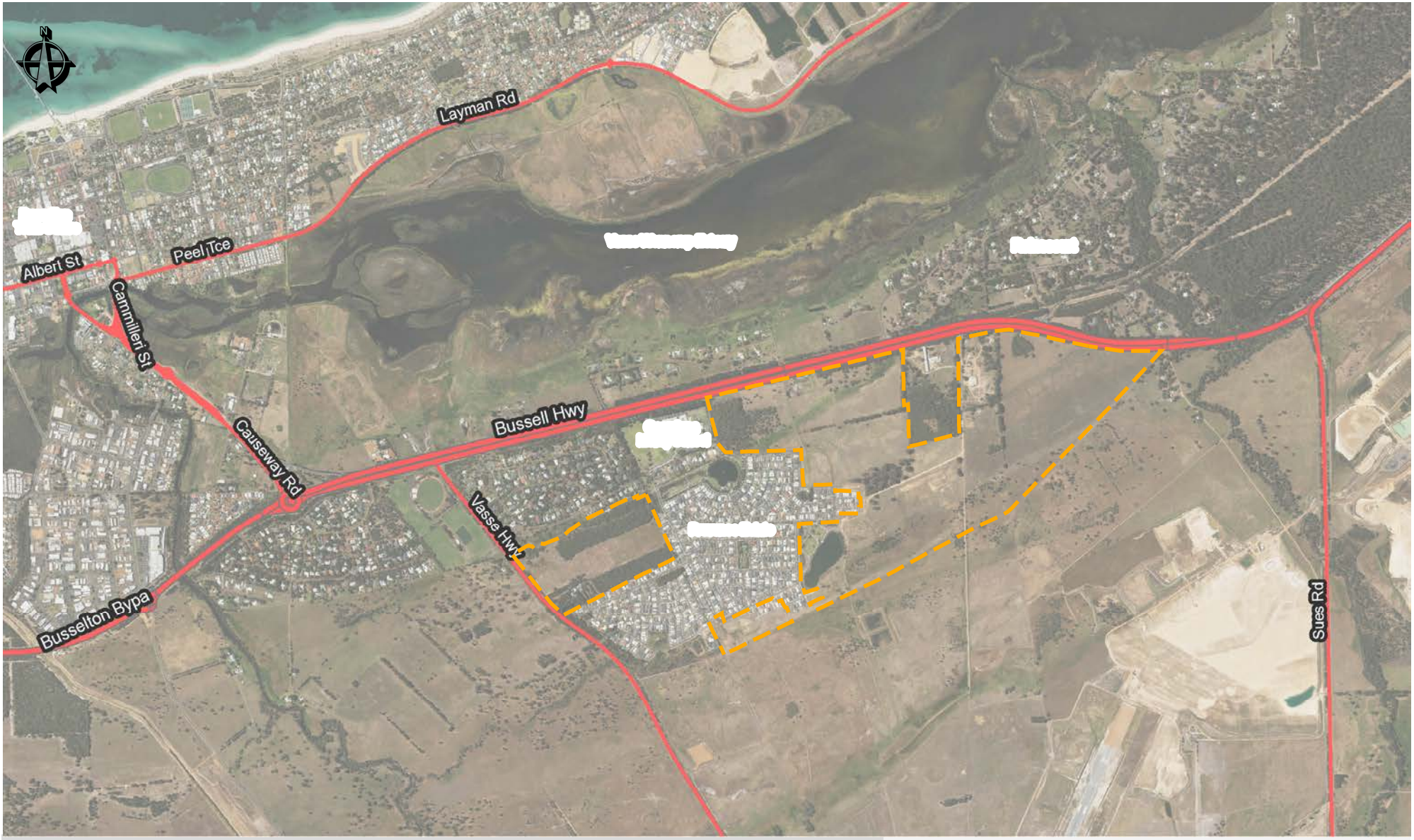
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FIGURES



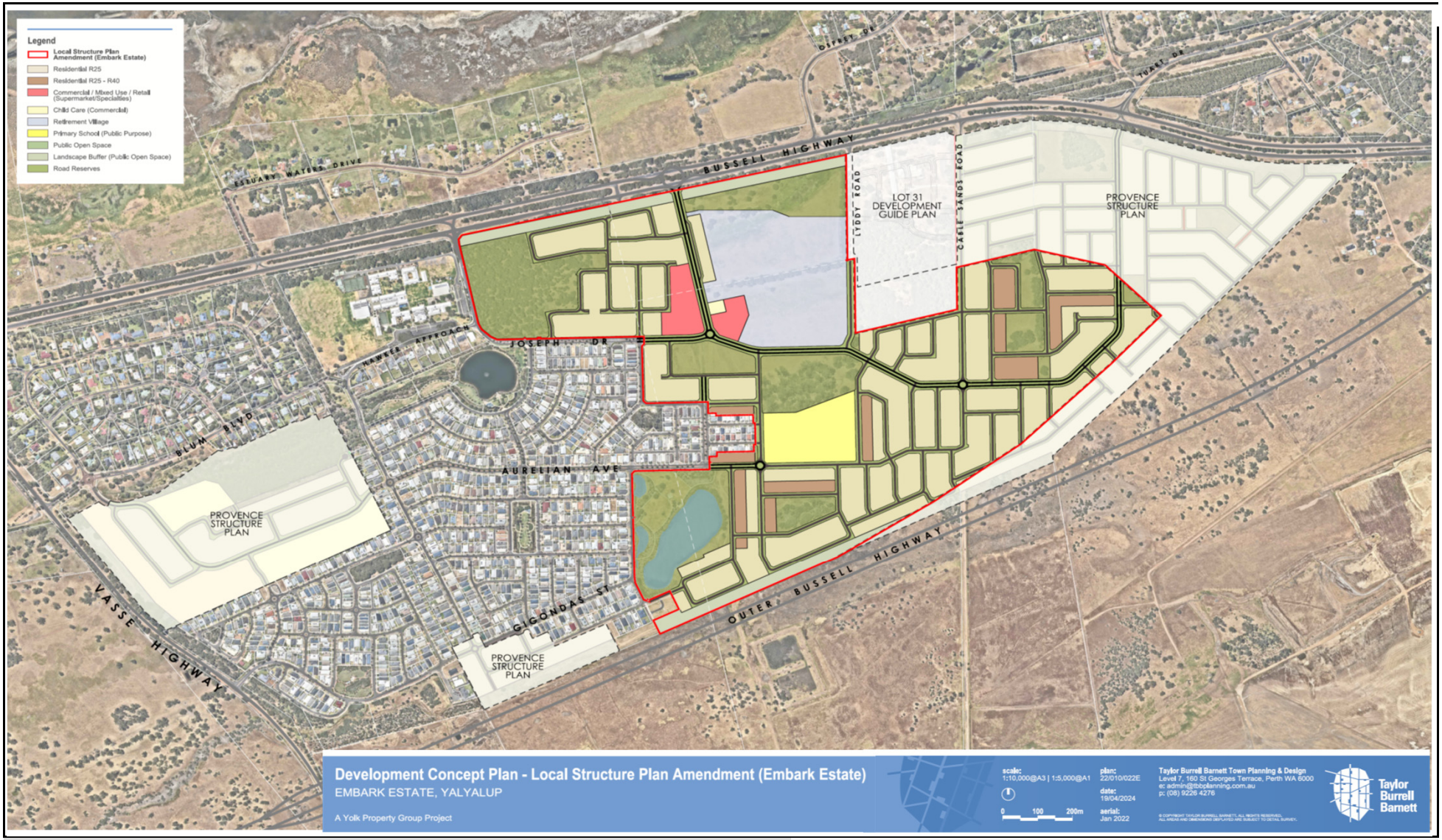
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Location Plan

Figure 1

Date : 3/4/2025 Job No: H22018



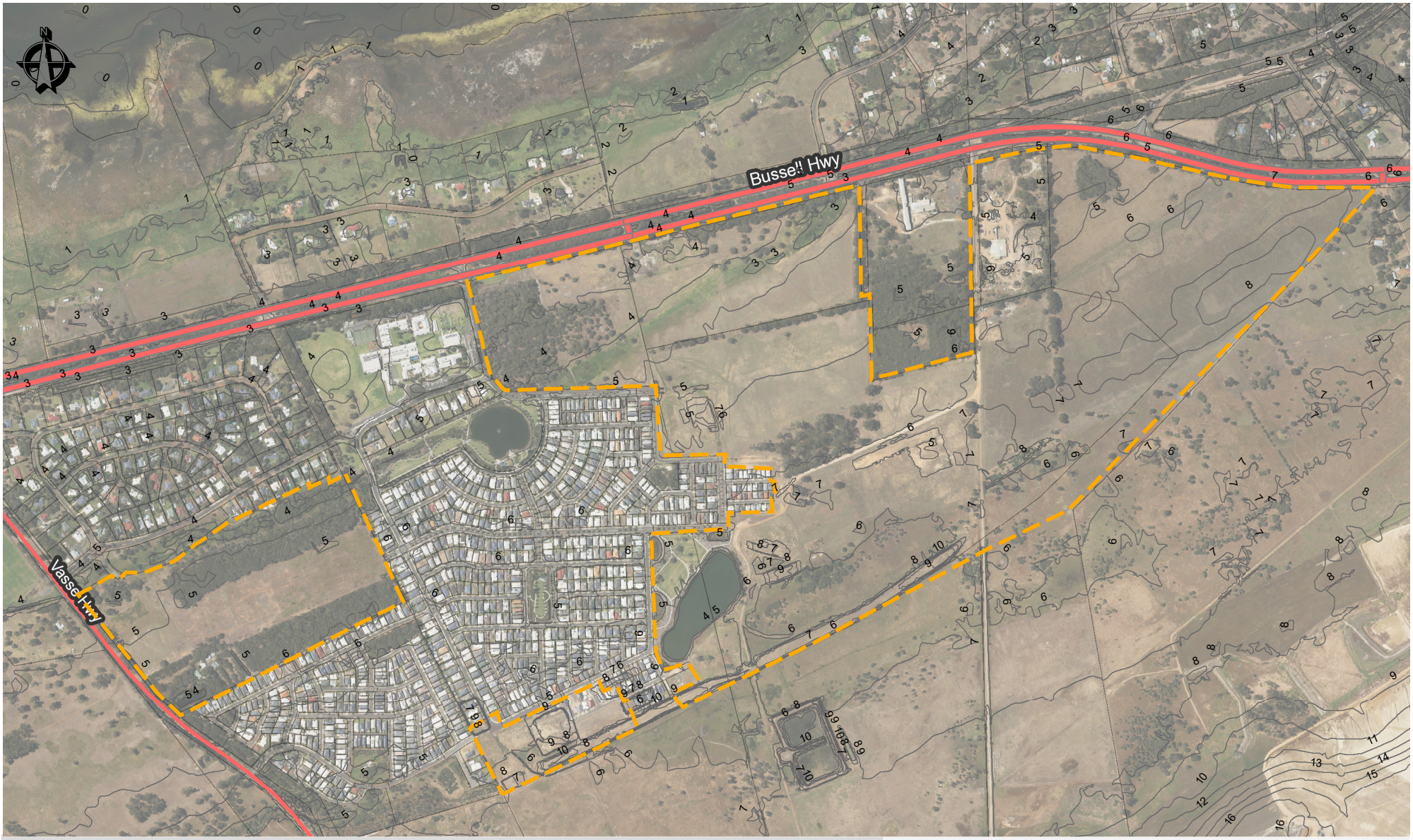
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Local Strucure Plan

Figure 2

Date: 22/02/2023 Job No. H22018



Site

DWER LiDAR Contours Swan Coastal Plain (mAHD)

0 75 150 300 450 600
Meters

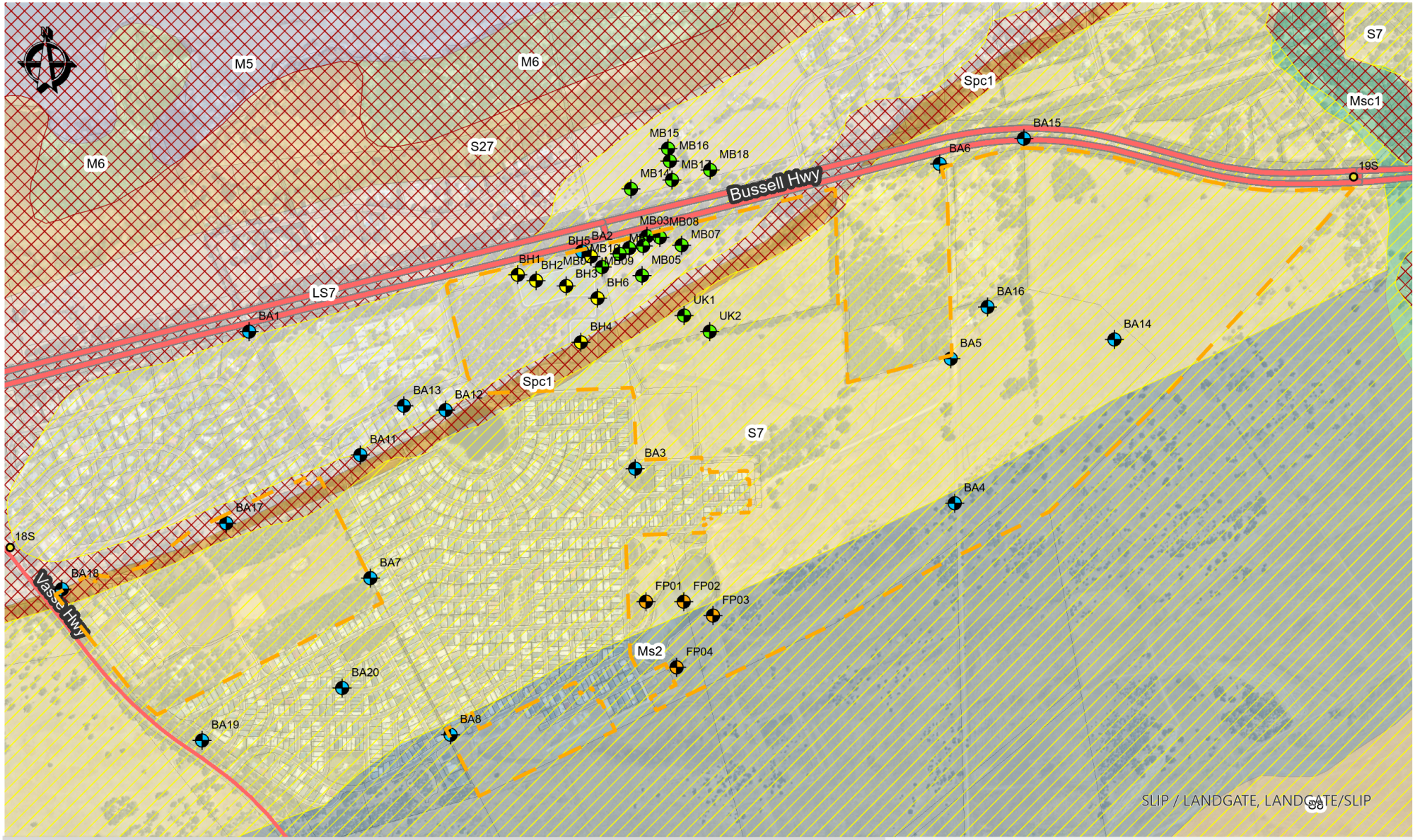
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Site Conditions Plan

Figure 3

Date: 22/02/2023 Job No. H22018

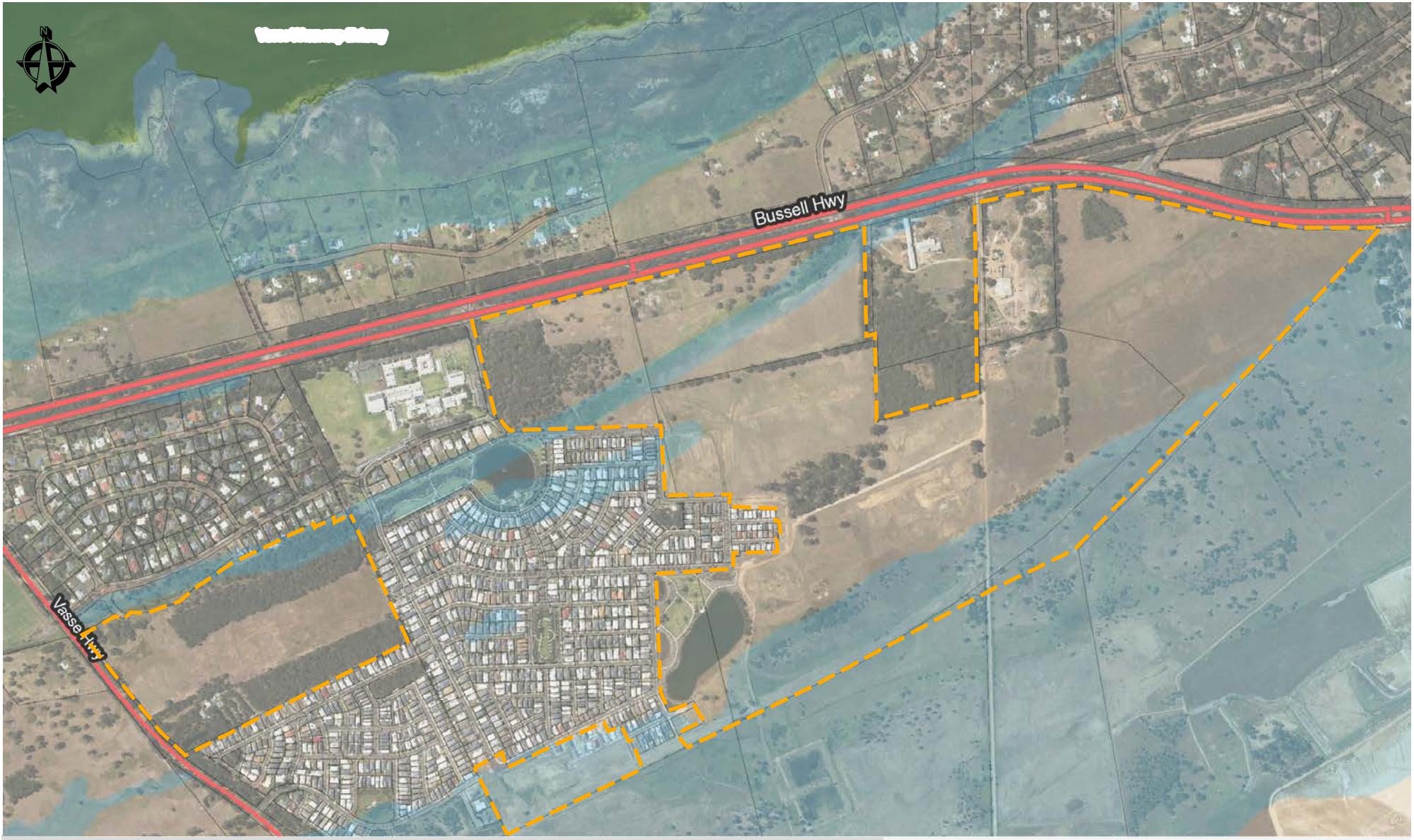


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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Geotechnical Plan

Figure 4



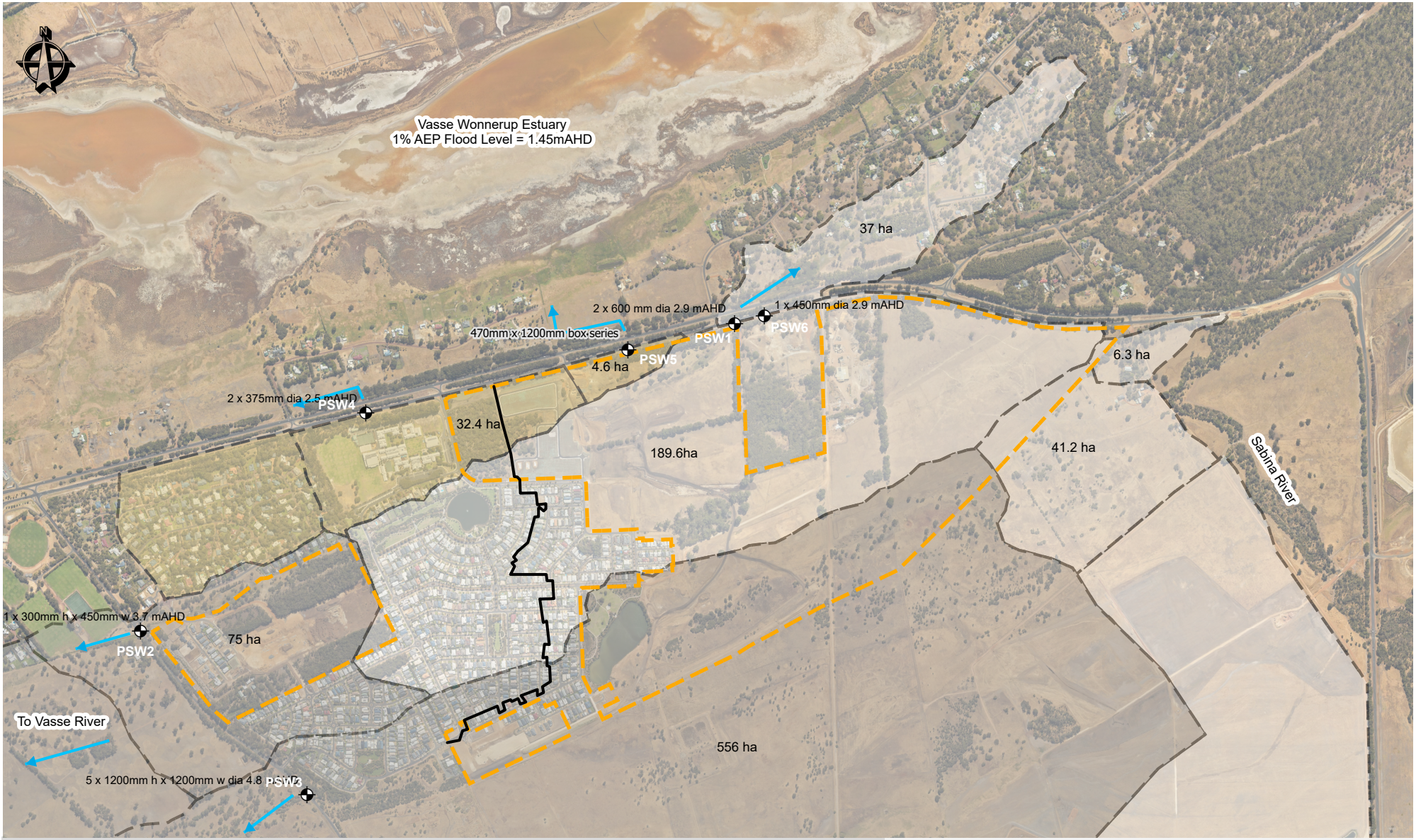
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Wetland Plan

Figure 5

Date: 20/02/2026 Job No. H22018



Site
DWER Hydrography Linear
Culverts / Monitoring Site
Outflow
Post Development Vasse Sabina Catchment Divide

Floodway
Flood Fringe

Pre Development Catchments
Sabina
Vasse
Wonnerup

0 100 200 400 600 800
Meters

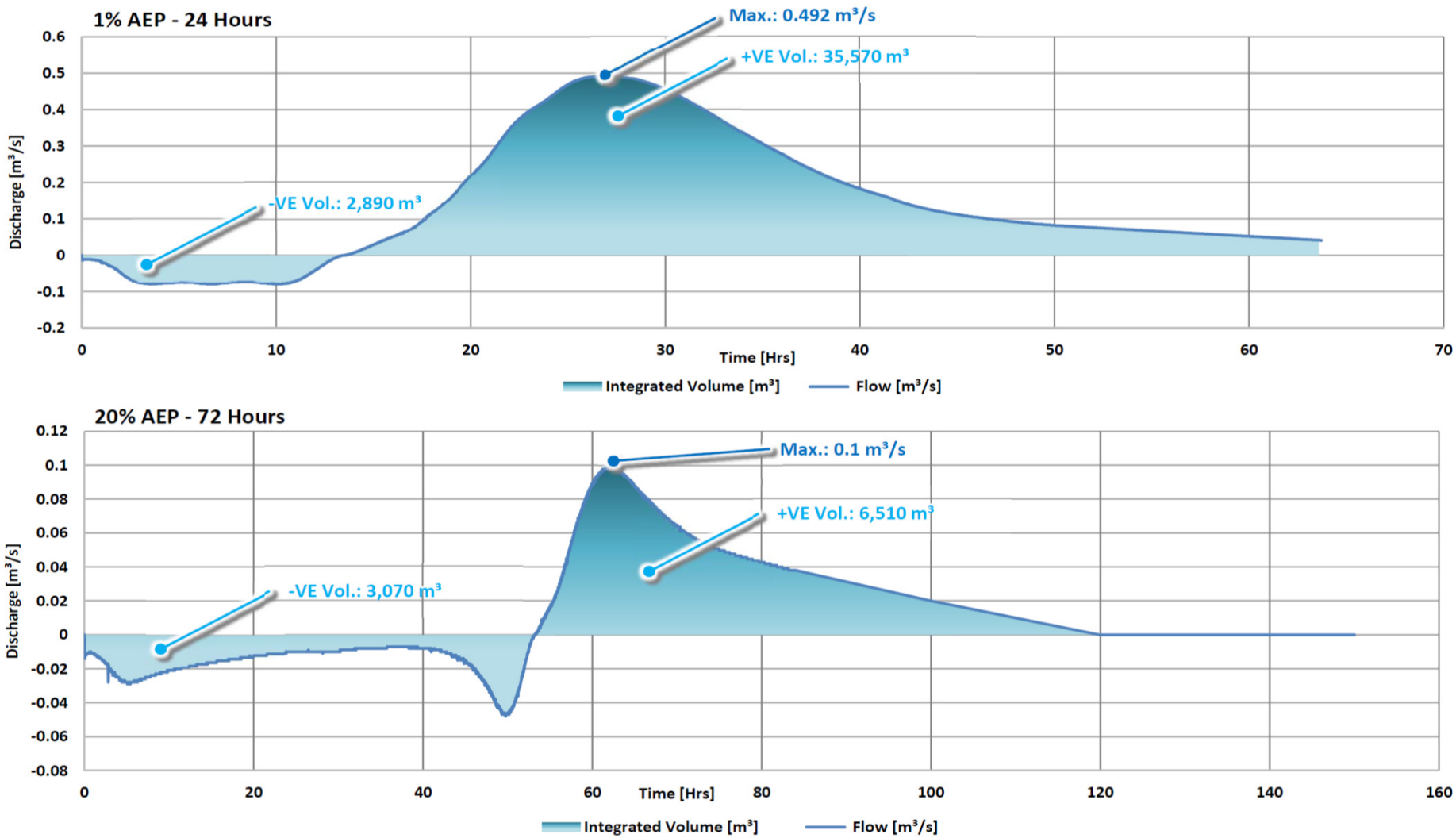
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Surface Water Plan

Figure 6

Date : 21/2/2023 Job No: H22018



Source : JDA (2019) : Predevelopment Hydrographs for critical duration events

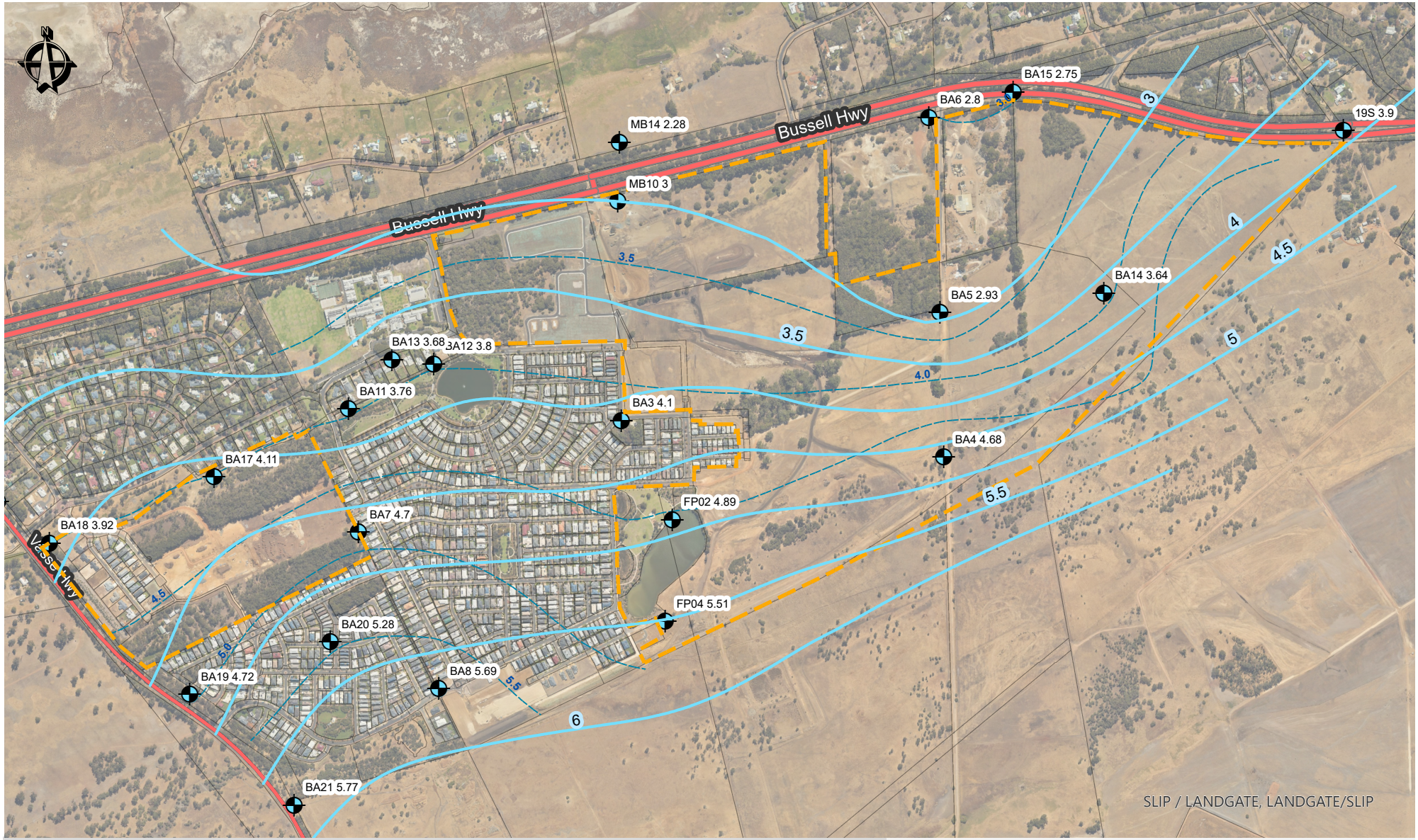
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Predevelopment Flow at Bussell Hwy to Reinscourt

Figure 7

Date: 20/02/2026 Job No. H22018



Site

Bore Locations & AAMGL (mAHD)

JDA (2019) AAMGL Contours

Updated AAMGL Contours based on Additional Data

0 75 150 300 450 600 Meters

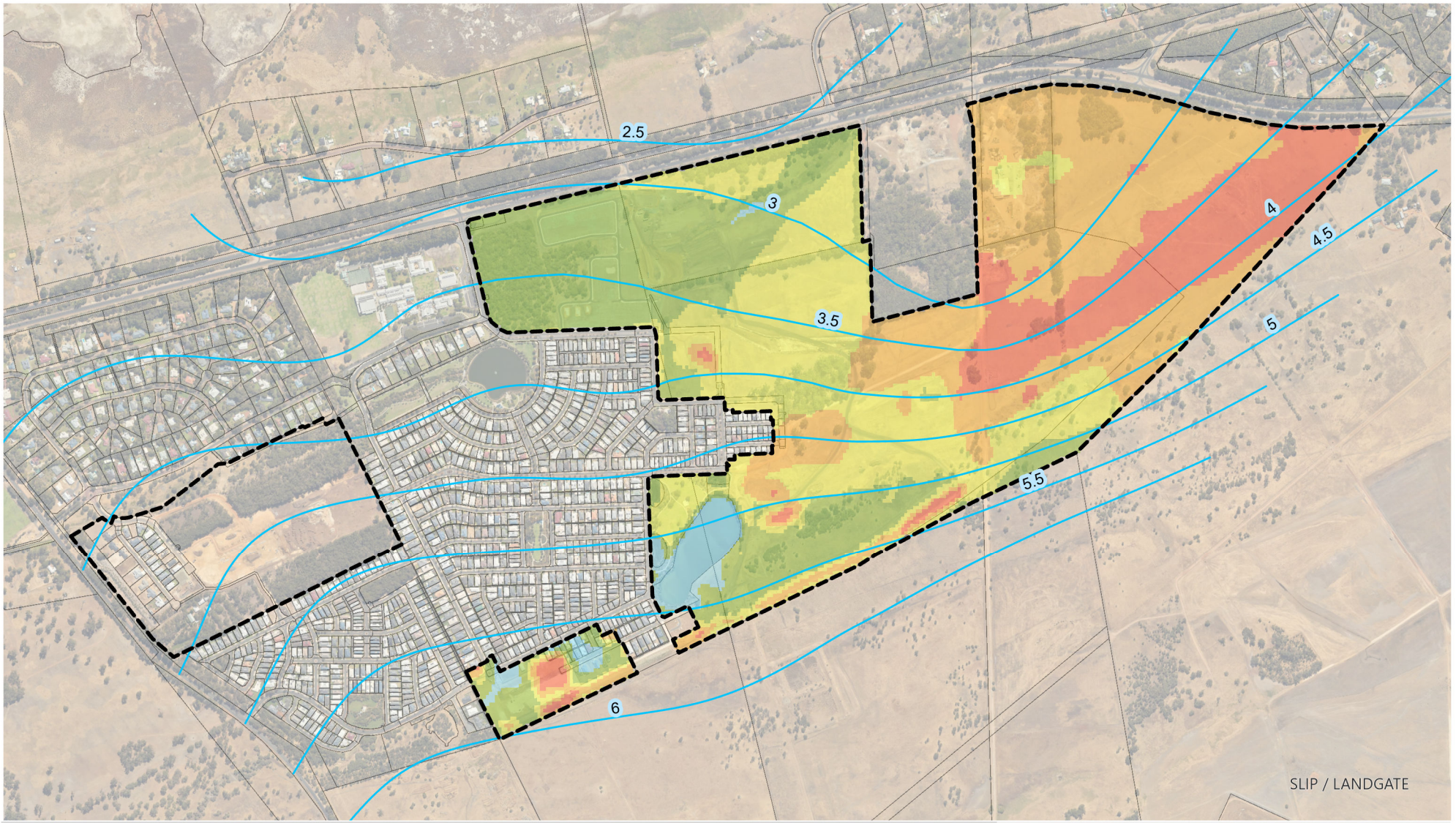
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Groundwater Plan

Figure 8

Date: 02/04/2025 Job No. H22018



LWMS Site

AAMGL Contours

Depth to GW (from DWER 1m LiDAR)

- Less than 0 m
- 0 - 1 m
- 1 - 2 m
- 2 - 3 m
- 3 - 4.5 m

0 200 400 800 Meters

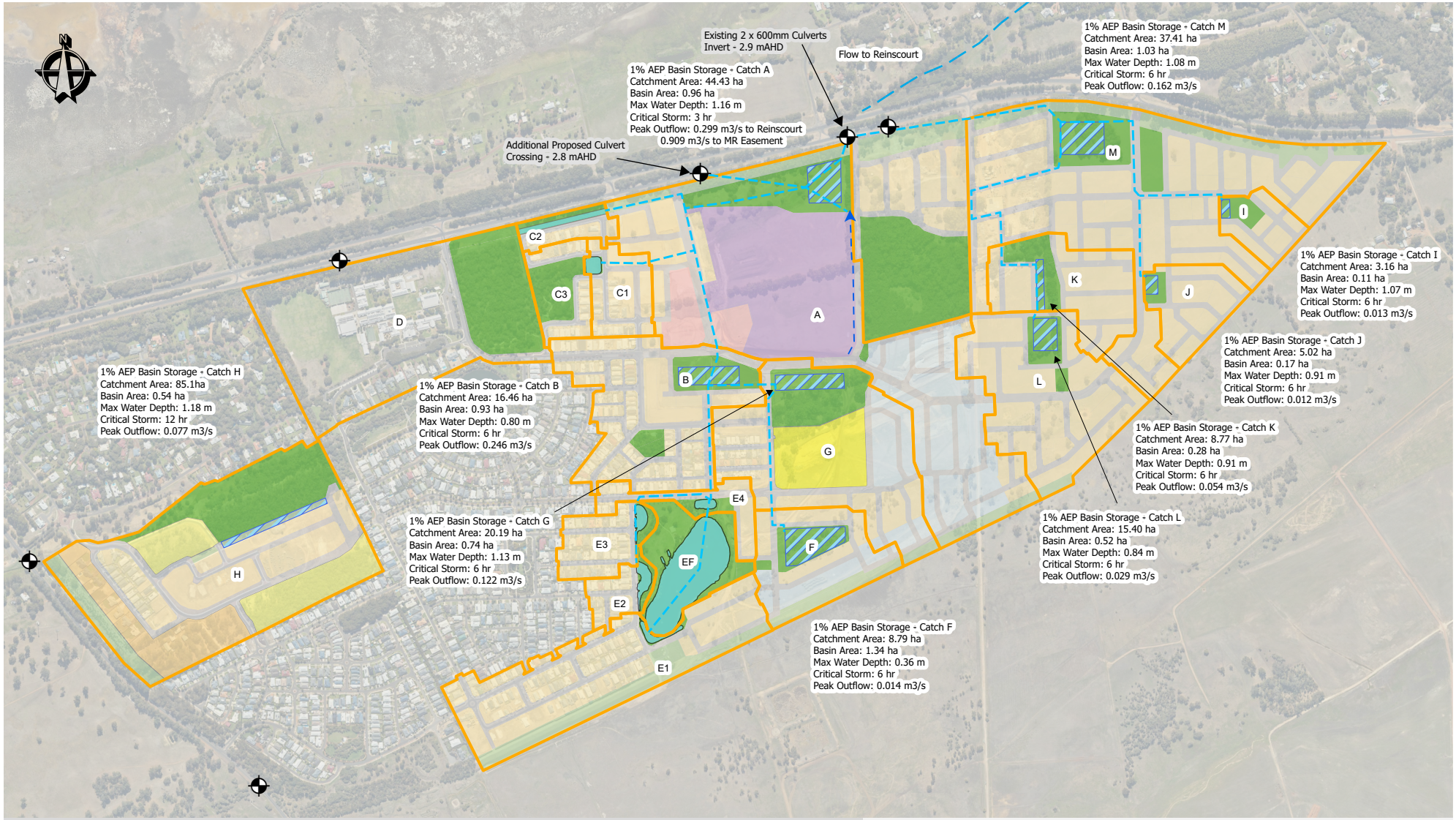
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Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Depth to Groundwater Plan

Figure 9

Date: 14/09/2026 Job No. H22018



Post Dev Catchments
Basins - Proposed
Basins - Existing
Culverts
Drainage Flow Path
Drainage Swale

Commercial
Landscape
Lots R2/R5
Lots R5/R10
Lots R25/R40 - Soakwells
Lots R25/R40 - Modelled Lot Connections

POS
Primary School
Retirement Village
Roads

0 125 250 375 500 Meters

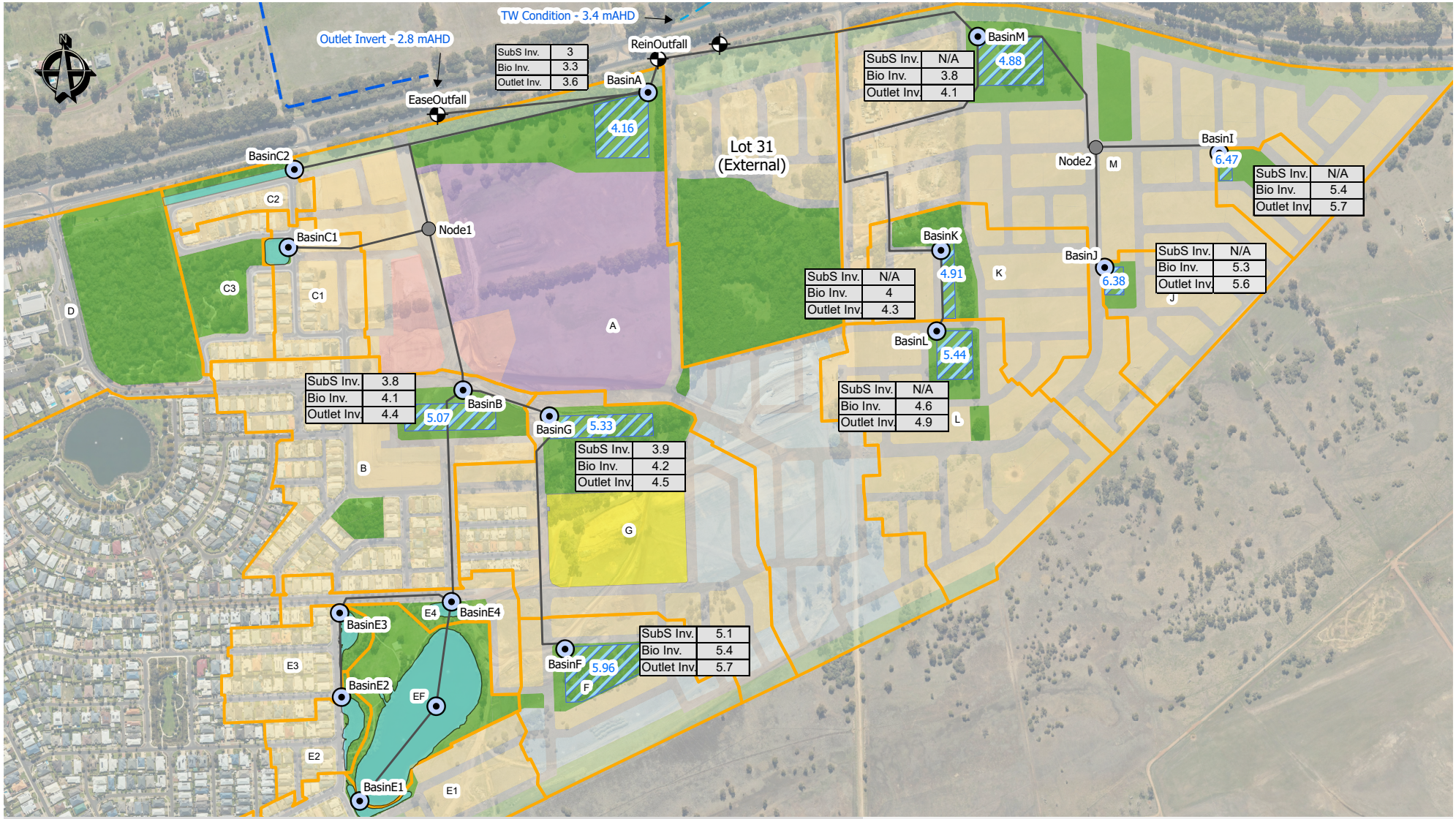
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Lot 2, 9032 & 9034 Bussell Highway Busselton LWMS

Stormwater Management Plan

Figure 10

Date: 14/09/2026 Job No. H22018



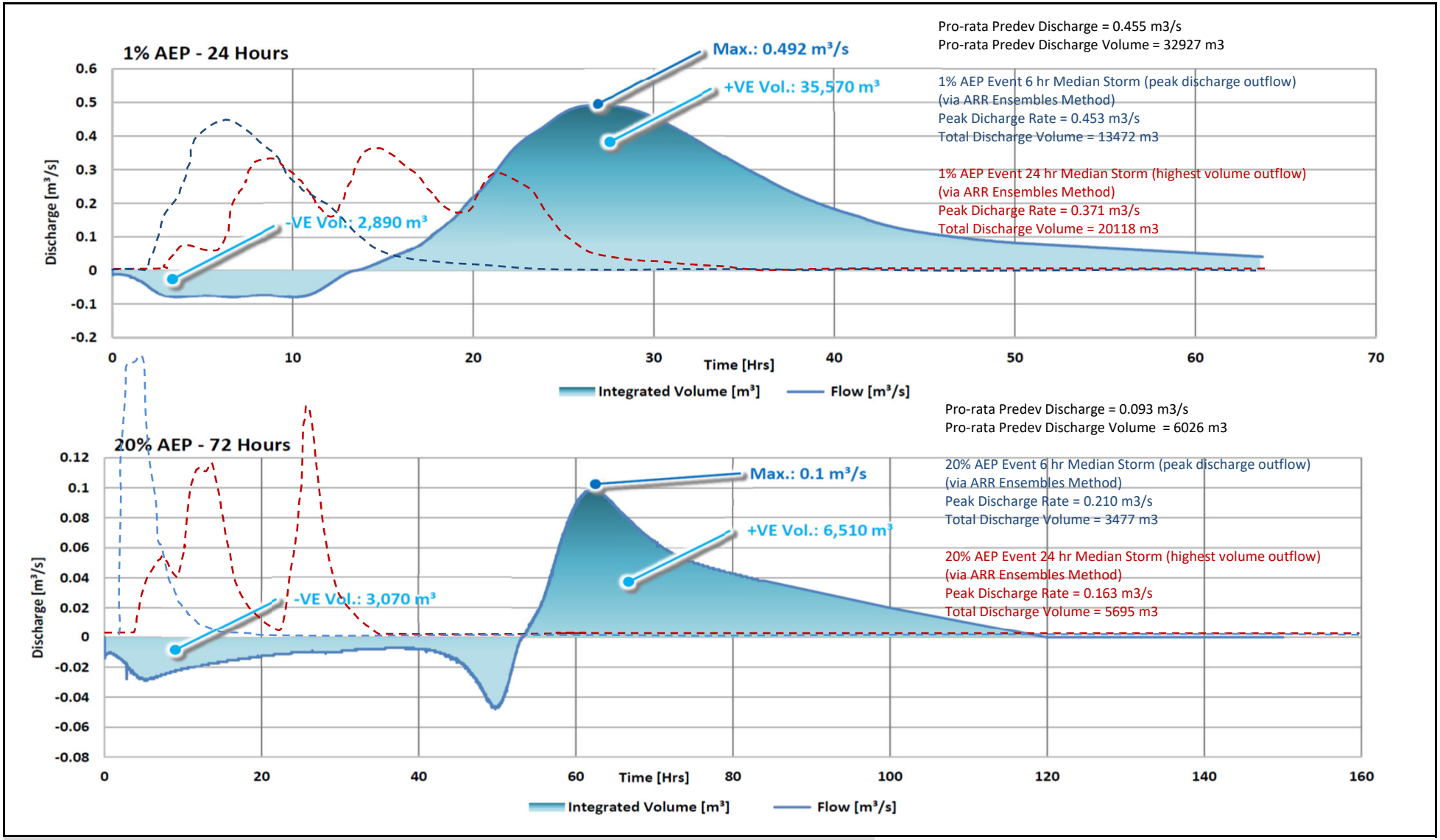
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Lot 2, 9032 & 9034 Bussell Highway Busselton LWMS

Stormwater System Critical System Points and Key Levels

Figure 11

Date : : 20/02/2026 Job No: H22018



Source : JDA (2019) : Predevelopment Hydrographs for critical duration events

Red hydrographs represent LWMS site outfall hydrographs post development at Bussell Hwy culvert for volume outflow critical event

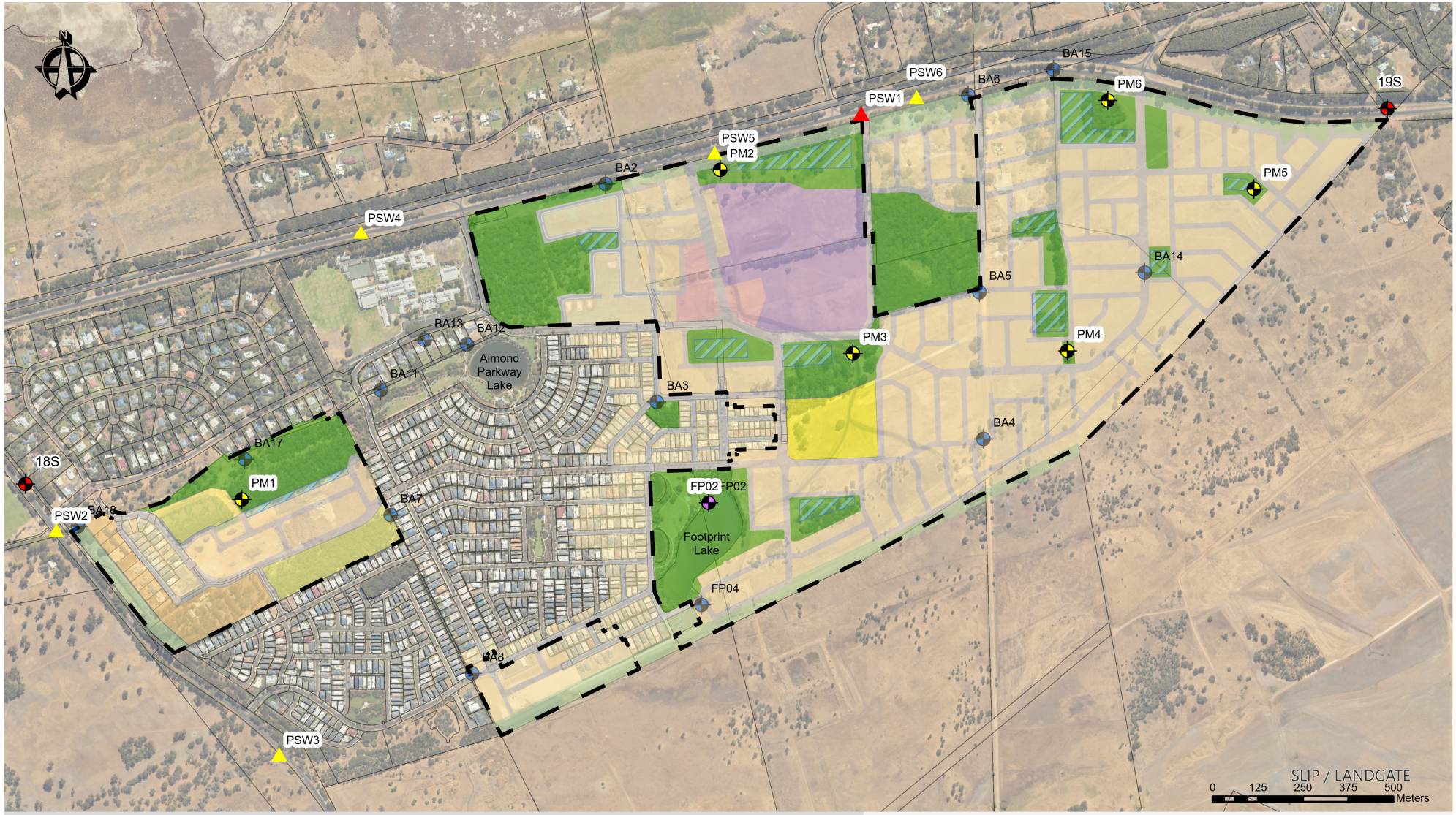
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Lot 2, 9012 & 9034 Bussell Hwy Busselton LWMS

Post Development Flows to Reinscourt

Figure 12

Date: 3/4/2025 Job No. H22018



Site
Commercial
Landscape
Lots R2/R5
Lots R25/R40
Lots R5/R10
Basins

POS
Primary School
Retirement Village
Roads

Surface Water Monitoring Location
Surface Water Monitoring Location (data logger to be installed)
Existing JDA Monitoring Bore (to be used on post development monitoring)
Post Development Monitoring Bores (to be installed)
DWER Monitoring Bores
Predevelopment JDA Monitoring Bores

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Lot 2, 9032 & 9034 Bussell Highway Busselton LWMS

Post Development Monitoring Plan

Figure 13

APPENDIX A
LWMS Checklist

Better Urban Water Management Checklist

Local Water Management Strategy Item	Deliverable	✓	Comments
Executive summary			
Summary of the development design strategy, outlining how the design objectives are poposed to be met	Table 1: design elements and requirements for BMP's and critical control points	☑	Executive Summary and Strategy Table
Introduction			
Total water cycle management - principles and objectives Planning background Previous studies		☑	Chapter 1
Proposed development			
Structure plan, zoning and land use Key landscape features Previous land use	Site context plan Local structure plan Site conditions plan	☑	Chapter 2, Figure 1, Figure 2, Figure 3
Landscape - proposed POS areas, POS credits, water source, bore(s), lake details (if applicable), irrigation areas	Landscape plan	☑	Appendix L & M. Stormwater Areas and Volumes to inform POS credits identified (Figure 10, Chapter 6). Water Availability identified (Section 5.3, Appendix M)
Design criteria			
Agreed design objective and source of objective		☑	Chapter 4, Appendix B
Pre-development environment			
Existing information and more detailed assessments (monitoring). How do the site characteristics affect the design?		☑	Chapter 3
Site conditions- existing topography/ contours, aerial photo underlay, major physical features	Site condition plan	☑	Section 3.1, Figure 3
Geotechnical - topography, soils including acid sulfate soils and infilteration capacity, test pit locations	Geotechnical plan	☑	Section 3.2, Figure 4, Appendix D, E
Environmental- areas of significant flora and fauna, wetlands and buffers, waterways and buffers, contaminated sites	Environmental plan plus supporting data where appropriate	☑	Section 3.3 & 3.4, Figure 5, Appendix F
Surface water- topography, 100 year floodways and flood fringe areas, water quality of flows entering and leaving (if applicable)	Surface water plan	☑	Section 3.5, Figure 6&7, Appendix G
Groundwater - topography, pre development groundwater levels and water quality, test bore locations	Groundwater plan plus details of groundwater monitoring and testing	☑	Section 3.6, Figure 8 & 9, Appendices J & K
Water use sustainability initiatives			
Water efficiency measures- private and public open spaces including method of enforcement		☑	Section 5.1
Water supply (fit- for-purpose strategy), agreed actions and implementation. If non-potable supply, support with water balance		☑	Section 5.3, Appendix M
Wastewater management		☑	Section 5.2
Stormwater management strategy			
Flood protection - peak flow rates, volumes and top water levels at control points, 100 year flow paths and 100 year detentions storage areas	100yr event plan Critical points	☑	Section 6.2, Table 11, Figures 11, 12, Appendix P,Q & R
Manage serviceability - storage and retention required for the critical 5 year ARI storm events Minor roads should be passable in the 5 year ARI event	5yr event plan	☑	Section 6.2, Table 11, Figure 12
Protect ecology - detention areas for the 1 yr 1 hr ARI event, areas for water quality treatment and types of (including indicative locations for) agreed structural and non-structural best management practices and treatment trains. Protection of waterways, wetlands (and their buffers), remnant vegetation and ecological linkages	1 yr event plan T	☑	Section 6.1 and Section 6.3, Table 10

Local Water Management Strategy Item	Deliverable	✓	Comments
Groundwater management strategy			
Post development groundwater levels, fill requirements (including existing and likely final surface levels), outlet controls, and subsoil areas/exclusion zones	Groundwater/subsoil Plan	☑	Section 7.1, Appendix T, Figure 11
Actions to adress acid sulphate soils or contamination		☑	Section 7.2, Figure 4
The next stage - subdivision and urban water management plans			
Content and coverage of future urban water management plans to be completed at subdivision. Include areas where further investigations are required prior to detailed design		☑	Section 8
Monitoring			
Recommended future monitoring plan including timing, frequency, locations and parameters, together with arrangements for ongoing actions		☑	Section 9, Tables 17-19, Figure 14
Implementation			
Developer commitments		☑	Chapter 9 & 10, Table 21
Roles, responsibilities, funding for implementation		☑	Chapter 10, Table 21
Review		☑	Chapter 10, Table 21

APPENDIX B

DCCEEW Development Conditions (2025)
& Evaluation Responses

Australian Government
Department of Climate Change, Energy, the Environment and Water

East Busselton 'Provence' Estate Development, Busselton, WA (EPBC No 2004/1878)

This decision to vary conditions of approval is made under section 143 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Approved action

approval holder	Almond Lake Pty Ltd 655 803 222
approved action	To develop the East Busselton Estate, on Lots 2, 9003 and 202 Bussell Highway and Vasse Highway, Western Australia, and associated infrastructure and activities (EPBC 2004/1878) See EPBC Act referral 2004/1878

Variation

variation of conditions attached to approval	The variation is: Vary conditions 2, 4, 5 and 6 attached to the approval as specified in the table below. Include new conditions 5A, 5B and 5C as specified in the table below. Vary figures – delete 'Attachment A' attached to the approval and substitute with the 'Figure 1' specified below. Add, vary and revoke definitions of as specified in the table below.
date of effect	This variation has effect on the date this instrument is signed.

Person authorised to make decision

name and position	signature block
signature	
date of decision	[date]

Date of decision	Conditions attached to approval
Original dated 3 April 2006	1) The person taking the action must construct the residential development on Lots 2, 9003 and 202, in accordance with the site plan provided in Annexure 2.
As varied on the date this instrument was signed	2) The person taking the action must ensure a minimum of 6.5 ha of remnant peppermint (*Agonis flexusosa*) is placed under **Management Order** for the designated purpose of conservation. The **Management Order** must include the areas listed as Public Open Space to be Placed Under **Management Order** (Conservation) shown on the site plan provided in Figure 1. The **Management Order** must ensure that the *Agonis flexusosa* is protected and maintained as long-term breeding and foraging habitat for the western ringtail possum (*Pseudocheirus occidentalis*).
Original dated 3 April 2006	3) The person taking the action must prepare and submit for the **Minister's** approval, a Western Ringtail Possum (*Pseudocheirus occidentalis*) Management **Plan** (the Plan). The **plan** must address the objective of long-term preservation of the Western Ringtail Possum and connectivity of its habitat on site. The **plan** must address the matters listed below and clearly state the performance criteria, monitoring and reporting actions, responsibility and timing of each. The **plan** must include: a) maps of the **construction** zone showing the areas to be cleared and the location of temporary fencing required to protect the remaining native vegetation during **construction** activities; b) clearly identified existing Western Ringtail Possum habitat and proposed additional habitat; c) planting of Agonis flexuosa to improve Western Ringtail Possum habitat corridors across the site; d) arrangements for the long-term management of conservation areas on site; e) conservation management measures to manage; i) rehabilitation; ii) habitat protection; iii) predator management; iv) fire management; f) maps of the areas for preservation of existing habitat in any public open space areas (not included in the conservation areas identified at Annexure 2) and designated building envelopes;

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Date of decision	Conditions attached to approval
	g) measures to mitigate impacts on the Western Ringtail Possum during vegetation clearing; h) a strategy prepared in consultation with a suitably qualified arborist to protect trees utilised by Western Ringtail Possums from impacts associated with infilling works throughout the site; i) environmental awareness training for all staff, contractors and other personnel working on the development site; j) interpretation and education strategies; and k) monitoring and review of the **plan**. Works must not commence on the site before the above **plan** is approved. The approved **plan** must be implemented.
As varied on the date this instrument was signed	4) The person taking the action must design and implement a Water Management Strategy (a Strategy) which is consistent with requirements of WAPC's Better Urban Water Management (BUWM) framework and implements water sensitive urban design principles and practices including, – a review of the **environmental values and water quality objectives** and **pollutant load targets** for the Vasse Wonnerup wetlands, including how those values, objectives and targets have informed the **environmental performance targets** developed in the Strategy; – **environmental performance targets** in order for the activity to, as a minimum, contribute to attainment of those **water quality objectives** and load targets. **Environmental performance targets** are to be defined in a manner consistent with the BUWM; – a commitment to supply surface and groundwater data, derived from implementation of the Strategy, to the Western Australian **Department of Water and Environmental Regulation**; – the nature, location and maintenance requirements for structural and non-structural water sensitive urban design practices, including as they relate to achieving performance targets. The assumptions relating to pollutant removal efficiencies of those practices must be clearly documented for future verification and supplied to the **department** upon request; – annual reporting to the **department**, via an **annual compliance report** which describes the status of the project, the results from monitoring and predictive modelling activities, – assesses those results against attainment of environmental performance targets, and describes management interventions taken in response to any failure or anticipated failure to achieve the environmental performance targets; and – The person taking the action must commence implementing the approved Strategy no later than when commencing **construction** and

Date of decision	Conditions attached to approval
	must continue to implement the approved Strategy at least until it has provided evidence to the **department** that a WA Government land management authority has assumed responsibility for the **project area** and that the WA Government land management authority is satisfied that the person taking the action has provided sufficient funds to that WA Government land management authority to implement the Strategy for at least the following two years.
As varied on the date this instrument was signed	5) The Strategy is to include a Contingency Management **Plan** (CMP) which describes: – surface and groundwater monitoring pre, during and post development (for subdivision and **construction**) in order to track attainment of **environmental performance targets** for total suspended solids, and total and dissolved inorganic nitrogen and phosphorus. Monitoring regimes (including the nature, timing and frequency of monitoring activities, the relationship between monitoring activities and hydrologic conditions) are to be described; – management measures that will be taken by the proponent, and options for adjusting existing and proposed practices over the duration of the project, in response to measured or predicted failure to meet **environmental performance targets** during the period of the CMP. This is to include a description of circumstances where a stop work order will be issued by the proponent during **construction** due to failure to meet environmental performance targets. The CMP is to be effective for the duration of the project, and for a period of five years following transfer of responsibility for the project to a land management authority. The proponent will provide funds to that land management authority to implement the CMP for the first two years of that five year period.
As varied on the date this instrument was signed	5A. The approval holder may choose to revise a **plan** required to be implemented under conditions 4 and 5 without submitting it for approval under section 143A of the **EPBC Act**, if: a) the taking of the Action in accordance with the revised **plan** would be consistent with the approved Action, b) the taking of the Action in accordance with the revised **plan** would be consistent with the conditions attached to this approval, c) the taking of the Action in accordance with the revised **plan** would not be likely to have a **new or increased impact**, and d) the approval holder notifies the **department** electronically that it has prepared a revised version of the **plan** (the 'revised **plan**'). In

Date of decision	Conditions attached to approval
	notifying the **department**, the approval holder must specify each condition which references the **plan** and provide the **department** with: i. an electronic copy of the revised **plan**, ii. an electronic copy of the revised **plan** marked up with track changes to show the differences between the **plan** and the revised **plan**, iii. a comprehensive explanation of all differences between the **plan** and the revised **plan**, iv. a declaration that the approval holder has read and understands the *Guidance on 'new or increased impact' relating to changes to approved management **plans** under **EPBC Act** environmental approvals*, Commonwealth of Australia 2017, v. a comprehensive analysis and detailed discussion on the likelihood that taking the Action in accordance with the revised **plan** will not have, or will be not likely to have, a **new or increased impact**, vi. written notice of the date on which the approval holder will implement the revised **plan** (the 'revised **plan** implementation date'), being at least 30 **business days** after the date of providing notice of the revision of the **plan**, or a date agreed to in writing with the **department**, and vii. a copy of the **compliance report** for the latest **ACR period** and a statement of any relevant history of compliance (including non-compliance) in relation to the **plan**. The approval holder must commence implementation of the revised **plan** from the revised **plan** implementation date unless otherwise notified in writing by the **Minister**.
As varied on the date this instrument was signed	5B. If the **Minister** notifies the approval holder that the **Minister** is satisfied that the taking of the Action in accordance with a **plan** which has been revised without submitting it for the **Minister's** approval would be likely to have a **new or increased impact**, then: a) the approval holder's ability to revise a **plan** without submitting the **plan** for **Minister** approval does not apply, or ceases to apply, in relation to the revised **plan**,

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Date of decision	Conditions attached to approval
	b) the approval holder must implement the **plan** in force immediately prior to that revised **plan** or a version of the **plan** specified by the **Minister** in the notice, and the **Minister** may also notify that, for a specified period, the approval holder's ability to revise a **plan** without submitting the **plan** for **Minister** approval does not apply for one or more specified **plans**.
As varied on the date this instrument was signed	5C. The approval holder may, at any time by giving written notice to the **department**, revoke its choice to implement a **plan** which has been revised without submitting it for the **Minister**'s approval. If the approval holder revokes the choice to implement a revised **plan**, the approval holder must implement the **plan** in force immediately prior to that revised **plan**.
As varied on the date this instrument was signed	6) If any environmental monitoring performance target specified in the approved Strategy is exceeded or predicted by modelling to be exceeded, the person taking the action must: a. within 2 **business days** of becoming aware of an exceedance or predicted exceedance notify the **department** of this and of the measures the person taking the action will take to mitigate any exceedance or to prevent an exceedance re-occuring; and b. within 14 days of notifying the **department** of an exceedance or predicted exceedance, notify the **department** of i) the measures that have been taken to mitigate or prevent that exceedance, and the effectiveness of those measures, and ii) the measures the person will take to prevent and/or minimise the likelihood of any similar future exceedance.
Variation dated 22 July 2008	7) **REVOKED**
Variation dated 22 July 2008	8) **REVOKED**
Original dated 3 April 2006	9) If, at any time after 5 years from the date of this approval, the **Minister** notifies the person taking the action in writing that the **Minister** is not satisfied that there has been substantial commencement of the residential development on Lots 2, 9003 and 202, the residential development on Lots 2, 9003 and 202 must not thereafter be commenced.

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Date of decision	Definitions attached to approval
Added on the date this instrument was signed	**Annual Compliance Report period or ACR period** means each subsequent 12-month period following the date of this approval decision until the expiry date of this approval, unless otherwise specified in writing by the **Minister**.
Added on the date this instrument was signed	**Business day** means a day that is not a Saturday, a Sunday, or a public holiday in Western Australia.
Added on the date this instrument was signed	**Compliance report** means a written report of compliance with, and fulfilment of, the conditions attached to the approval.
Revoked on the date this instrument was signed	**Conservation covenant -** REVOKED
Added on the date this instrument was signed	**Construction** means the erection of a building or structure that is, or is to be, fixed to the ground and wholly or partially fabricated on-site; the alteration, maintenance, repair or demolition of any building or structure; any work which involves breaking of the ground (including pile driving) or bulk earthworks; the laying of pipes and other prefabricated materials in the ground, and any associated excavation work; but excluding the installation of temporary fences and signage. Construction does not include geotechnical studies, the installation of SPEL filters or any earthworks or activities completed prior to 30 April 2025 not associated with the building of structures or roads.
Added on the date this instrument was signed	**Department** means the Australian Government agency responsible for administering the **EPBC Act**.
As varied on the date this instrument was signed	**Department of Water and Environmental Regulation** means the Western Australian department administering water.
As varied on the date this instrument was signed	**Environmental performance targets** may be based on 'trigger' values published in the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000* or the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2022) Framework.

DRAFT

As varied on the date this instrument was signed	**Environmental values (EVs) and water quality objectives (WQOs)** are to be described consistent with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality, National Water Quality Management Strategy, 2000 and Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG 2022) Framework. EVs and WQOs must be sought from the **Department of Water and Environmental Regulation**.
Added on the date this instrument was signed	**EPBC Act** means the *Environment Protection and Biodiversity Conservation Act 1999* (Cth).
Added on the date this instrument was signed	**Management Order** means a **Management Order** in accordance with the *Land Administration Act 1997* (WA), or another enduring protection mechanism agreed to in writing by the **department**, to provide protection for the site against development incompatible with conservation.
Added on the date this instrument was signed	**Minister** means the Australian Government Minister administering the EPBC Act, including any delegate thereof.
Added on the date this instrument was signed	**Plan** means any action management plan or strategy that the approval holder is required by these conditions to implement.
As varied on the date this instrument was signed	**Pollutant load targets** are to be derived from, in priority order and as they become available: a) the Vasse-Geographe Water Quality Improvement **Plan** (VGWQIP), b) draft load targets prepared by the **Department of Water and Environmental Regulation** for the purpose of developing a draft VGWQIP, and c) interim values prepared by the proponent and subject to suitably qualified third party audit and review.

Date of decision	**Attachments attached to approval**
As varied on the date this instrument was signed	**Figure 1 –** Site Plan

DRAFT

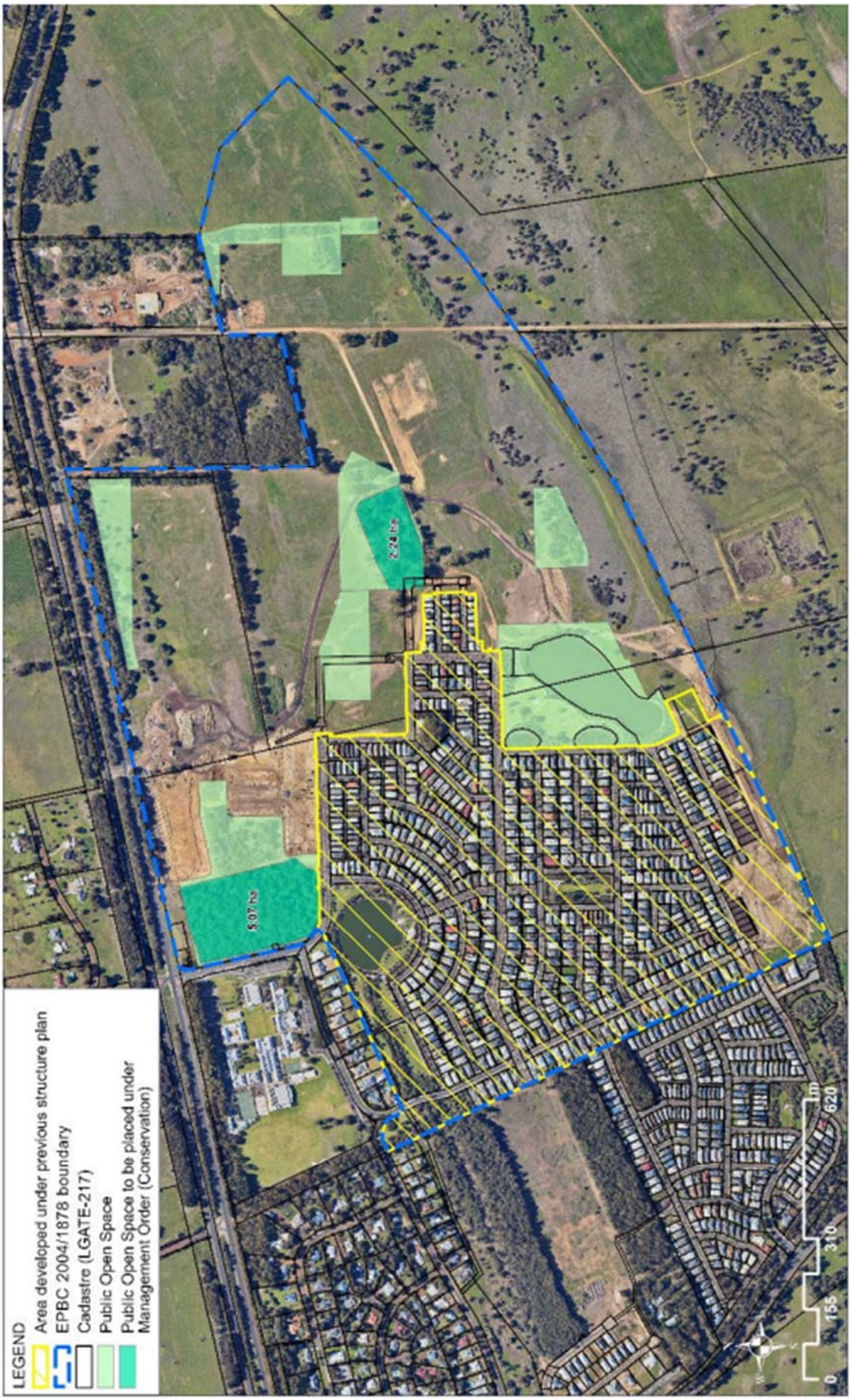
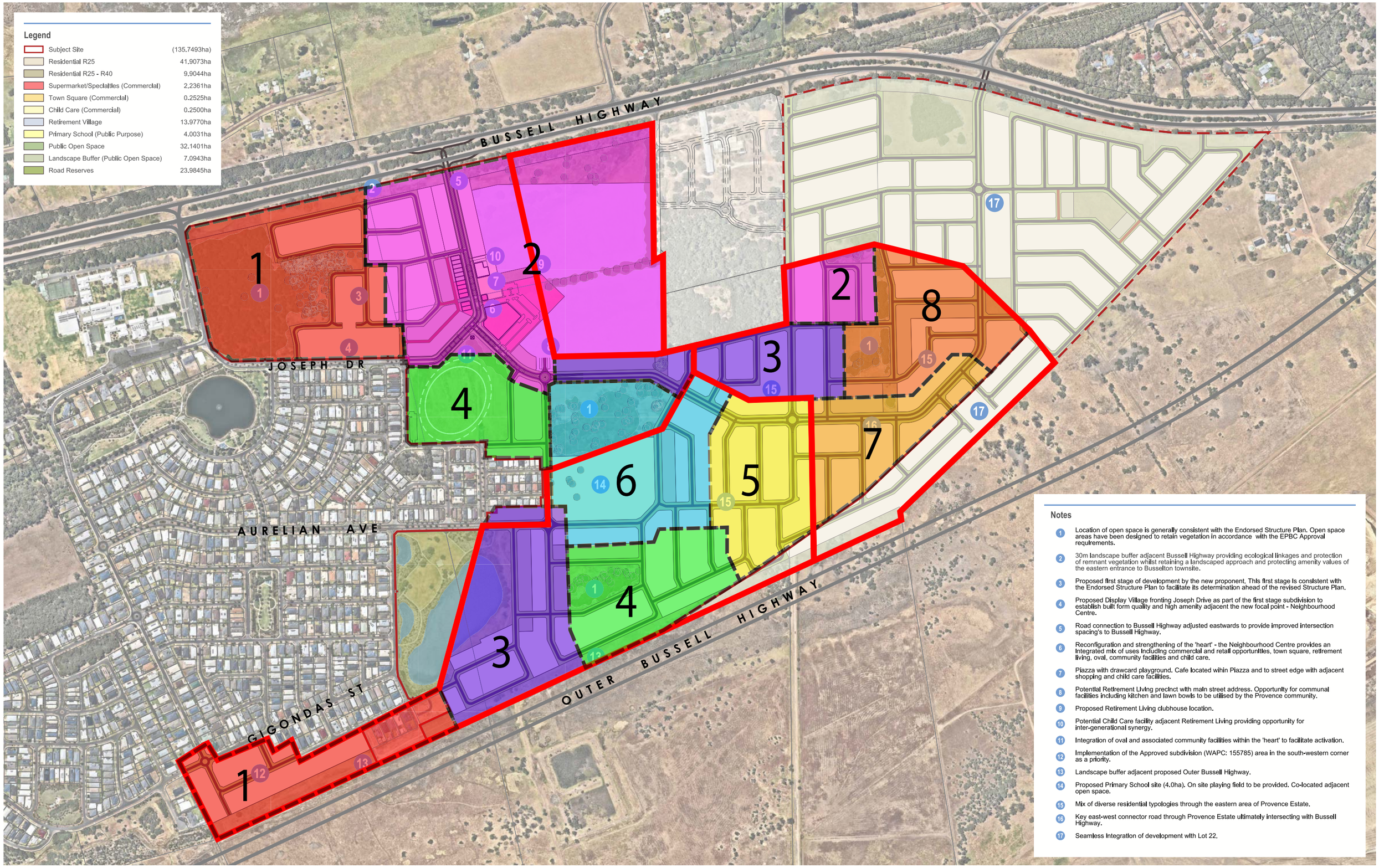


Figure 1: Site plan for EPBC approval 2004/1878 project area with updated POS

APPENDIX C
Staging Plan



Notes

1. Location of open space is generally consistent with the Endorsed Structure Plan. Open space areas have been designed to retain vegetation in accordance with the EPBC Approval requirements.
2. 30m landscape buffer adjacent Bussell Highway providing ecological linkages and protection of remnant vegetation whilst retaining a landscaped approach and protecting amenity values of the eastern entrance to Busselton townsite.
3. Proposed first stage of development by the new proponent. This first stage is consistent with the Endorsed Structure Plan to facilitate its determination ahead of the revised Structure Plan.
4. Proposed Display Village fronting Joseph Drive as part of the first stage subdivision to establish built form quality and high amenity adjacent the new focal point - Neighbourhood Centre.
5. Road connection to Bussell Highway adjusted eastwards to provide improved intersection spacing's to Bussell Highway.
6. Reconfiguration and strengthening of the 'heart' - the Neighbourhood Centre provides an integrated mix of uses including commercial and retail opportunities, town square, retirement living, oval, community facilities and child care.
7. Piazza with drawcard playground. Cafe located within Piazza and to street edge with adjacent shopping and child care facilities.
8. Potential Retirement Living precinct with main street address. Opportunity for communal facilities including kitchen and lawn bowls to be utilised by the Provence community.
9. Proposed Retirement Living clubhouse location.
10. Potential Child Care facility adjacent Retirement Living providing opportunity for inter-generational synergy.
11. Integration of oval and associated community facilities within the 'heart' to facilitate activation.
12. Implementation of the Approved subdivision (WAPC: 155785) area in the south-western corner as a priority.
13. Landscape buffer adjacent proposed Outer Bussell Highway.
14. Proposed Primary School site (4.0ha). On site playing field to be provided. Co-located adjacent open space.
15. Mix of diverse residential typologies through the eastern area of Provence Estate.
16. Key east-west connector road through Provence Estate ultimately intersecting with Bussell Highway.
17. Seamless Integration of development with Lot 22.

Structure Plan Concept

PROVENCE ESTATE, YALYALUP

A Yolk Property Group Project

scale: 1:8000@A3 | 1:4000@A1

0 80 160m

plan: 22/010/010E

date: 9/05/2022

aerial: Jan 2022

Taylor Burrell Barnett Town Planning & Design
Level 7, 160 St Georges Terrace, Perth WA 6000
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ALL AREAS AND DIMENSIONS DISPLAYED ARE SUBJECT TO DETAIL SURVEY.

Taylor Burrell Barnett

APPENDIX D
Geotechnical Reports

Doc: GE2.4.8

Project No: D290141 **Job No: J418413/1**

21/10/2022

Almond Lake Pty Ltd
C/- Banner Asset Management Pty Ltd
Level 21/ 90 Collins Street
Melbourne Victoria 3000

Attention: Mr Tao Burton

GEOTECHNICAL ASSESSMENT AND PROPOSED EARTHWORKS RECOMMENDATIONS FOR

EMBARK SUBDIVISION - YALYALUP WA.

1. INTRODUCTION

At the request of ALMOND LAKE PTY LTD, (The Client) Structerre Consulting (Structerre) have undertaken a geotechnical assessment of the proposed Embark residential development, located in Yalyalup, WA.

This report summarises the geotechnical information from assessments conducted previously on the site by Structerre on behalf of Almond Lake Pty Ltd and Golder Associates on behalf of Wood & Grieve Engineers.

2. PREVIOUS GEOTECHNICAL ASSESSMENTS

2.1. Geotechnical Assessment and Report Golder Associates (2007)

A geotechnical assessment and report was conducted in 2007 by Golder Associates (Golder) titled “Remainder of Provence Residential Development Busselton Western Australia”, Golder reference 06642457-R01 dated August 2007 incorporating the area of the proposed Embark Estate in 2007.

The Golder report provided a summary of previous investigations conducted by Coffey Partners in 1995, Golder in 2004 and additional two staged investigation (September 2006 and April / June 2007) including Electric Friction Cone Penetrometer tests (EFCPT), backhoe excavated test pits, Dynamic Cone Penetrometer tests (DCP) and or Perth Sand Penetrometer tests. Samples were collected from test pitting and further laboratory analysis was conducted by Golder’s in-house testing facility.

The field and laboratory results from the assessments identified three (3) separate geological zones within the site, labelled Zone 1, Zone 2 and Zone 3.

The proposed Embark residential development is located within the areas depicted by Golder as Zone 1 and Zone 2.

Zone 1 consists predominately of natural sands overlying limestone and the area depicted as Zone 2 included ground conditions consisted with Zone 1 however interspersed with reworked sands and sand residues from previous mining activities conducted over the site.

Recommendations for development and remediation of the Zones 1 and 2 areas consisted of the following:

Zone 1 – Proposed Earthworks Remediation

Standard earthworks consisting of stripping of vegetation and topsoils, proof compaction of the excavated base followed by placement and compaction of structural filling to design levels.

Zone 2 – Proposed Earthworks Remediation

Topsoil and vegetation removal, removal of any clay soils (or fines residue) to within 1m of design levels, proof compaction of the base of excavation and filling with clean granular fill to design levels.

2.2. Structerre Report on In-situ Sands (2022)

Representatives from Structerre have attended the site in March 2022 and conducted an assessment of the existing natural sand materials within the proposed Embark site to assess the suitability of the materials for reuse as structural (sand) fill.

The assessment consisted of soil retrieval probing over the site to ascertain the thickness of the sand cover in the northern section of the site for proposed borrow. Six boreholes were condcuted to a depth of up to -2.5m over this portion of the site providing a depth of insitu sand ranging from -0.6m to the south adjacent to the existing drain, extending to approximately -2m in thickness to the northern boundary of the site.

Based on the visual assessments conducted during the investigation, the natural sand materials encountered are considered suitable borrow material for use as free draining sand fill in the upper soil profile for residential developments.

3. EARTHWORKS RECOMMENDATIONS FOR CLASS S LOTS

Based on the field and laboratory assessments conducted within the proposed development area, the following methodology provides an earthworks program for the construction of residential Lots to provide "Class S" Lots as defined in AS2870 (2011):

- Stripping of all topsoils and vegetation.
- Excavation of clean free draining sand (above groundwater level) to stockpile for reuse in the upper free draining profile of the Lots.
- Proof compaction of the base of all excavated bases. Proof compaction to conducted with a vibrating flat drum or pad foot roller with a minimum mass of 12 tonnes to provide a minimum of (4) four passes allowing for a 20% overlap between each pass.
- General fill to be placed up to -1m below design levels. Placement and compaction of the general fill to be placed in layers (not greater than 300mm loose lift thickness per layer) and compacted to meet the requirements as set out in Table 5.1 of AS3798 (2007), Guidelines on earthworks for commercial and residential developments.

AS3798 (2007) Table 1.1 (Extract) – Compaction Requirements

Item	Application	Minimum relative compaction, %	
		Minimum density ratio (Standard Compaction Effort) (Cohesive soils)	Minimum density index (Cohesionless soils)
1	**Residential - lot, fill, house, sites**	**95**	**70**
2	Fill to support pavements *a)* General fill *b)* Subgrade (to a depth of 0.3m)	 95 98	 70 75

- The upper 1m of fill (to finished design levels) to be clean free draining sand fill, either won from the site or imported sand fill. Any import sand fill to have a fines content (material finer than 0.075mm) of not more than 5% by mass and insitu permeability of 5m/day when placed and compacted to 95% dry density ratio. The upper sand fill can be assessed using a Perth Sand Penetrometer, (PSP), however it is recommended a correlation between dry density ratio and PSP resistance be conducted on each material type / source prior to use to confirm adequate compaction as outlined in the above table has been achieved.
- Once structural filling is completed the resultant Lots will achieve a classification of Class "S" with Ys of <5mm.

4. LIMITATIONS

This report has been prepared in accordance with generally accepted consulting practice for ALMOND LAKE PTY LTD (ACN 655 803 222) using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

The conclusions and recommendations in this report are based information provided by others in conjunction with the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that actually exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions. If ground conditions encountered during construction are different to that described in this report, Structerre should be notified immediately.

Structerre shall not be liable in any respect whatsoever for any damage to buildings or infrastructures on, adjacent to, or surrounding the work site that may be caused by vibration, settlement of footings of buildings or any other damage occurring as a result of work by The Client or their subcontractor utilising the information provided by Structerre.

We trust this meets with your requirements. Should you require any additional information, or clarification of the above, please contact the undersigned.
For and behalf of
STRUCTERRE CONSULTING

Mel Castle
Geotechnical Division Manager

Disclaimer
This report is at the request of the addressee and no liability is accepted by Structerre Consulting Engineers to any third person reading or relying upon the report, not withstanding any rule of law and/or equity to the contrary and that this report is strictly confidential and intended to be read and relied upon only be the addressee.

Job #	Revision	Authored	Checked	Authorised
J418413/1	0	MEC	GH	MEC

Doc: GE2.4.8

Project No: D290141 **Job No: J404705**

11/4/2022

Almond Lake Pty Ltd
C/- Banner Asset Management Pty Ltd
Level 21/ 90 Collins Street
Melbourne Victoria 3000
Attention: Mr Tao Burton

PROVENCE 1 ESTATE (PROJECT YOLBUFEA) - LYDDY RD YALYALUP WA.

1. INTRODUCTION

At the request of ALMOND LAKE PTY LTD, (The Client) representatives from Structerre Consulting (Structerre) have undertaken a preliminary geotechnical assessment of the existing surcharge materials and potential sand borrow at the Provence Estate located in Yalyalup, WA.

This report details the scope of the geotechnical investigation, presents an interpretation of the ground conditions and geotechnical design parameters across the site. Interpretation of site conditions are based on the sub-surface lithology revealed during the investigation programme, visual assessments of the in situ materials and the results of in situ testing.

2. GEOTECHNICAL ASSESSMENT

2.1. Scope of Works

Representatives from Structerre visited the site on 30 March 2022 to assess the Insitu materials during test holing to assess the suitability of the stockpiled surcharge materials located to the south of the site and Soil Retrieval Probing of proposed sand borrow materials toward the northern portion of the site for reuse as structural fill materials within residential Lots of the development.

The following works were undertaken:

Stockpile Surcharge Area

- Observations of 8 x excavated test holes (by others) to a depth of approximately 4m for material assessment and soil profiling,
- Collect representative samples for material classification,
- Visual inspection of the fill profile and underlying exposed natural ground profile.

Proposed Sand Borrow Area

- 6 x excavated Soil Retrieval Probe holes to a maximum depth of 2.5m for material assessment and soil profiling

All fieldwork interpretation and terminology used in this report are in accordance with the guidelines presented in AS 1726-2017 Geotechnical Site Investigations.

2.2. Field Results – Surcharge Stockpile Material

Based on the site investigation, the surcharge stockpile consists generally of mixed fill materials including sands and clayey sands with some clay lump inclusions. Site plan outlining excavation locations are included in Appendix 1 of this report.

The subsurface soil profile at each test hole is presented in the table below:

Table 1 – Soil Profile (Surcharge Area)

Location	Material Description
1	FILL –Sand with clay inclusions
2	FILL –Sand with clay inclusions
3	FILL –Clayey Sand
4	FILL –Clayey Sand (sampled)
5	FILL –Sand with clay
6	FILL –Clayey Sand
7	FILL –Clayey Sand (sampled)
8	FILL –Clayey Sand

Samples of the excavated cuttings were selected from two of the test holes for laboratory analysis including Liquid Limit, Plastic Limit, Plasticity Index, Linear Shrinkage and Particle Size Distribution in accordance with AS1289 3.1.2, 3.2.1, 3.3.1, 3.4.1 and 3.6.1. Test results classify the sampled material as "**clayey Sand, trace gravel, of low plasticity**". The laboratory test results are attached to this report and summarised in Table 2, below:

Table 2 – Laboratory Test Results

Sample ID	Liquid Limit %	Plastic Limit %	Plasticity Index %	Linear Shrinkage %	Percent Fines %
Location 4	25	15	10	4	27
Location 7	34	14	20	9	27

Based on the laboratory test results and observations conducted onsite during the investigation, the stockpiled material will be suitable for reuse as structural fill subject to adequate blending of the variable materials contained. This can be achieved by excavation and placement using elevator scrapers, placing in thin layers and blending insitu prior to moisture conditioning and compacting as required. Once adequately blended, the structural fill can be placed in layers, (typically not exceeding 300mm loose lift thickness), compacted to achieve a minimum of 95% standard maximum dry density, as determined by AS1289 5.1.1 and 5.4.1.

Due to the percentage of fines, (material finer than 0.075mm = 27%), the blended material would not be considered as free draining and this should be allowed for within the design of stormwater drainage disposal for the proposed Lots.

2.3. Field Results – Sand Borrow Area

Soil retrieval probing was conducted over the site to ascertain the thickness of the sand cover in the northern section of the site for proposed borrow. Six boreholes were located to a depth of up to 2.5m over the portion of the site providing a depth of insitu sand ranging from 0.6m to the south adjacent to the existing drain, extending to approximately 2m in thickness to the northern boundary of the site. A site plan outlining the SRP locations are included in Appendix 1 of the report.

The SRP borehole logs are included in Appendix 3 of this report and summary of the observed sand profile and encountered water levels (from existing surface levels) is presented in the table below:

Table 3 – Inferred Subsurface Sand Profile

SRP Test Location	Depth to Base of Sand Layer (m)	Water Level @ 30/03/2022 (m)
SRP1	2.1	-2.4
SRP2	2.1	-2.1
SRP3	1.8	-2.4
SRP4	0.6	-1.5
SRP5	2.4	-2.4
SRP6	>2.5	>2.5

The sand materials encountered in Boreholes 1, 2, 3 and 5 and 6 would be considered suitable borrow material for use as free draining sand fill in the upper soil profile for residential developments.

Further review of the previous Geotechnical investigation and report conducted by Golder Associates, (reference 06642457-R01 dated August 2007), conducted on the remainder of the site indicate similar materials should continue along the northern boundary of this site.

Some natural sand deposits were identified within various test pits to the south of the existing drain, however locations are interspersed within the previous mineral sands mining backfill. Further investigation would be recommended to ascertain any future potential of winning of clean sands within this area.

3. LIMITATIONS

This report has been prepared in accordance with generally accepted consulting practice for ALMOND LAKE PTY LTD (ACN 655 803 222) using information supplied at the time and for the project specific requirements as understood by Structerre. To the best of our knowledge the information contained in this report is accurate at the date of issue, however it should be emphasised that any changes to ground conditions and/or the proposed structures may invalidate the recommendations given herein.

The conclusions and recommendations in this report are based on the site conditions revealed through selective point sampling, representing the conditions of the site in total, although the area investigated represents only a small portion of the site. The actual characteristics may vary significantly between successive test locations and sample intervals other than where observations, explorations and investigations have been made.

The materials and their geotechnical properties presented in this report may not represent the full range of materials and strengths that actually exist on site and the recommendations should be regarded as preliminary in nature. Allowances should be made for variability in ground conditions and any consequent impact on the development. Structerre accepts no responsibility and shall not be liable for any consequence of variations in ground conditions. If ground conditions encountered during construction are different to that described in this report, Structerre should be notified immediately.

Structerre shall not be liable in any respect whatsoever for any damage to buildings or infrastructures on, adjacent to, or surrounding the work site that may be caused by vibration, settlement of footings of buildings or any other damage occurring as a result of work by The Client or their subcontractor utilising the information provided by Structerre.

We trust this meets with your requirements. Should you require any additional information, or clarification of the above, please contact the undersigned.

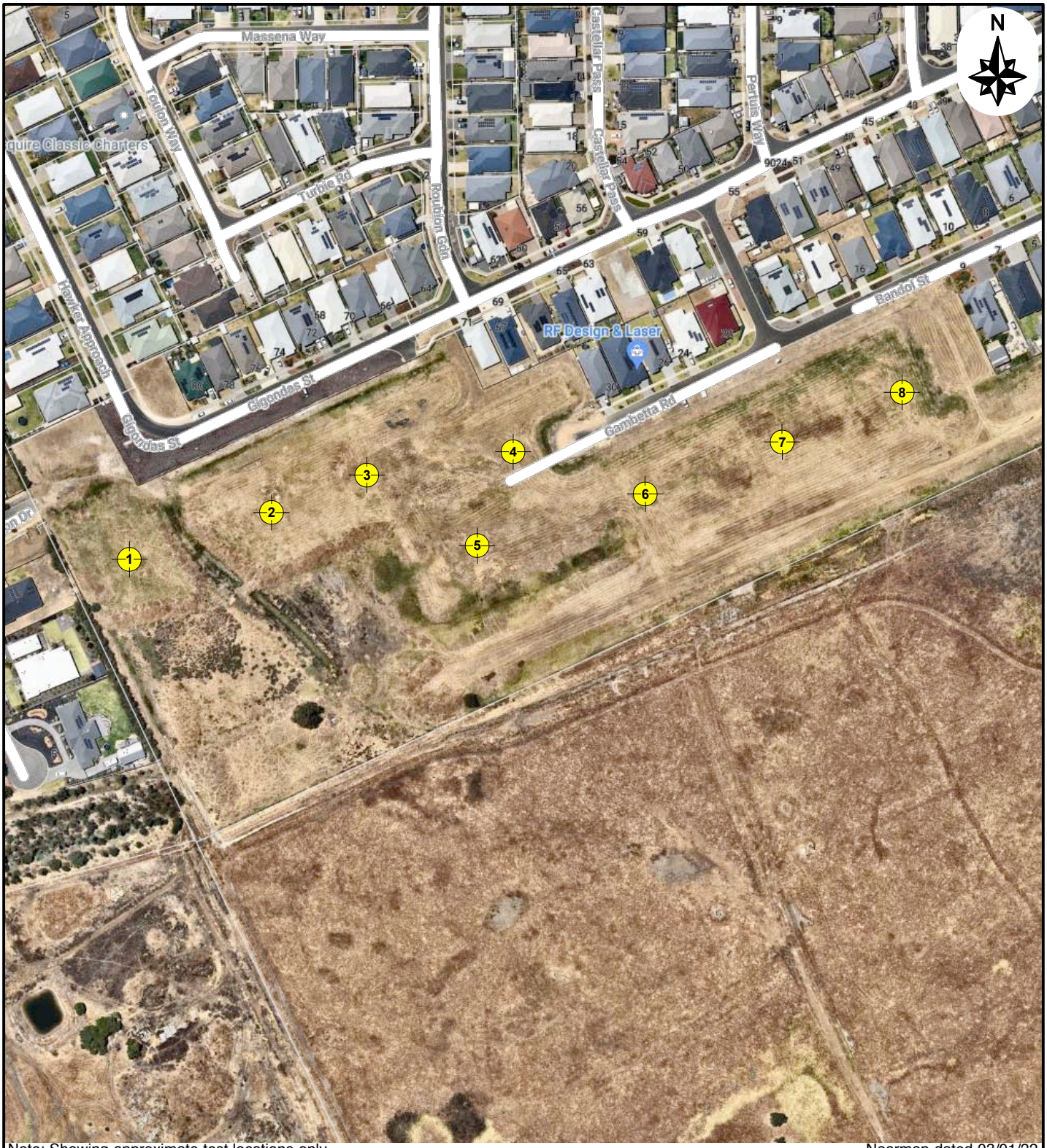
For and behalf of
STRUCTERRE CONSULTING

Author: Mel Castle
Title: Geotechnical Division Manager

Disclaimer
This report is at the request of the addressee and no liability is accepted by Structerre Consulting Engineers to any third person reading or relying upon the report, not withstanding any rule of law and/or equity to the contrary and that this report is strictly confidential and intended to be read and relied upon only be the addressee.

Job #	Revision	Authored	Checked	Authorised
J404705	0	MEC	GH	MEC

APPENDIX 1 - SITE PLANS



Note: Showing approximate test locations only

Nearmap dated 03/01/22

LEGEND

Excavation

STRUCterre consulting

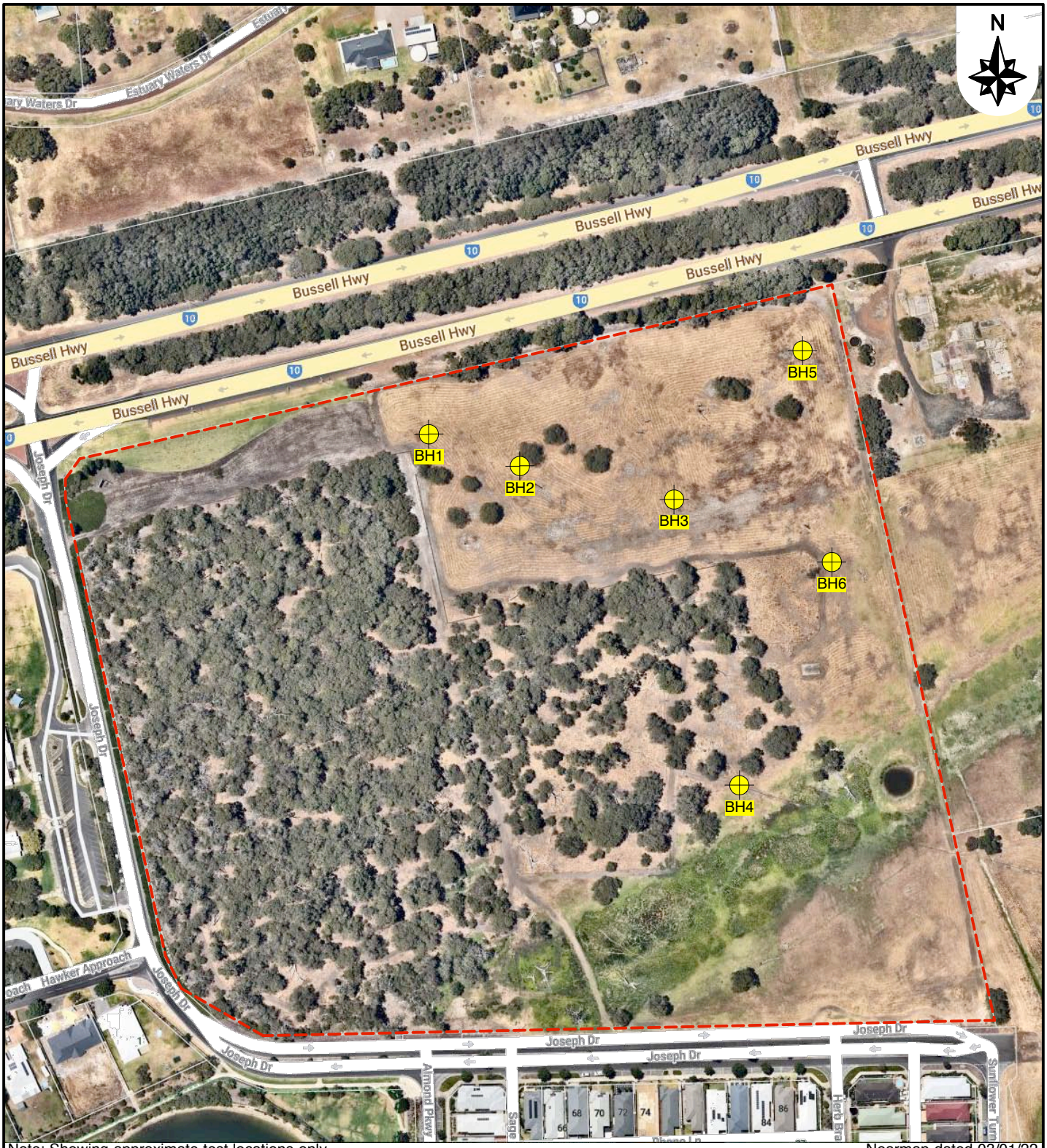
Zemla Pty Ltd (ABN 71 349 772 837) ATF the Young Purich and Higham Unit Trust trading as Structerre Consulting

1 ERINDALE ROAD, BALCATTA, WA 6021
TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT:	Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup
PROJECT #:	D290141
JOB #:	J404705
CLIENT:	Almond Lake Pty Ltd (ACN 655 803 222)
SCALE:	NTS
TITLE:	Geotechnical Investigation Site Plan Stockpile Surcharge Area
DATE:	30 Mar '22
DRAWN BY:	MM
CHECKED BY:	MC

DOC: GE:3.001

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Note: Showing approximate test locations only

Nearmap dated 03/01/22

LEGEND

BH Borehole

STRUCterre consulting

Zemla Pty Ltd (ABN 71 349 772 837) ATF the Young Purich and Higham Unit Trust trading as Structerre Consulting

1 ERINDALE ROAD, BALCATTA, WA 6021
TEL 9205 4500 FAX 9205 4501 EMAIL: wageotecheng@structerre.com.au

PROJECT: Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

PROJECT #: D290141

JOB #: J404705

CLIENT: Almond Lake Pty Ltd (ACN 655 803 222)

SCALE: NTS

TITLE: Geotechnical Investigation Site Plan Proposed Sand Borrow Area

DATE: 30 Mar '22

DRAWN BY: MM

CHECKED BY: MC

DOC: GE:3.001

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APPENDIX 2 – LABORATORY TEST RESULTS

Sample No.	**36404**	**Client**	Geotechnical
Job No.		**Project**	Provence 1 Estate - Lyddy Rd, Yalyalup

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

SAMPLE DETAILS

BH No. / Depth	TP4 -	Sampling Method	Client
Sample History	50°C Oven Dried	Sample Preparation	AS 1289 1.1

ATTERBERG LIMITS

Description	Method	Result (%)
Liquid Limit	AS 1289.3.1.2	25
Plastic Limit	AS 1289.3.2.1	15
Plasticity Index	AS 1289.3.3.1	10
Linear Shrinkage	AS 1289.3.4.1	4
Nature of Shrinkage		Flat

PARTICLE SIZE DISTRIBUTION

Method: AS 1289.3.6.1
Description: Particle size distribution by sieve analysis

Sieve Size (mm)	% Passing
19.0	100
2.36	99
0.425	83
0.075	27

AS 1726:2017 Clause 6.1
Material Description: Clayey SAND trace gravel
AS Group Symbol: SC

Accredited for compliance with ISO/IEC 17025
NATA
WORLD RECOGNISED ACCREDITATION
STRUCTERRE CONSULTING ENGINEERS BALCATTA LABORATORY ACCREDITATION NUMBER 18742

Jacob Pritchard
Senior Laboratory Technician

Date: 11-Apr-22

Sample No.	**36405**	**Client**	Geotechnical
Job No.		**Project**	Provence 1 Estate - Lyddy Rd, Yalyalup

Laboratory testing carried out at Malaga Laboratory 44 Crocker Dr Malaga WA 6090

SAMPLE DETAILS

BH No. / Depth	TP7 -	Sampling Method	Client
Sample History	50°C Oven Dried	Sample Preparation	AS 1289 1.1

ATTERBERG LIMITS

Description	Method	Result (%)
Liquid Limit	AS 1289.3.1.2	34
Plastic Limit	AS 1289.3.2.1	14
Plasticity Index	AS 1289.3.3.1	20
Linear Shrinkage	AS 1289.3.4.1	9
Nature of Shrinkage		Flat

PARTICLE SIZE DISTRIBUTION

Method: AS 1289.3.6.1
Description: Particle size distribution by sieve analysis

Sieve Size (mm)	% Passing
19.0	97
2.36	97
0.425	83
0.075	27

AS 1726:2017 Clause 6.1
Material Description: Clayey SAND trace gravel
AS Group Symbol: SC

Accredited for compliance with ISO/IEC 17025
NATA
WORLD RECOGNISED ACCREDITATION
STRUCTERRE CONSULTING ENGINEERS BALCATTA LABORATORY ACCREDITATION NUMBER 18742

Jacob Pritchard
Senior Laboratory Technician

Date: 11-Apr-22

APPENDIX 3 – BOREHOLE LOGS (SRP)

STRUCterre consulting engineers

Project Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

Client Almond Lake Pty Ltd (ACN 655 803 222)

Test No. **BH01**

Project No.	D290141	**Logged By**	Callum Vane	**Machine**	Soil Retrieval Probe	**Easting**	350361
Job No.	J404705	**Date**	30/03/2022	**Hole Dia.**	65mm	**Northing**	6274511

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	VL - L				D	
1		*trace gravel, yellow*	MD				D to M	
2		SC: Clayey SAND: fine to medium grained, low plasticity, trace gravel, yellow	D				M to W	▼
		SP: SAND: fine to medium grained, non-plastic, yellow					S	
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

Client Almond Lake Pty Ltd (ACN 655 803 222)

Test No. **BH02**

Project No.	D290141	**Logged By**	Callum Vane	**Machine**	Soil Retrieval Probe	**Easting**	350369
Job No.	J404705	**Date**	30/03/2022	**Hole Dia.**	65mm	**Northing**	6274521

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, grey (Sand derived from Tamala Limestone)	L - MD				D	
		pale yellow						
1			MD					
		yellow					M to W	
2			D					
		SC: Clayey SAND: fine to medium grained, low plasticity, with gravel, white					W	
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

WA | QLD | NSW | VIC

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ABN 71 349 772 837 Zemla Pty Ltd ACN 008 966 283 as trustee for the Young Purich and Higham Unit Trust trading as Structerre Consulting Engineers

STRUCterre consulting engineers

Project Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

Client Almond Lake Pty Ltd (ACN 655 803 222)

Test No. **BH03**

Project No.	D290141	**Logged By**	Callum Vane	**Machine**	Soil Retrieval Probe	**Easting**	350536
Job No.	J404705	**Date**	30/03/2022	**Hole Dia.**	65mm	**Northing**	6274458

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, brown (Sand derived from Tamala Limestone)					D	
		orange	L - MD				D to M	
1								
		SC: Clayey SAND: fine to medium grained, low plasticity, trace gravel, white	D				M to W	
2								
		SP: SAND: fine to medium grained, non-plastic, with gravel, orange					S	
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

Client Almond Lake Pty Ltd (ACN 655 803 222)

Test No. **BH04**

Project No.	D290141	**Logged By**	Callum Vane	**Machine**	Soil Retrieval Probe	**Easting**	350614
Job No.	J404705	**Date**	30/03/2022	**Hole Dia.**	65mm	**Northing**	6274168

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, brown (Sand derived from Tamala Limestone)	VL - L				D	
		SC: Clayey SAND: fine to medium grained, low plasticity, trace gravel, pale grey					M	
1		*with gravel, white*	MD - D				M to W	▼
		SP: SAND: fine to medium grained, non-plastic, orange	MD				S	
2		GP: GRAVEL: coarse grained, non-plastic, white	D - VD					
		Terminated at 2.10 m						
3								

Remarks

1. Termination reason: Refusal - interpreted on limestone
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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Project Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

Client Almond Lake Pty Ltd (ACN 655 803 222)

Test No. **BH05**

Project No.	D290141	**Logged By**	Callum Vane	**Machine**	Soil Retrieval Probe	**Easting**	350591
Job No.	J404705	**Date**	30/03/2022	**Hole Dia.**	65mm	**Northing**	6274564

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:						
		SP: SAND: fine to medium grained, non-plastic, dark grey (Sand derived from Tamala Limestone)					D	
		pale yellow	VL - L				D to M	
1								
		yellow	L - MD				M to W	
2								
		GP: Sandy GRAVEL: fine to medium grained, cream	D				S	
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

STRUCterre consulting engineers

Project Provence 1 Estate (Project Yolbufea) - Lyddy Road, Yalyalup

Client Almond Lake Pty Ltd (ACN 655 803 222)

Test No. **BH06**

Project No.	D290141	**Logged By**	Callum Vane	**Machine**	Soil Retrieval Probe	**Easting**	350542
Job No.	J404705	**Date**	30/03/2022	**Hole Dia.**	65mm	**Northing**	6274172

Depth	Graphic	Stratum Description	Consistency	PSP Blows/300mm (4 8 12 16)	Samples Depth	Samples Type	Moisture	Water Level
		Topsoil:	L - MD				M to W	▼
		SP: SAND: fine to medium grained, non-plastic, yellow (Sand derived from Tamala Limestone)						
1								
2								
		Terminated at 2.50 m						
3								

Remarks

1. Termination reason: Target depth
2. Hole stability: Hole stable
3. Samples taken: None
4. Co-ordinate system: WGS 84

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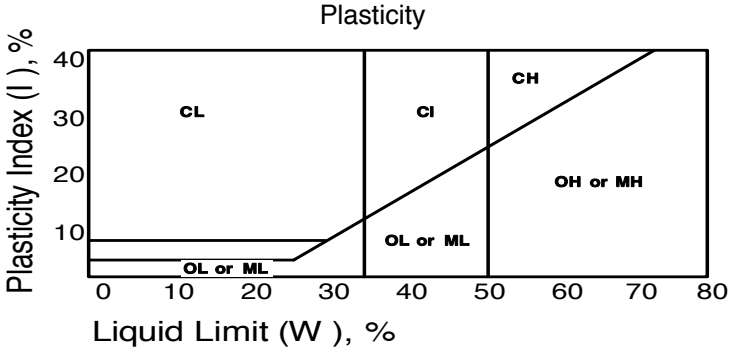
Inspect & Investigate | Energy Assessment | Environmental

BOREHOLE TERMINOLOGY

Particle Size Distribution

Major Division	Subdivision	Size
Boulders		>200mm
Cobbles		200 - 63mm
Gravel	Coarse	63 - 20mm
	Medium	20- 6mm
	Fine	6 - 2.36mm
Sand	Coarse	2.36 - 0.6mm
	Medium	0.6 - 0.2mm
	Fine	0.2 - 0.075mm

Plasticity



Consistency of Cohesive Soils

Term	Undrained Strength Su (kPa)	Field Guide
Very Soft	< 12	Exudes between the fingers when squeezed in hand
Soft	12 - 25	Can be moulded by light finger pressure
Firm	25 - 50	Can be moulded by strong finger pressure
Stiff	50 - 100	Cannot be moulded by Fingers. Can be indented by thumb.
Very Stiff	100 - 200	Can be indented by thumb nail
Hard	> 200	Can be indented with difficulty by thumb nail.
Friable	-	Crumbles or powders when scraped by thumbnail

Consistency/Density of Non-Cohesive Soils

Term	Density Index (%)	SPT "N" Value Comparison
Very Loose	< 15	0 - 4
Loose	15 - 35	4 - 10
Medium Dense	35 - 65	10 - 30
Dense	65 - 85	30 - 50
Very Dense	> 85	> 50

Moisture Content

D	Dry
M	Moist
W	Wet
S	Saturated

Minor Components

Term	Assessment Guide	Proportion of Minor Component In:
Trace	Presence just detectable by feel or eye, but soil properties little or no different to general properties of primary component	Coarse grained soils: < 5 % Fine grained soils: <15%
With	Presence easily detected by feel or eye, soil properties little different to general properties of primary component	Coarse grained soils: 5 - 12 % Fine grained soils: 15 - 30%

Soil Legend

FILL	CLAY	GRAVEL	CONCRETE
TOPSOIL	SILT	LIMESTONE	COMBINATIONS
PEAT	SAND	BEDROCK	eg: Clay, Silty, Sandy

USCS

GW	Well graded gravel	SC	Clayey sand	OL	Organic low plasticity silt	CL	Low plasticity clay
GP	Poorly graded gravel	SM	Silty sand	ML	Low plasticity silt	CI	Intermediate plasticity clay
SW	Well graded sand			MH	High plasticity silt	CH	High plasticity clay
SP	Poorly graded sand			OH	Organic high plasticity silt	PT	Peat

DOC:GE:3.003

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REPORT ON

GEOTECHNICAL INVESTIGATION
REMAINDER OF PROVENCE
RESIDENTIAL DEVELOPMENT
BUSSELTON, WESTERN AUSTRALIA

Submitted to:

Wood & Grieve Engineers
22 Queen Street
BUSSELTON WA 6280

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1.0 INTRODUCTION

This report presents the findings of a geotechnical investigation for the remainder (Stage One has previously been investigated in detail, refer Golder Associates (Golder) Report No. 05642450-R02) of the proposed Provence residential subdivision development in Busselton. The work was carried out at the request of Mr Darren Pesich of Wood & Grieve Engineers on behalf of Satterley Property Group.

The site is located to the south of Bussell Highway about 4 km south-east of the Busselton town site as shown on Figure 1, Location Plan.

The land has been predominantly cleared for pasture and grazing purposes. Some remnant bushland is located on the northern and western portions of the site. A man-made lake about 37,500 m^2 in area is located in the south-western area of the development. The size of the remaining area to be developed is about 150 hectares.

Surface levels vary between about RL 3 to RL 4 m AHD on the northern section of the site to RL 6 to RL 7 m AHD on the southern extent of the site.

The objectives of the investigation were

Geotechnical

- assess subsurface soil and groundwater conditions across the proposed development area, in particular identify areas with poor founding conditions;
- classify the site in accordance with AS 2870 “Residential Slabs and Footings”, including recommendations for site improvement for residential use where necessary;
- outline appropriate site preparation procedures;
- provide indicative pavement design parameters for the roads; and
- carry out laboratory testing to assist in the above objectives;

Hydrogeological

- broadly assess site hydrogeology and drainage characteristics based on the results of the geotechnical investigation and previous studies at the site;
- compare the current assessment against the previous assessment and recommendations provided for the overall Site, as well as against the more specific findings of the Stage 1 work. Where appropriate, provide recommendations and a cost estimate for additional field studies or analysis, if required.

The findings of the hydrogeological studies will be provided as a separate document.

2.0 PREVIOUS INVESTIGATIONS

Several geotechnical investigations have been conducted at the site and are detailed below:

- November 1995 – A preliminary geotechnical investigation was conducted by Coffey Partners International Pty Ltd with the results presented in their Report No. P835/1-AB. The study comprised thirty test pits, C1 to C30, excavated across the site and to the south of the site. Of the thirty test pits, about 18 were excavated on the site. Summary test pit reports are presented in Appendix A.

- April 2004 – Further investigation was conducted by Golder across the site and south of the site with the results presented in our Report No. 03642387-R01. A total of 57 test pits, A1 to A26 and B1 to B32, were excavated during the studies, with about 25 test pits positioned on the current site. Summary test pit reports and Perth Sand Penetrometer (PSP) test reports are presented in Appendix B.

- January 2006 – Golder conducted a detailed investigation for Stage 1 of the development with the results of the work presented in our Report No. 05642450-R02. The investigation comprised:

    - testing with an electric friction-cone penetrometer (EFCP) at 31 locations;

    - excavation of 38 test pits with a rubber tyred backhoe;

    - drilling of 10 hand auger boreholes;

    - drilling of 14 boreholes at nominated locations (both within and outside the Stage 1 area) for the sewerage system design and to provide information for hydrogeological purposes; and

    - drilling of four boreholes primarily to provide information for hydrogeological purposes.

- March 2006 – Golder conducted test pits in a potential borrow area with the results of the work presented in our letter No. 06642077-L01 dated 15 March 2006. The investigation comprised excavation of 43 test pits, BP1 to BP43, with a rubber tyred backhoe. Summary test pit reports are presented in Appendix C.

Previous investigations indicated that sections of the site have been previously mined for mineral sands and then rehabilitated. It is understood that the mining was generally about 3 m in depth with localised excavations up to 15 m in depth. Following processing of the sand, the slurry was hydraulically pumped into dams where it remained for several weeks to dry.

The coarser sands were initially extracted from the mining process. The medium to coarse sands and fines were separated in the typical process and were then mixed together using dozers and replaced in layers of about 1 m in thickness. The remediation of the site comprised spreading and track rolling of the sand followed by re-vegetation.

Previous investigations indicated that the subsurface conditions at the northern and central sections of the site generally comprise sandy soils of variable depth overlying limestone, which may have weathered to produce clayey soils in some areas. It was also found that the southern area of the development is underlain by clayey soils.

Previous investigation locations are presented on Figure 2, Site Plan.

3.0 FIELD PROGRAMME

The fieldwork was carried out in two phases due to access difficulties associated with wet ground conditions during the first phase. The first phase was conducted between 25 and 29 September 2006 and comprised the following:

- Positioning of the test locations using a handheld GPS unit accurate to about ±5 m.
- Testing with an EFCP at 82 locations, P1 to P84, excluding P48 and P50, extending to depths of between 0.75 and 8.5 m.
- Excavation of 206 test pits with a rubber tyred backhoe, TP1 to TP231, extending to depths of between 0.8 and 3.0 m. Many of the test pits were terminated due to refusal, groundwater inflow or collapse of the excavation.
- PSP or dynamic cone penetrometer testing adjacent to selected test pits.
- Collection of samples for inspection and laboratory testing.

The second phase was conducted on 18 to 20 April, 21 and 28 June and comprised the following:

- Positioning of the test locations using a handheld GPS unit accurate to about ±5 m.
- Testing with an EFCP at 19 locations, P2-01 to P2-19, extending to depths of between 1.4 and 6.2 m.
- Excavation of 66 test pits with a rubber tyred backhoe, TP2-01 to TP2-09, TP2-12 to TP2-19, TP2-21 to TP2-49, TP2-51 to TP2-57, TP2-61 to TP2-62, TP2-64 to TP2-70, TP2-72, TP2-74 and TP2-76 to TP2-77 extending to depths of between 0.8 and 3.2 m. Several of the test pits were terminated due to refusal on well cemented limestone or iron cemented sands.

- PSP or dynamic cone penetrometer testing adjacent to selected test pits.

- Collection of samples for inspection and laboratory testing.

Geotechnical engineers from Golder positioned the test locations, logged the materials encountered in the test pits, observed the EFCP probing and collected samples for laboratory testing.

GPS co-ordinates for each investigation location are presented in Appendix D. The investigation locations are shown on Figure 2, Site Plan.

The EFCP testing was performed using a 12 tonne track-mounted rig supplied and operated by Probedrill Pty Ltd. Testing was performed in accordance with AS 1289 6.5.1-1999. The results of the EFCP testing are presented as plots of cone resistance (q_c), sleeve friction (f_s) and friction ratio (FR = (f_s/q_c) × 100%) versus depth in Appendix E. A method of soil classification proposed by Robertson and Campanella based on values of q_c and FR is also presented in Appendix E. The depth to groundwater at each location, where it was possible to measure, is shown on the test reports.

Test pits were excavated using a JCB 3CX backhoe supplied and operated by Busselton Crane and Plant Hire and fitted with a 600 mm wide toothed bucket. Test pit reports are presented in Appendix F along with a list of notes and abbreviations and a description of the method of soil description used. Results of the penetrometer tests are provided on the test pit reports.

4.0 LABORATORY TESTING

Laboratory testing was carried out on samples recovered during the field investigations. The testing comprised:

- seven particle size distribution tests;

- twelve Atterberg limits and linear shrinkage tests;

- nine percentage finer than 0.075 mm determinations;

- two one-dimensional consolidation tests; and

- one shrink swell test.

The laboratory testing was conducted in the laboratories of Golder Associates and Tricon testing. Test results are presented in Appendix G, along with a summary table.

5.0 SITE CONDITIONS

5.1 Surface Conditions

The site is generally relatively clear of vegetation although it has relatively thick vegetation in some parts. The site is currently used for grazing purposes. At the time of the investigation, parts of the site had water at or close to the ground surface, with some sections inaccessible to the investigation vehicles. Soft surficial soils made trafficking the site difficult during the investigation in the southern portion of site. The various lots comprising the site are fenced. Several drainage courses traverse the site as shown in the aerial photograph presented as Figure 3.

5.2 Site Geology

The Busselton Sheet of the 1:50,000 Urban Geology series maps show the site is underlain by the following:

- Tamala Limestone and Sand derived from Tamala Limestone over the northern portion of the site;
- a thin seam of Clayey Peaty Sand along a drainage channel near to Bussell Highway; and
- various thicknesses of Bassendean Sands overlying Guildford Formation clayey soils over the central and southern portions of the site.

The subsurface conditions have been reworked by the mining operations at the site as indicated in Section 2.0.

5.3 Subsurface Conditions

The subsurface conditions across the site are described below for various areas. The inferred boundaries for each zone have been approximated on Figure 3, Inferred Subsurface Condition Zones. These areas have been selected to encompass areas where ground conditions are broadly similar. It must be recognised that that the boundaries of these areas are approximate. Further investigation is recommended to better define these boundaries when lot layouts for each of the stages are known.

5.3.1 Zone 1 (Sand Overlying Limestone)

The subsurface conditions encountered in Zone 1 are summarised in general terms below:

- TOPSOIL – SAND (SP) and Silty SAND (SM), loose, with minor organics, varying in thickness from about 0.1 m to 0.5 m, although typically 0.2 m thick, overlying;

- SAND (SP), very loose to dense, generally loose to medium dense, contains very loose zones up to 1.5 m in thickness, extending to depths of between about 1.3 m and 1.9 m, overlying;

- LIMESTONE, variably cemented and weathered, with very loose to loose un-cemented sand infill zones, with interbedded un-cemented clayey zones, causing refusal at depths as shallow as 0.9 m.

A drainage channel traverses the western portion of Area 1 as illustrated on Figure 3. The subsurface conditions encountered along the drainage channel comprise variable interbedded zones of very loose to medium dense sandy and gravelly materials with variable fines contents. Very loose and soft to firm zones of Clayey SAND/Silty Sandy CLAY and Silty CLAY were encountered at test locations P9, TP42 and TP43; within the drainage channel. Limestone is present over much of the northern area of Zone 1 at varying depths. The inferred depth to limestone where encountered is presented on Figure 4, Depth to Limestone.

Groundwater was encountered as shallow as 1.0 m deep in Area 1. It was difficult to assess the static groundwater level within the test pits due to the collapse of the pits and the time taken for the level within the pit to stabilise. The level at which seepage of groundwater into the test pits was observed is recorded on the test reports and is summarised in Appendix D.

5.3.2 Zone 2 (Reworked Sand/Residue deposits)

The inferred subsurface conditions encountered in Zone 2 are summarised below:

- TOPSOIL – SAND (SP), loose, with some silt and rootlets, up to about 0.4 m in thickness, not present in all areas, overlying;

- SAND (FILL) with interbedded fines residue, generally stiff to hard when dry, generally consisting of low to high plasticity CLAY/Sandy CLAY with variable amounts of residue material, varying in thickness between about 0.1 m and 2.5 m; overlying

- SAND, loose to dense but generally medium dense, with weakly cemented zones, extending to the depth investigated of 8.5 m; overlying

- LIMESTONE, variably cemented and weathered, with very loose to loose un-cemented sand infill zones, with interbedded un-cemented clayey zones, causing refusal at depths as shallow as 1.2 m and increasing in depth to the south.

Variations to the above include;

- Very loose SAND was encountered at probe location P18 at depths of between 3.7 and 5.2 m.

- Very loose to loose SAND was encountered at probe location P32 at depths of between 5.0 m to 6.2 m.

- Very loose SAND was encountered at probe location P40 at depths of between 5.0 and 5.7 m.

- Very loose SAND was encountered at probe location P52 at depth of between 4.7 and 5.3 m. This was underlain by loose Clayey SAND extending to a depth of 6.8 m.

The distribution of the fines material is irregular and is presented on Figure 5, Thickness of Fines Residue (Zone 2) Where Encountered. The depth to limestone where encountered is presented on Figure 4, Depth to Limestone.

5.3.3 Zone 3 (Clayey Deposits)

The inferred subsurface conditions encountered in Zone 3 are summarised in general terms below:

- SAND (SP), very loose to loose, up to about 1.5 m in thickness, not present in all areas; overlying

- Sandy CLAY/Clayey SAND, very soft to soft/very loose to loose, up to about 2.0 m in thickness (with an average thickness of about 0.9 m), not present in all areas; overlying

- Interbedded SAND and CLAY, loose to very dense and firm to very stiff, with moderately to well iron cemented zones, extending to the depth investigated of 7.3 m.

The inferred thickness of the very soft to soft and very loose to loose materials is presented on Figure 6, Thickness of Weak Materials.

The thickness of sand overlying the clayey soil in Zone 3 is shown on Figure 7, Thickness of Sand Overlying Clayey Soil.

5.4 Groundwater

Where possible, groundwater levels were measured in the holes remaining open after EFCP testing. Groundwater observations are noted on the test pit logs. However, these observations may not represent the static water level at the time of testing since levels may not have stabilised or the sides of the test pit/probe may have collapsed. These readings are summarised in Appendix D. Levels across the site varied between 0.3 m and 4.6 m where encountered.

Water was present close to the ground surface at the time of the investigation in the southern section of the development. Groundwater levels were generally slightly lower towards the northern area of the site.

6.0 DISCUSSION

6.1 Development in Zone 1

The available data indicates that ground conditions in Zone 1 (defined in Section 5.3.1) comprises primarily sandy soil overlying variably cemented limestone. These materials are generally expected to provide good founding conditions for a residential subdivision development. Figure 4 provides the inferred depth to limestone where encountered.

The basic site preparation procedure to be followed in Zone A would involve the following:

- Remove topsoil.
- Carry out proof compaction.
- Place and compact sand fill up to design lot level and include appropriate drainage.

Along the drainage channel highlighted on Figure 3, over-excavation of variable interbedded zones of loose sandy and gravelly materials and very loose and soft to firm zones of clayey materials is considered an appropriate treatment. Further details on site preparation are provided in Section 6.4.

For Zone 1, a site classification of "Class S" should be achieved provided adequate compaction is achieved and sand fill is used to elevate the site. This also assumes that all unsuitable founding material identified in the drainage channel is excavated and removed.

6.2 Development in Zone 2

The available data indicates that ground conditions in Zone 2 (defined in Section 5.3.2) comprises primarily sandy soil with interbedded zones of fines residue overlying loose to dense but generally medium dense sand overlying limestone in the northern areas. These materials are generally expected to provide good founding conditions for a residential subdivision development provided the fines residue is removed to a depth of at least 1 m below finished level. Figure 4 provides the depth to limestone where encountered.

The basic site preparation procedure to be followed in Zone 2 would involve the following:

- Remove topsoil, organic and unsuitable founding material.

- Remove any layers of clayey soil (fines residue) to a depth of at least 1 m below finished level.

- Carry out proof compaction.

- Place and compact sand fill up to design lot level and include appropriate drainage.

Further details on site preparation are provided in Section 6.4.

For Zone 2, a site classification of "Class S" should be achieved provided adequate compaction is achieved and sand fill is used to elevate the site. The site classification will partly depend on the strength and thickness of the fines residue present across this area.

6.3 Development in Zone 3

The available data indicates that ground conditions in Zone 3 (defined in Section 5.3.3) are broadly similar and comprise a surficial zone of loose sand (present mainly near the Zone 2 boundary) of maximum thickness of about 1.5 m thickness overlying clayey soil. Figure 7 provides the thickness of sand overlying the clayey soils at relevant test locations, that is in the vicinity of the Zone 2 boundary where the sand is between about 0.5 and 1.5 m thick.

The sand typically overlies very soft to firm clay, very loose clayey sand and zones of surficial peaty sand that are generally between about 0.3 m and 2.0 m thick. The weak material is not present at all locations, particularly near the Zone 2 boundary, and as discussed in Section 6.11, it is recommended that as design progresses and the final lot layouts become known, further work be undertaken for each stage to assess the requirement for ground improvement and site preparation measures in relation to the lot layout.

Where present, the weak materials are underlain by stiff to very stiff clay, medium dense sands and cemented sands. The weak layer of very soft clay and very loose clayey sand is relatively compressible and will undergo settlement in response to loading from placement of fill and future construction. A permanent minimum fill thickness of 1.5 m in recommended overlying the clayey soils in Zone 3.

6.3.1 Development Options

There are a number of options for development in Zone 3. In general, any treatments that require dewatering or drainage in part or overall must be accompanied by a thorough understanding of the influence this may have on adjoining existing or future developments. The development options include the following:

Option 1 – Excavate and Replace

The basic procedure to be followed for this option would involve the following:

- Remove topsoil.
- Remove surficial sand where present and stockpile for re-use.
- Remove very soft clay/very loose clayey sand zone and either stockpile for drying and blending before re-use or remove from site.
- Carry out proof compaction of the exposed clayey soil.
- Place and compact sand fill up to design lot level and include appropriate drainage.

This option would require dewatering of the site to enable excavation and removal of the weak clayey layer down to the level of the top of the stronger underlying clayey or sand layer. Based on the inferred depths of the unsuitable founding material summarised on Figure 6, excavations would need to extend to depths of up to about 3.0 m. Consideration should be given to the possibility of acid sulphate soils should this option be adopted. Upon removal of the undesirable founding material, fill would then be placed up to the required level (in accordance with the requirements outlined in Section 6.4.2 and Section 6.4.3).

Should this option be adopted it is recommended that further EFCP testing be undertaken to obtain a better understanding of the excavation depths required.

Option 2 – Fill Only

The basic procedure to be followed for this option would involve the following:

- Remove topsoil.
- Carry out relatively heavy proof compaction of the exposed surface.
- Place and compact sand fill up to design lot level and include appropriate drainage.

This option is not recommended due to the potential for significant post-construction settlement. A permanent minimum fill thickness of 1.5 m is recommended overlying the clayey soils in Zone 3.

Option 3 – Fill and Surcharge

The basic procedure to be followed for this option would involve the following:

- Remove topsoil.
- Carry out relatively heavy proof compaction of the exposed surface.
- Place and compact sand fill up to design lot level.
- Place a surcharge load of fill (typically at least 2 m thickness and possibly up to about 6 m thickness) over the site and allow settlement to occur over a period of time.
- Remove surcharge fill down to design lot level and include appropriate drainage.

Further information about this option is provided in Section 6.3.3. A permanent minimum fill thickness of 1.5 m in recommended overlying the clayey soils in Zone 3.

6.3.2 Settlement

Settlement calculations have been carried out using the results of consolidation tests completed on samples collected from the site. The calculations have been carried out for a compressible layer thickness of between 0.4 and 2.0 m to cover the range of thicknesses encountered during the field investigation. Based on the data, the average thickness of the clay is about 0.9 m.

The results of the settlement calculations are summarised in Table 1. The calculations are for settlement resulting from fill placement. A nominal thickness of 1.5 m of fill has been assumed for calculation purposes for Option 2. Additional settlement could occur in response to further loading from construction of a structure at design lot level. For this reason, Option 2 would not be recommended.

The range of laboratory test results have also been used to estimate the amount of time required for settlement to occur. The range of times calculated is relatively broad as a result of the variability in the laboratory test results. Our experience indicates that the upper end of the time estimates is likely to be less applicable due to the effect of drainage features that may be present in the ground. On this basis, the most likely range of times would correspond to the lower and middle of the time ranges given in Table 1.

Further comments on the surcharge requirements for Option 3 are provided in Section 6.3.3.

Table 1: Summary of Settlement Calculations

Option	Thickness of very soft clay/very loose clayey sand layer	Estimated total primary consolidation settlement	Time for 90% of primary consolidation settlement to occur (t_{90})	Estimated total secondary (creep) settlement (mm)	
	(m)	(mm)	(months)	30 years	100 years
1	0 (removed)	5 to 10	1 to 3	< 5	< 5
2	0.4	15 to 20	1 to 12	< 5	< 5
	1.0	30 to 45	9 to 75	5 to 10	10 to 15
	2.0	70 to 85	35 to 298	10 to 15	10 to 15
3	0.4	35 to 45	0.3 to 3	< 5	< 5
	1.0	80 to 100	2 to 18	5 to 10	5 to 10
	2.0	180 to 200	9 to 73	5 to 10	5 to 10

Note: 2 m thick surcharge assumed for Option 3. See text for comments. Additional settlement could occur in response to loading from a structure constructed after completion of filling. Settlements for Option 3 are due to surcharge fill and lower long term settlements would occur after removal of surcharge.

6.3.3 Surcharge Requirements for Option 3

One of the basic premises behind Option 3 is that the surcharge loading should be of greater magnitude than the load that will be imposed in the future by a structure. On this basis, a minimum surcharge thickness of 2 m (equivalent to about 40 kPa pressure) would be required. However, a thicker surcharge fill would be preferred to reduce the potential for post-construction settlement. The height of surcharge that is selected will also depend on the amount of time that is available for the surcharge to remain in place. The minimum thickness surcharge should remain in place until primary settlement is effectively complete. However, a thicker surcharge could achieve a similar or better outcome over a shorter period of time, as indicated in Table 2. A surcharge thicker than 2 m is recommended to limit the amount of post-construction settlement.

A similar comment to that provided in the previous section regarding the estimated rate of settlement also applies. On this basis, the most likely range of times would correspond to the lower and middle of the time ranges given in Table 2.

Table 2: Surcharge Thickness and Time Details

Thickness of Surcharge Fill (m)	Estimated Time (months) Required for Surcharge to Remain in Place for Indicated Thickness of Very Soft Clay/Very Loose Clayey Sand Layer		
	0.4 m	1.0 m	2.0 m
2	0.3 to 3	2 to 18	9 to 73
3	0.2 to 2	1 to 12	6 to 49
4	0.2 to 1.4	1 to 9	4 to 35
5	0.1 to 1	1 to 7	3 to 26
6	0.1 to 0.8	1 to 5	2 to 20

Note: Estimated times have been derived to achieve a similar minimum degree of consolidation for each case.

6.3.4 Site Classification (Based on Consolidation)

The results of the settlement analysis presented in Table 1 have been interpreted to assess the likely site classification (AS 2870) that would apply for each of the site preparation options. These expected site classifications are outlined below. For reference, a list of the site classifications and descriptions provided in AS 2870 is provided in Table 3. The geotechnical studies have been directed towards providing site classifications over broad areas of the development site in accordance with AS 2870 (1996). The site classifications are based on the expected ground surface movement relating to changes in moisture content of the underlying strata. The definitions of the various site classes and the surface movements to which they relate taken from the code are presented in part in Table 3.

Table 3: AS 2870 Site Classifications

Class	Foundation Type	Characteristic Surface Movement y_s (mm)
A	Most sand or rock sites with little or no ground movement from moisture changes.	-
S	Slightly reactive clay sites with only slight ground movement from moisture changes.	0 - 20
M	Moderately reactive clay or silt sites, which can experience moderate ground movement from moisture changes.	20 - 40
H	Highly reactive clay sites, which can experience extreme ground movement from moisture change.	40 - 70
E	Extremely reactive clay sites, which can experience extreme ground movement from moisture change.	> 70
A to P	Filled sites.	-
P	Sites which include soft soils, such as soft clay or silt, loose sands, landslip, mine subsidence, collapsing soils, soils subject to erosion, reactive sites subject to abnormal moisture conditions or sites which can not be classified otherwise.	-

The expected site classifications given below assume that sand fill with less than about 20% fines is used to elevate the site up to design lot level.

Option 1 – Excavate and Replace

For Option 1, a site classification of "Class S" should be achieved. The site classification will depend on factors such as the thickness and relative density of the sand cover over the underlying very stiff clay, the potential for the clay to become unsaturated during the dry months of the year and the amount of care applied during the site preparation work to remove the weak layer.

Option 2 – Fill Only

For Option 2, a site classification of "Class P" for some lots is likely to apply. However, detailed assessment of individual sites after completion of filling might enable a less onerous site classification, such as "Class M" or "Class H" to be applied. A minimum thickness of 1.5 m of fill overlying the soft clayey materials at finished level should be maintained at all times. This option is not recommended.

Option 3 – Fill and Surcharge

For Option 3, a site classification of "Class S" or "Class M" should be achieved. The site classification will depend on factors such as the relative density of the *in situ* sand remaining in place, the thickness of the surcharge fill and the length of time available for the surcharge to remain in place. A minimum thickness of 1.5 m of fill overlying the soft clayey materials at finished level should be maintained at all times.

6.3.5 Seasonal Movement and Site Classification

In addition to the consolidation settlement, seasonal movements associated with the shrink/swell movements of the underlying clay can be expected. The expected characteristic surface movement is dependent upon several factors including:

- thickness of inert granular soil overlying soil prone to seasonal movement (clayey soil);
- plasticity of fines (particles less than 0.75 mm) within the soil;
- proportion of fines, sand and gravel within the soil;
- degree of cementing within the soil;
- presence of trees;
- thickness of soil prone to movement; and

- climate and drainage characteristics of the site including depth of permanent groundwater.

The site classification applicable to the development site is particularly governed by the properties of the clayey soils, the degree of cementing within the profile, the thickness of the sandy surficial material and the thickness of inert granular fill to be placed.

Laboratory test results show that the clayey soils in Zone 3 contain up to 63% high plasticity fines. A shrink/swell index test conducted at test pit location TP206 indicates a shrink swell index (I_{ss}) of 4.0 for clayey material sampled at this location. The results indicate that the material has a relatively high shrink-swell potential and therefore, surface movement associated with seasonal wetting and drying can be expected to be relatively high.

Given the variation in the thickness and characteristics of the soil types across the site, it is considered that a "Class H" site classification in accordance with AS 2870–1996 "Residential Slabs and Footings" is appropriate for Zone 3 when only considering shrink/swell movement. This assumes finished levels are not lower than existing levels.

Based on site observations and laboratory test data a minimum thickness of granular fill of 1.5 m is required to be placed at each test location to improve the site classification to a "Class S".

6.4 Site Preparation

6.4.1 General

Preparation of the site during drier periods of the year when groundwater levels are near their seasonal low will greatly reduce difficulties with groundwater and trafficability.

The detailed site preparation procedure to be followed will depend on the location of the area that is being prepared within the site and the development option that is selected, refer Section 6.1 to Section 6.3. The general site preparation requirements are described below:

- Remove topsoil, organic and unsuitable material. Topsoil and organic material is not suitable for inclusion in earthworks.

- Where required by the selected development option, strip surficial sand and stockpile for re-use.

- Where required by the selected development option, strip very soft clay/very loose clayey sand zone. Information on the re-use of these materials is provided in Section 6.4.2.

- In Zone 2 remove any layers of clayey soil (fines residue) to a depth of at least 1 m below finished level. In Zone 3 remove clayey soil, where required by design levels, to a depth of at least 1.5 m below finished level. Information on the re-use of these materials is provided in Section 6.4.2.

- Where clayey soil is exposed, grade the exposed surface to provide drainage and as far as practicable ensure that ponding of water will not occur under areas of residential development or under road pavements.

- Inspect the stripped surface and confirm that unsuitable materials have been removed appropriately.

- Carry out proof compaction of the exposed surface. Compaction requirements are described in Section 6.4.3.

- Remove any weak areas that develop in response to compaction and replace with approved compacted granular fill. Areas of loose sand or soft clay may require over-excavation and replacement to achieve the required level of compaction.

- Place and compact approved granular fill in loose layer thickness of typically no greater than 0.3 m thickness up to the required level. Compaction requirements are described further in Section 6.4.3.

- Install drainage.

6.4.2 Fill Materials

Sand

Where on-site or imported material is used as structural fill, it must comply with the material requirements as stated in AS 3798-1996, "Guidelines on Earthworks for Commercial and Residential Developments."

It is recommended that select granular fill required to elevate the site or backfill holes left after the removal of loose and deleterious material comprises either on-site or imported clean sand fill free of organic matter or other deleterious materials and with a fines content of preferably less than 3% to promote drainage.

Sand with a fines content of greater than 3% could be used as fill, although this material will have poorer drainage characteristics and may require additional surface and subsurface drainage measures to be applied.

Cemented Material

Imported material containing some gravel and cobble size inert material (such as limestone) less than 150 mm in diameter can be used. The gravel and cobble size material present should be less than 15% by mass for each 1 m^3 of material. Variably iron cemented materials could be encountered within some excavations on the site. Where this material is excavated for possible re-use as fill, it may be necessary to break down oversize materials for inclusion in the earthworks or screen the larger particles out. This material should typically not be used within about 0.6 m of the finished surface level to avoid interference with future housing development.

Fine Residue and Zone 3 Material

The fine residue material generally appears to be relatively well blended with sand during excavation and does not typically have a high plasticity. On this basis, the majority of the material is likely to be suitable for re-use as deeper fill material.

The material that would be excavated during removal of the weak clayey material in Zone 3 (and where required to allow 1.5 m cover below finished level) will vary between relatively clean sand and high plasticity, saturated clays. The sand and clayey sand materials are likely to have sufficient workability to be readily used, however the clayey materials may be difficult to dry back to near optimum moisture content for compaction. In addition, the high plasticity materials may be difficult to handle and compact. Trials to would be required to confirm the requirements for sufficient dry back and blending of the materials to be suitable for use as structural fill.

The excavated unsuitable material, comprising weak clayey material and fine residue material, may be re-used provided it is appropriately blended to produce a homogenous material that can be appropriately moisture conditioned and compacted to the standard provided below. It may be used beneath lot areas provided at least 1.5 m of granular fill is maintained above these materials. Although reduced thicknesses may apply depending upon the material type, this would need to be reviewed for the particular material being used.

The excavated and blended material may be re-used beneath pavement areas provided at least 0.5 m of granular fill is maintained above these materials. Again, a reduced thicknesses may apply depending upon the material type, this would need to be reviewed for the particular material being used.

As discussed previously the surface of the clayey soil should be graded to drain to subsoil drains prior to placement of granular fill.

It should also be noted that use of clayey fill will be limited for use in excavations where groundwater is at or close to base level because of the potential for excessive wetting of the clayey soil during placement and compaction and the sensitivity of clayey soils to moisture.

6.4.3 Placement and Compaction

Sandy fill should be placed and compacted in horizontal layers not greater than 0.5 m in loose thickness. Layers of greater thickness should only be used if the earthworks contractor is able to demonstrate that adequate compaction can be achieved reliably. Layers of less than 0.5 m thickness may need to be used if adequate compaction can not be demonstrated.

The required level of compaction for fill and *in situ* areas is outlined below:

- Clean sandy soils should be moisture conditioned and compacted to achieve a density index of at least 70% in accordance with AS 1289 5.6.1.

- Where the density index method is not appropriate or can not be carried out confidently, the material should be moisture conditioned and compacted to achieve a Modified dry density ratio of at least 95% in accordance with AS 1289 5.2.1. This is likely to apply where sandy soil contains more than about 5% clayey or silty fines or where fill material comprising both sand and gravel to cobble size pieces is used.

- In accordance with AS 3798 – 2007, clayey fill beneath residential structures and pavements should be compacted to a dry density ratio at least 95% (Standard compaction) in accordance with AS 1289.5.1.1.

For sandy soils, the PSP may be used for compaction control provided it is calibrated for each soil type used on-site.

For development Option 2 and Option 3 within Zone 3, an extended PSP should be used to check that adequate compaction has been achieved to a depth of at least 1.5 m following proof compaction of the stripped existing surface.

Level 2 site supervision should be applied to the earthworks construction in accordance with AS 3798-1990, “Guidelines on Earthworks for Commercial and Residential Developments”.

6.4.4 Compaction

Compaction should be applied uniformly over the whole area of each layer of fill or the area being proof compacted to ensure even compaction. The earthworks contractor should select compaction plant that is appropriate to the material being compacted and for the relative density requirements of the project. This may require several alternative items of plant being available.

For proof compaction of the *in situ* soils, the following requirements apply:

- A minimum of six passes of a suitable compaction plant must be provided in all areas beneath building lots and roads.

- Where relatively clean sandy soils are being proof compacted, a minimum 5 tonne static mass vibratory smooth drum roller should be used.

- Where clayey soils are being proof compacted, a minimum 5 tonne static mass vibratory pad foot roller should be used.

Care will need to be taken when compacting in the vicinity of existing structures, including retaining walls. This is particularly important if vibratory compaction is being carried out. Tynan (1973)[1] provides assistance with the selection of compaction equipment for use adjacent to structures.

6.4.5 Groundwater Control During Compaction

Depending on the development option selected, there may be a requirement to control groundwater to enable excavation and replacement to be carried out. Excavations and earthworks should be graded to allow drainage or sump dewatering. During wet conditions the clayey material may be difficult to work and may become unsuitable with excessive disturbance and softening. Softened zones may require further excavation and replacement.

Experience indicates that difficulties can occur in sandy soils where compaction is applied within about 1 m of the groundwater level.

6.5 Excavations

Depending on the depths of excavation across the site, variably cemented limestone could be encountered within some excavations in the northern portion of the site. These materials resulted in refusal of the backhoe and EFCP testing during the investigation. Variably iron cemented materials could be encountered within some excavations in the southern sections of the site. This material caused refusal of the backhoe and EFCP testing at some locations during the investigation.

Excavations in sand are prone to instability and care must be exercised, especially where groundwater inflow can occur. Temporary excavations should be made at a slope angle of no steeper than 1V:2H unless support is provided.

6.6 Groundwater

Groundwater levels across the site varied between 0.3 m and 4.6 m where encountered. Water was present close to the ground surface at the time of the investigation in the southern section of the development. Preparation of the site, particularly in the southern portion and within drainage courses, during drier periods of the year when groundwater levels are near their seasonal low will greatly reduce difficulties with groundwater and trafficability.

[1] Tynan (1973) Ground Vibration and Damage Effects on Buildings, Australian Road Research Board, Special Report No. 11

For development Zone C, dewatering will be required to enable excavation and removal of the weak clayey layer down to the level of the top of the stronger underlying clayey/sandy layer.

The requirements for dewatering in other parts of the site will depend on the development option that is selected. Experience indicates that difficulties can occur in sandy soils where compaction is applied within about 1 m of the groundwater level. On this basis, some dewatering may need to be allowed for across the remainder of the site to facilitate compaction of the existing surficial sandy soils.

6.7 Trafficability

Some areas of the site could not be trafficked with four wheel drive passenger vehicles at the time of the site investigation due to the presence of surface water and weak near-surface soils. Access to some of these areas could be achieved with the rubber tyred backhoe and tracked EFCP testing rig. However, other parts of the site were considered to be not accessible due to the risk of these vehicles becoming bogged. Further testing of these areas will be conducted during the summer months when trafficability is likely to be possible.

6.8 Subsurface Drainage Characteristics

The surficial sandy soils present across Zone 1 and Zone 2 will generally provide good drainage. Drainage is poor where clayey materials exist near to the surface. Poor drainage characteristics were also noted along existing drainage courses present across the site. The "fines residue" present across Zone B will act as a drainage barrier and will require consideration in drainage design. It is understood that the drainage design requires about 1.2 m of freeboard above the Average Annual Mean Groundwater Level (AAMGL) to promote drainage. Drainage aspects will be further addressed in the hydrogeological section of our final report.

6.9 Pavements

Based on the results of the field and laboratory studies and local experience with similar soils, we recommend that pavement design is carried out using subgrade CBR value of 12% which is appropriate for a well drained sand subgrade compacted to at least 95% Modified dry density ratio in accordance with AS 1289 5.2.1.

Where clayey soil is present at subgrade level it is recommended that this be over-excavated by 0.5 m and replaced with approved granular fill. A design CBR of 12% may then be adopted. As discussed in Section 6.4.1, the surface of the clayey soil should be graded to drain.

The above design CBR values assume that the site preparation procedures outlined previously have been carried out.

6.10 Earthquake Liquefaction

The results of the investigation indicate that relatively loose sand is present across the site at the following positions:

- Within the upper 1 to 2 m of the soil profile.

- Isolated zones of very loose to loose sand were identified at test locations P18, P32, P40 and P52 at depths greater than 3.7 m.

The near surface loose sand is indicated by the tests pits to have a fines content of typically less than 5%. The deeper lenses of loose sand are indicated by the EFCP testing to have a higher (unknown) fines content.

On the basis of a relatively simple assessment of earthquake liquefaction potential, we estimate that the near surface sands (below the water table) could potentially liquefy and therefore suffer loss of strength and give rise to additional settlement following a major earthquake. However, these near surface sands should be improved by compaction carried out during the site earthworks and therefore should not be liquefiable when the development is complete. Furthermore the near surface sands in Zones 1 and 2 are typically above the water table and will not be subject to liquefaction.

The deeper zones of potentially liquefiable soil may not be liquefiable if they have a fines content of about 15% or greater. Based on the maximum thickness of 1.5 m of very loose sand encountered during the investigation, settlements of up to 45 mm can be expected during a large seismic event. The settlements are expected to be irregular in nature due to the variability of the loose zones.

6.11 Further Investigations

It is recommended that as the design progresses that, where it is critical to design, the boundaries of the zones be better defined in terms of the final lot layout.

Should the excavation and replacement option be adopted for ground improvement in Zone 3, it is recommended that further EFCP testing be undertaken to obtain a better understanding of the excavation depths required.

Further work is particularly recommended near the Zone 2 and 3 boundary where the depth of sand overlying clay and the strength of the clayey soil is variable. When final lot layouts are known the ground improvement and site preparation measures can be more accurately defined.

6.12 Hydrogeological Advice

The provision of adequate surface and/or subsurface drainage will be a significant factor in successfully developing the site. Hydrogeological input to these studies will be provided as a separate document.

7.0 IMPORTANT INFORMATION

Your attention is drawn to the document - "Important Information About Your Geotechnical Engineering Report", which is included in Appendix H of this report. This document has been prepared by the ASFE *(Professional Firms Practicing in the Geosciences)*, of which Golder Associates is a member. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be, and to present you with recommendations on how to minimise the risks associated with the groundworks for this project. The document is not intended to reduce the level of responsibility accepted by Golder Associates, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing.

GOLDER ASSOCIATES PTY LTD





Daniel Kain
Senior Geotechnical Engineer

Dale Screech
Geotechnical Engineer

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APPENDIX E
Bore Logs

JDA Consultant Hydrologists
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Tel: 9388 2436
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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	349620 mE, 6274364 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA1	Total Depth:	1.78 m
Drill type:	Hand Auger	R.L. TOC:	3.45 m AHD
Hole diameter:	75mm	Natural Surface:	2.98 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Dark Grey	Fine	Loamy Sand	Medium	Moist	Topsoil
						Light Grey	Medium	Sand	Low		Some Limestone
					1.0m	Light Brown	Medium-Coarse			Very Moist	
					1.5m	Light Grey				Saturated	
											Limestone
											end of hole
					2.0m						Limestone Refusal
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 1.26 m

Stickup above NS 0.47 m

WL 0.79 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	350554 mE, 6274589 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA2	Total Depth:	2.79 m
Drill type:	Hand Auger	R.L. TOC:	4.52 m AHD
Hole diameter:	75mm	Natural Surface:	3.77 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m						Top Soil
					1.0m	Brown	Fine - Medium	Sand	Low	Slightly Moist	
					1.5m	Red Orange					Coffee Rock
					2.0m	Yellow	Medium			Moist / Very Moist	Increasing Moisture ↓
					2.5m	Orange	Medium - Coarse			Saturated	*end of hole*
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

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Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 2.32 m

Stickup above NS 0.75 m

WL 1.57 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	350722 mE, 6274080 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA3	Total Depth:	1.91 m
Drill type:	Hand Auger	R.L. TOC:	4.92 m AHD
Hole diameter:	75mm	Natural Surface:	4.50 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Brown	Fine	Sand	Medium	Slightly Moist	Top Soil
						Cream			Low		
					1.0m	Yellow	Fine - Medium			Moist	Black Grey Consolidated Rock below Watertable
					1.5m						*end of hole*
					2.0m						
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

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TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 1.64 m

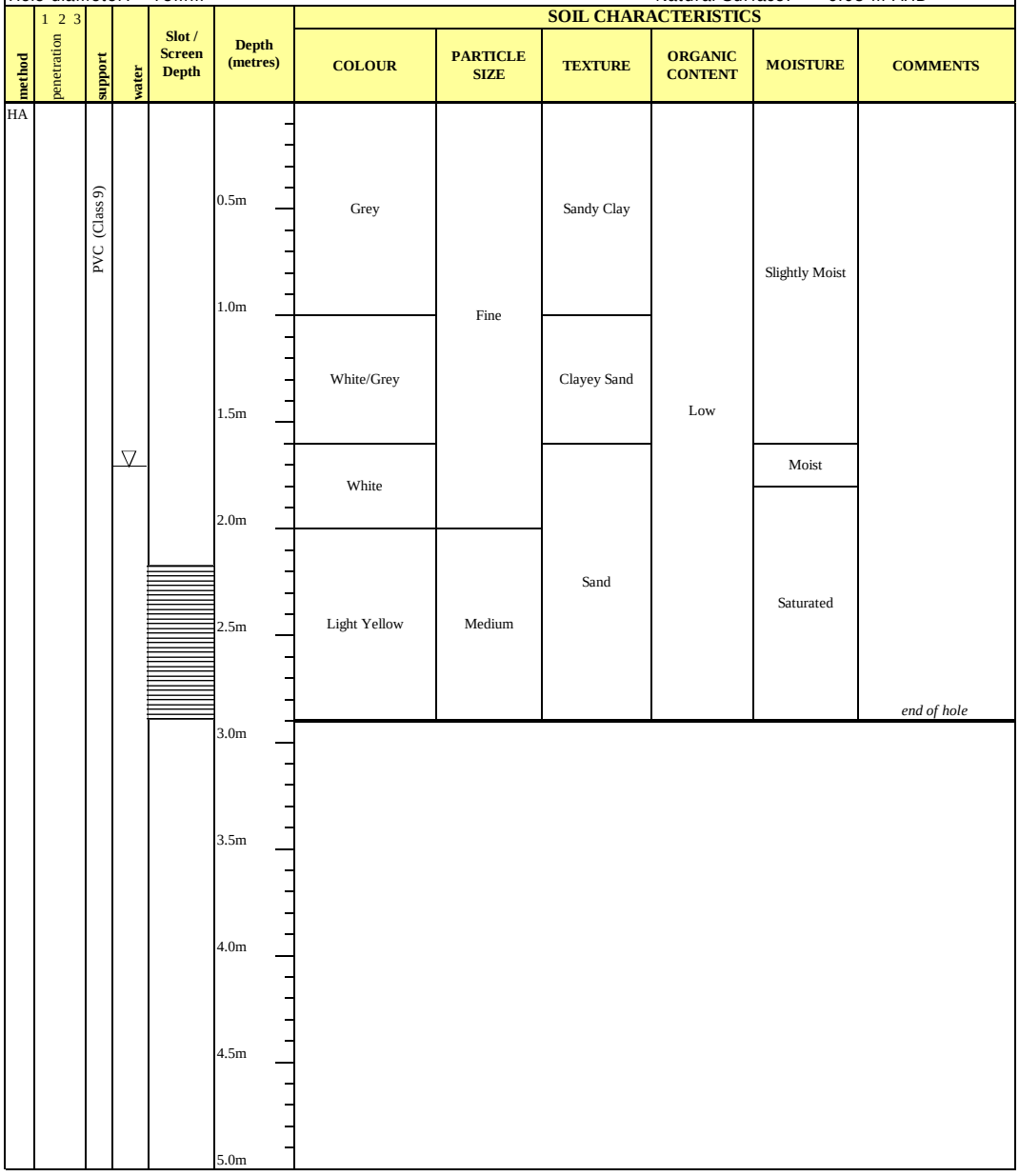
Stickup above NS 0.42 m

WL 1.22 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	351599 mE, 6273883 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA4	Total Depth:	2.90 m
Drill type:	Hand Auger	R.L. TOC:	6.89 m AHD
Hole diameter:	75mm	Natural Surface:	6.08 m AHD



NOTES ON BORELOG

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Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 2.52 m

Stickup above NS 0.81 m

WL 1.71 m below NS

JDA Consultant Hydrologists
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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	351588 mE, 6274288 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA5	Total Depth:	3.7 m
Drill type:	Hand Auger	R.L. TOC:	6.21 m AHD
Hole diameter:	75mm	Natural Surface:	5.78 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)			0.0m	Cream	Fine	Sand	Low	Dry	
						Light Brown				Slightly Moist	
					0.5m	Medium Brown					
					1.0m						
					1.5m	Orange Brown					
					2.0m						
					2.5m	Orange					
					3.0m					Moist	Limestone
					3.5m						*end of hole*
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC N/A

Stickup above NS 0.43 m

WL Dry

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	351557 mE, 6274834 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA6	Total Depth:	3.48 m
Drill type:	Hand Auger	R.L. TOC:	5.26 m AHD
Hole diameter:	75mm	Natural Surface:	4.75 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Brown	Fine - Medium	Gravelly Loam	Low	Slightly Moist	Fill
					1.0m	Dark Brown	Fine	Sand			Traces of Clay
					1.5m	Orange	Fine - Medium				
					2.0m						
					2.5m					Saturated	
					3.0m						Limestone
					3.5m						*end of hole*
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 3.02 m

Stickup above NS 0.51 m

WL 2.51 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	349960 mE, 6273673 mE	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA7	Total Depth:	2.16 m
Drill type:	Hand Auger	R.L. TOC:	5.92 m AHD
Hole diameter:	75mm	Natural Surface:	5.61 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Light Brown	Fine	Sand	Medium	Slightly Moist	Top Soil
					1.0m	Orange/Brown			Low		Note: No Limestone
					1.5m	Orange				Moist	
					2.0m					Saturated	*end of hole*
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 1.89 m

Stickup above NS 0.31 m

WL 1.58 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	350185 mE, 6273234 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA8	Total Depth:	2.09 m
Drill type:	Hand Auger	R.L. TOC:	6.07 m AHD
Hole diameter:	75mm	Natural Surface:	5.61 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m						Top Soil
						Beige	Medium	Sand		Slightly Moist	
					1.0m	Grey	Fine	Sandy Clay	Low	Moist	Possibly Saturated
					1.5m						
					2.0m	Light Grey Blue	Medium			Saturated	Limestone Chunks Present
											end of hole
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below TOC 1.25 m

Stickup above NS 0.46 m

WL 0.79 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	11/11/2002
Bore location:	351130 mE, 6274121 mN	Hole completed:	11/11/2002
Datum:	MGA94/AHD	Logged by:	ASM/AR
Bore Name:	BA10	Total Depth:	1.5 m
Drill type:	Hand Auger	R.L. TOC:	
Hole diameter:	75mm	Natural Surface:	

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)			0.5m	Coffee	Fine	Sand	Medium	Slightly Moist	
						Cream			Low		
					1.0m	Dark Cream					
						Dark Brown					
					1.5m	Dark Orange					
						Limestone					
					2.0m						
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 11/11/02

WL below N/A

Stickup above N/A

WL N/A

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JDA Consultant Hydrologists

LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	5/12/2002
Bore location:	349932 mE, 6274018 mN	Hole completed:	5/12/2002
Datum:	MGA94/AHD	Logged by:	MY/SW
Bore Name:	BA11	Total Depth:	1.50 m
Drill type:	Hand Auger	R.L. TOC:	4.89 m AHD
Hole diameter:	75mm	Natural Surface:	4.03 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Grey	Medium - Fine	Sand		Dry	
						Brown					
					1.0m	Beige		Sandy Clay		Slightly Moist	
						White	Medium	Clay		Saturated	Limestone
					1.5m						*end of hole*
					2.0m						
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 5/12/02

WL below TOC 1.97 m

Stickup above NS 0.86 m

WL 1.11 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	5/12/2002
Bore location:	350171 mE, 6274144 mN	Hole completed:	5/12/2002
Datum:	MGA94/AHD	Logged by:	MY/SW
Bore Name:	BA12	Total Depth:	2.00 m
Drill type:	Hand Auger	R.L. TOC:	5.64 m AHD
Hole diameter:	75mm	Natural Surface:	4.30 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Black				Dry	Soft
					1.0m	Limestone	Fine	Silty Sand	Medium	Moist	
					1.5m						
					2.0m	Yellow/Olive		Sand	Low	Saturated	*end of hole*
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 5/12/02

WL below TOC 2.90 m

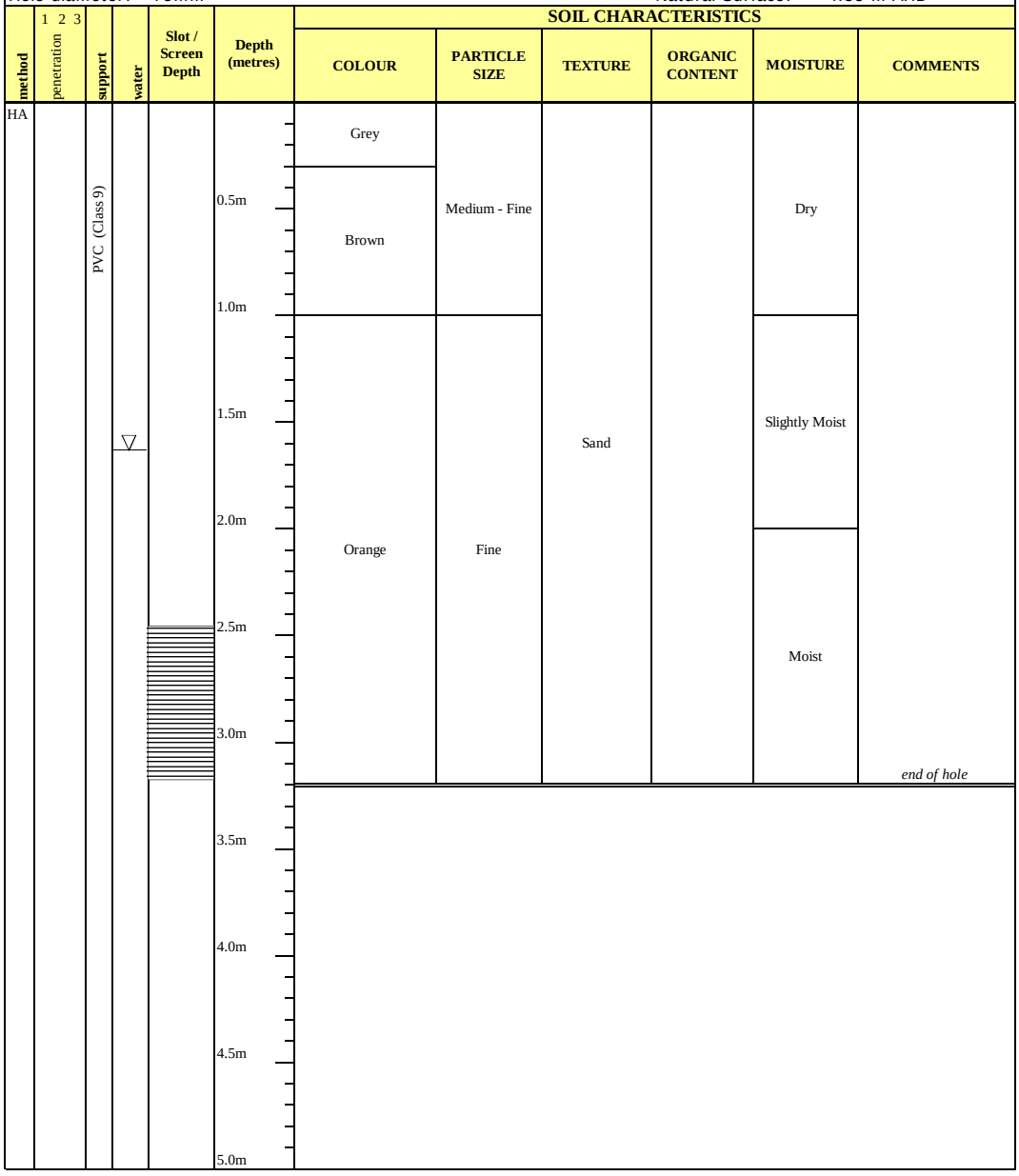
Stickup above NS 1.34 m

WL 1.56 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3121
Project:	Land East of Busselton: Development Options	Hole commenced:	5/12/2002
Bore location:	350054 mE, 6274156 mN	Hole completed:	5/12/2002
Datum:	MGA94/AHD	Logged by:	MY/SW
Bore Name:	BA13	Total Depth:	3.17 m
Drill type:	Hand Auger	R.L. TOC:	5.62 m AHD
Hole diameter:	75mm	Natural Surface:	4.35 m AHD



NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 5/12/02

WL below TOC 2.91 m

Stickup above NS 1.26 m

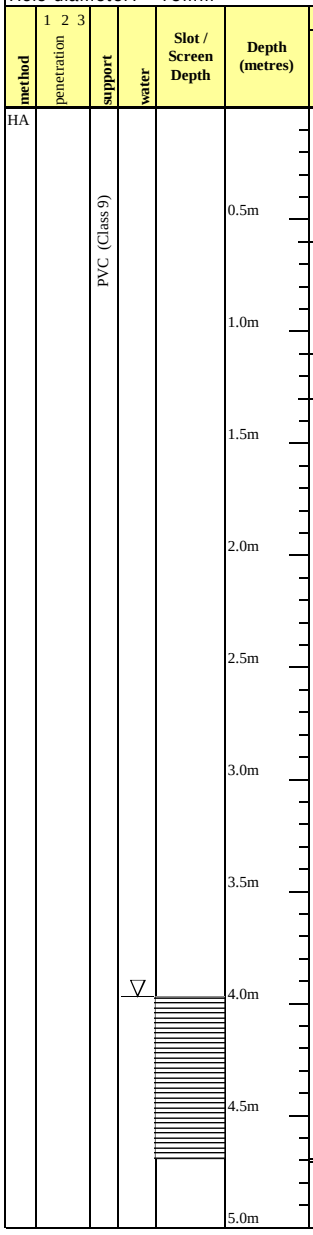
WL 1.65 m below NS

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JDA Consultant Hydrologists

LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	352047 mE, 6274342 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA14	Total Depth:	4.8 mBNS
Drill type:	Hand Auger	R.L. TOC:	7.74 m AHD
Hole diameter:	75mm	Natural Surface:	6.94 m AHD



SOIL CHARACTERISTICS					
COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
Medium Brown	Fine	Loamy Sand	Low	Dry	Clay Chunks
		Sandy Clay			
Light Brown		Sand			
Light Yellow	Medium			Moist	
		Sandy Clay			
Light Brown		Sand			
				Very Moist	Hard layer of clay
		Sandy Clay		Saturated	Blue clay chunks
					end of hole

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 5/2/04

WL below TOC 4.72 m

Stickup above NS 0.80 m

WL 3.92 m below NS

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	351793 mE, 6274905 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA15	Total Depth:	2.8 mBNS
Drill type:	Hand Auger	R.L. TOC:	5.18 m AHD
Hole diameter:	75mm	Natural Surface:	4.94 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)			0.5m	Dark brown	Fine	Sand	Low	Dry	
					1.0m	Light brown					
					1.5m	Yellow	Medium				
					2.0m					Slightly moist	
					2.5m					Very moist	*end of hole*
					3.0m						Limstone Refusal
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 4/2/04

Bore Dry

Stickup above NS 0.24 m

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	351691 mE, 6274433 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA16	Total Depth:	2.3 mBNS
Drill type:	Hand Auger	R.L. TOC:	6.06 m AHD
Hole diameter:	75mm	Natural Surface:	5.47 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)			0.5m	Dark Brown	Fine	Loamy Sand	Medium	Dry	
					1.0m						
					1.5m	Brown	Medium	Sand	Low		
					2.0m	Yellow				Moist	*end of hole*
					2.5m						Limestone Refusal
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark : Brown, Red, Orange, Yellow, Grey, Blue — Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 4/2/04

Bore Dry

Stickup above NS 0.59 m

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	349556 mE, 6273827 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA17	Total Depth:	1.0 mBNS
Drill type:	Hand Auger	R.L. TOC:	4.80 m AHD
Hole diameter:	75mm	Natural Surface:	3.91 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)			0.5m	Grey	Medium	Loamy Sand	Medium	Slightly Moist	Limstone Chunks
						Dark Grey		Sandy Clay			
						Light Grey		Clay	Low	Moist	*end of hole*
					1.0m						Limstone Refusal
					1.5m						
					2.0m						
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 6/2/04

Bore Dry

Stickup above NS 0.89 m

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LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	349095 mE, 6273642 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA18	Total Depth:	1.3 mBNS
Drill type:	Hand Auger	R.L. TOC:	4.59 m AHD
Hole diameter:	75mm	Natural Surface:	4.37 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Dark Grey	Fine		Medium	Slightly Moist	
						Light Brown	Medium	Sand	Low	Moist	
					1.0m					Very Moist	
						Grey		Clay		Saturated	*end of hole*
					1.5m						Limestone Refusal
					2.0m						
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE
Dark : Brown, Red, Orange, Yellow, Grey, Blue Tones : solid colour, blemish or mottle
Medium : Brown, Red, Orange, Yellow, Grey, Blue
Light : Brown, Red, Orange, Yellow, Grey, Blue

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 6/2/04

WL below TOC 0.55 m

Stickup above NS 0.22 m

WL 0.33 m below NS

JDA Consultant Hydrologists
Jim Davies & Associates
Suite 1, 27 York Street
Subiaco WA 6008
Tel: 9388 2436
Fax: 9381 9279

LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	349488 mE, 6273218 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA19	Total Depth:	2.8 mBNS
Drill type:	Hand Auger	R.L. TOC:	6.92 m AHD
Hole diameter:	75mm	Natural Surface:	6.10 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Dark Grey	Fine	Sand	Medium	Dry	
					1.0m						
					1.5m	Beige	Medium - Fine		Low	Slightly Moist	
						Light Yellow				Moist	
					2.0m	White	Medium				
					2.5m					Saturated	
						Light Blue		Clayey Sand			*end of hole*
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 6/2/04

WL below TOC 3.06 m

Stickup above NS 0.82 m

WL 2.24 m below NS

JDA Consultant Hydrologists
Jim Davies & Associates
Suite 1, 27 York Street
Subiaco WA 6008
Tel: 9388 2436
Fax: 9381 9279

LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	349881 mE, 6273365 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA20	Total Depth:	2.1 mBNS
Drill type:	Hand Auger	R.L. TOC:	6.91 m AHD
Hole diameter:	75mm	Natural Surface:	6.2 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS: COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Dark Brown	Fine	Sand		Slightly Moist	
						Beige		Sandy Clay	Low		
					1.0m		Medium - Fine			Moist	
					1.5m		Medium	Sand			
					2.0m		Coarse			Saturated	*end of hole*
					2.5m						
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
Light :	Brown, Red, Orange, Yellow, Grey, Blue	

PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 6/2/04

WL below TOC 2.39 m

Stickup above NS 0.71 m

WL 1.68 m below NS

Jim Davies & Associates
Suite 1, 27 York Street
Subiaco WA 6008
Tel: 9388 2436
Fax: 9381 9279

JDA Consultant Hydrologists

LITHOLOGICAL LOG

Client:	Satterley Property Group Pty Ltd	Job No:	J3309
Project:	East Busselton DNMP	Hole commenced:	4/02/2004
Bore location:	349780 mE, 6272908 mN	Hole completed:	4/02/2004
Datum:	MGA94/AHD	Logged by:	ASM/KL
Bore Name:	BA21	Total Depth:	2.5 mBNS
Drill type:	Hand Auger	R.L. TOC:	6.92 m AHD
Hole diameter:	75mm	Natural Surface:	6.07 m AHD

method	1 2 3 penetration	support	water	Slot / Screen Depth	Depth (metres)	SOIL CHARACTERISTICS					
						COLOUR	PARTICLE SIZE	TEXTURE	ORGANIC CONTENT	MOISTURE	COMMENTS
HA		PVC (Class 9)	▽		0.5m	Dark Grey	Fine	Loamy Sand	Medium	Dry	Limestone chunks
						Grey/Orange mottle		Clay	Low	Slightly Moist	
					1.0m	Olive					
					1.5m	Grey/Orange mottle	Medium - Fine	Sandy Clay		Moist	Chunks of rock
					2.0m	Orange				Saturated	
					2.5m	White/blue-orange mottle					Cemented black layer *end of hole*
					3.0m						
					3.5m						
					4.0m						
					4.5m						
					5.0m						

NOTES ON BORELOG

COLOURS: Solid colours are BLACK, WHITE, BEIGE

Dark :	Brown, Red, Orange, Yellow, Grey, Blue	Tones : solid colour, blemish or mottle
Medium :	Brown, Red, Orange, Yellow, Grey, Blue	
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PARTICLE SIZE : Particles are either FINE, MEDIUM or COARSE

TEXTURE : Sand, Loamy Sand, Clayey Sand
Silt, Loam, Sandy Loam, Clay Loam
Clay, Sandy Clay

ORGANIC CONTENT: VOLUME: High, Medium, Low
SIZE: Fine, Medium, Coarse

MOISTURE: Soil Moisture can be either: DRY, SLIGHTLY MOIST, MOIST or SATURATED

STATIC WATER LEVEL

Date: 6/2/04

WL below TOC 2.52 m

Stickup above NS 0.85 m

WL 1.68 m below NS

APPENDIX F

Vasse Wonnerup Wetlands and
Geographe Bay WQIP (DoW, 2010) Extracts

Table 3: Categories of water quality objectives for the Geographe waterways.

	Protection	Intervention	Recovery
Management objective	Maintain current good water quality.	Prevent P rising; reduce N to criteria levels.	Reduce N and P to criteria levels.
Waterways: flowing to Vasse Wonnerup Estuary		Abba River	Lower Vasse River Sabina River Ludlow River
Waterways: flowing to Geographe Bay	Dunsborough streams Carbunup River Capel River	Jingarmup Brook Toby Inlet streams Annie Brook Buayanyup River	Vasse/Sabina Diversion Gynudup Brook Five Mile Brook
Assessment against Swan coastal plain criteria of 0.1 mg/L P and 1.0 mg/L N	Meets both N and P criteria.	Fails N criteria; meets P criteria.	Fails both N and P criteria.
Water quality objective nitrogen	Prevent further increases from current median winter concentrations.	Decrease median winter concentrations to 1.0 mg/L N.	Decrease median winter concentrations to 1.0 mg/L N.
Water quality objective phosphorus	Prevent further increases from current median winter concentrations.	Prevent further increases from current median winter concentrations.	Decrease median winter concentrations to 0.1 mg/L.

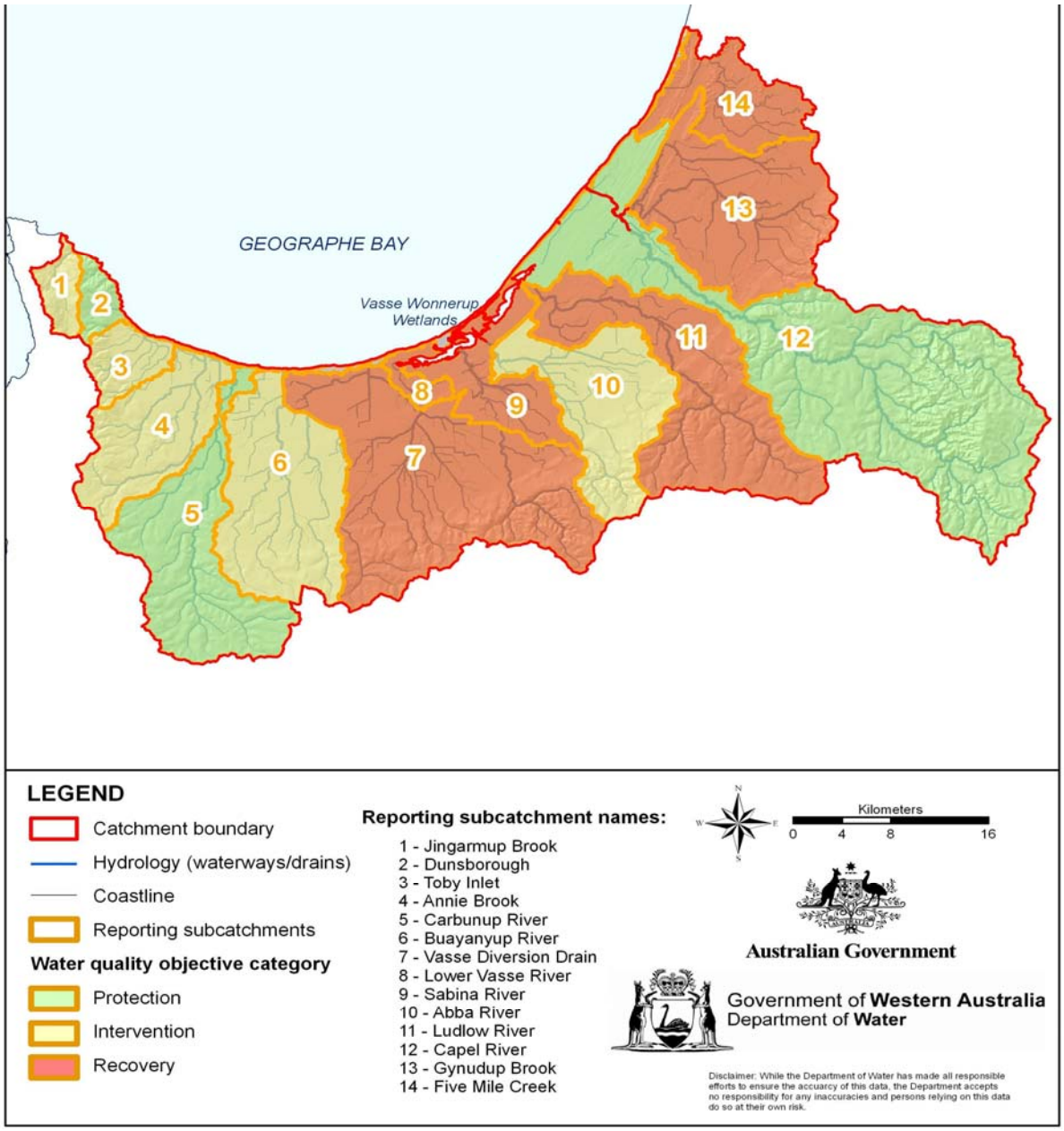


Figure 10: Location of reporting catchments within each water quality objective category.

Table 4: Integration of environmental values, water quality issues and water quality objectives.

Waterway	Environmental values	Are values being achieved?	Water quality Issues	Nutrient pollutant indicators	Water quality objectives (long term)
Vasse Wonnerup Ramsar wetlands	Ecosystem health	Not consistently	Nutrient enrichment. Phytoplankton blooms (toxic species). Regular sudden mass fish kills near Vasse and Wonnerup floodgates. Macroalgal blooms, possibly increasing. Seasonal odour from decaying algae and exposed sediment near Estuary View Drive. Potential remobilisation of nutrients from sediments. Nuisance mosquitoes. Possible loss of macrophytes (seagrass and chara) that are an important waterbird food source. Possible switch from macrophyte to phytoplankton/macroalgal-dominated system.	High nutrient concentrations. High chlorophyll levels, phytoplankton cell counts or macroalgae biomass. Low oxygen conditions. High colour, suspended solids and turbidity.	Phosphorus concentration of 0.1 mg/L. Nitrogen concentration of 1.0 mg/L in waterways flowing to the estuary. Total phosphorus load of 6 tonnes/year (or 41% less than current load). Total nitrogen load of 74 tonnes/year (or 55% less than current load).
	Maintain waterbird use of wetlands. High abundance (>20 000) and richness (>60 species) of waterbirds. >1% of Ramsar populations of blackwinged stilt, red-necked avocet, Australian shelduck and Australasian shoveler. Largest known breeding colony of black swan in WA (50–150 pairs).	Yes			
	Harvesting of fish for human consumption	Not consistently			
	Cultural and spiritual	Not consistently			
Recovery catchment waterways Vasse/Sabina Diversion Lower Vasse River Lower Sabina River Ludlow River Gynudup Brook Five Mile Brook	Aquatic ecosystem health	No	Nutrient enrichment – elevated phosphorus and nitrogen. Regular blooms of toxic phytoplankton in the Lower Vasse River. Seasonal odour from decomposition of algae in the Lower Vasse River. Loss of community uses such as festival activities on Lower Vasse River. High turbidity.	High nutrient concentrations. High chlorophyll levels or phytoplankton cell counts. Low oxygen conditions. High colour, suspended solids and turbidity.	Reduce phosphorus concentrations to 0.1 mg/L. Reduce nitrogen concentrations to 1.0 mg/L.
	Freshwater fish	Yes			
	Recreational contact	Not consistently			
	Cultural and spiritual	No			

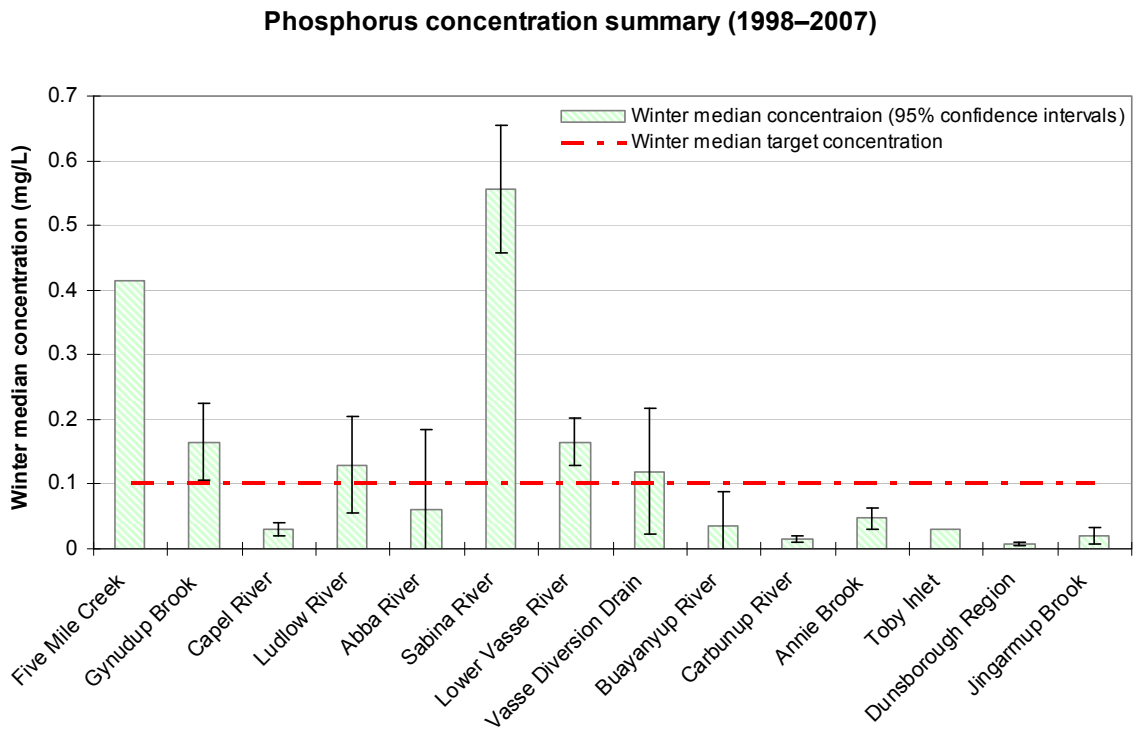


Figure 8: Median winter phosphorus concentration of Geographe waterways from fortnightly sampling between 1998 and 2007.

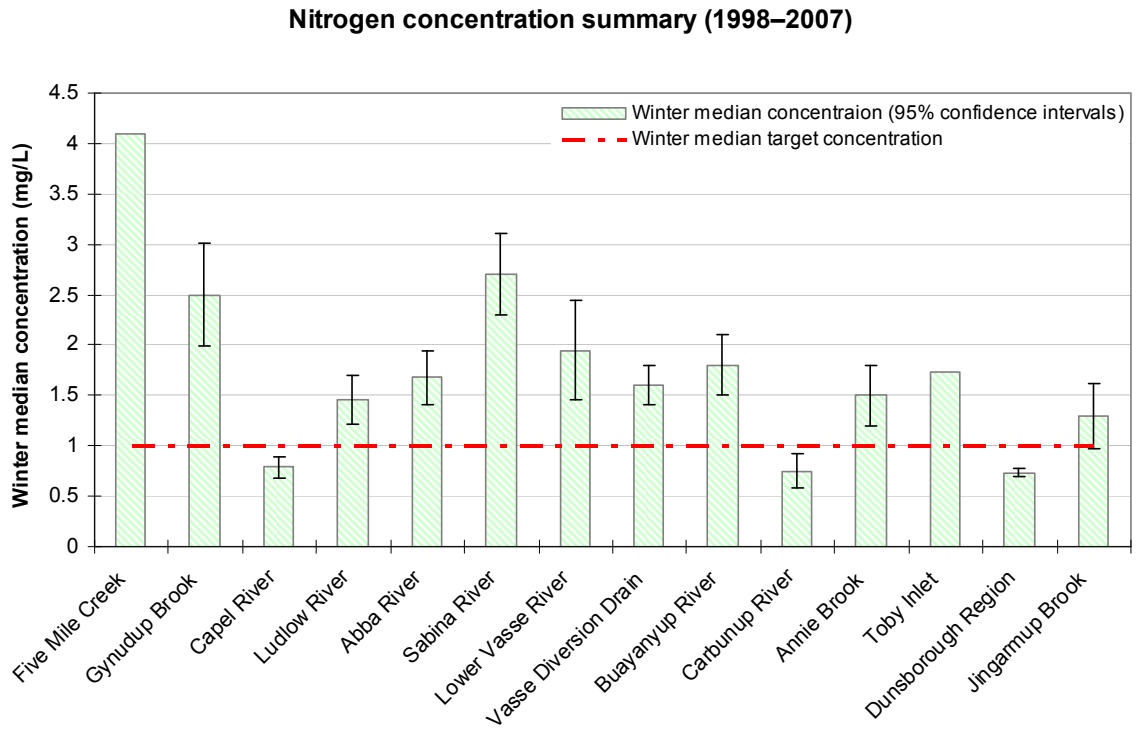


Figure 9: Median winter nitrogen concentration of Geographe waterways from fortnightly sampling between 1998 and 2007.

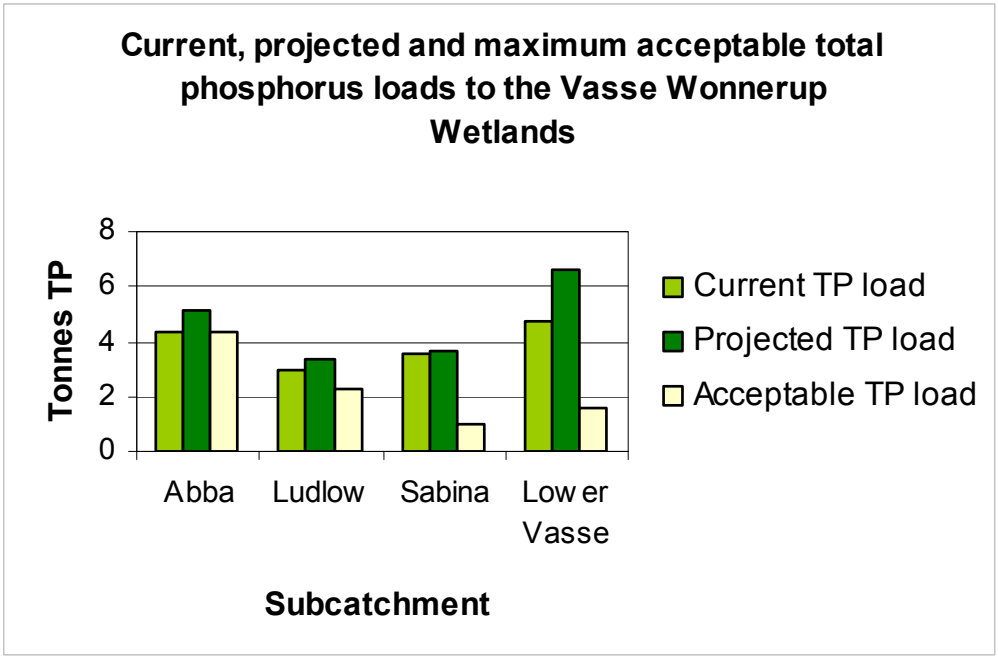


Figure 17: Current, projected and acceptable modelled phosphorus loads to the Vasse Wonnerup Wetlands.

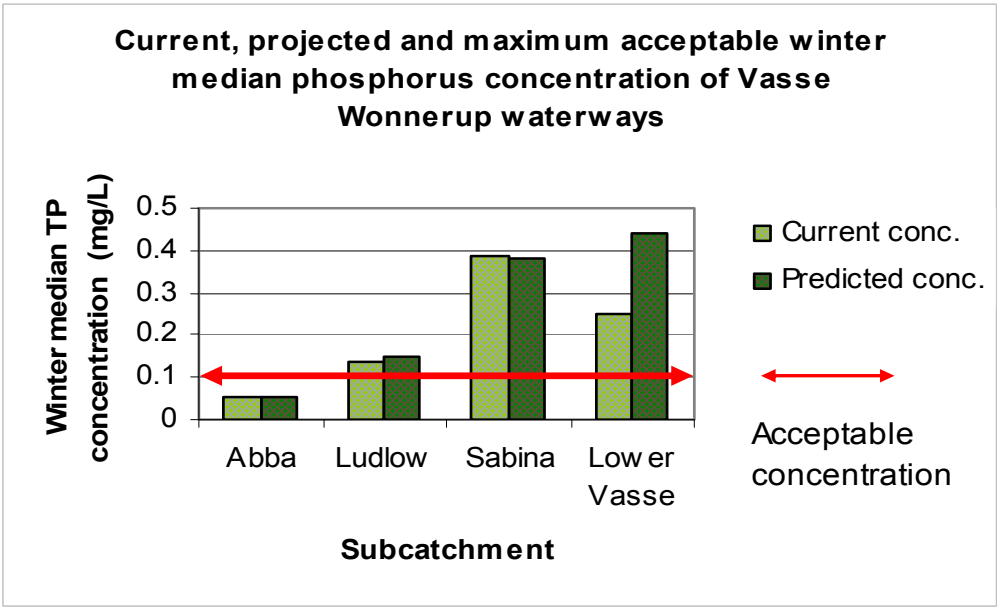


Figure 18: Current, projected and acceptable modelled phosphorus concentration at the drainage point of the Vasse Wonnerup reporting catchments.

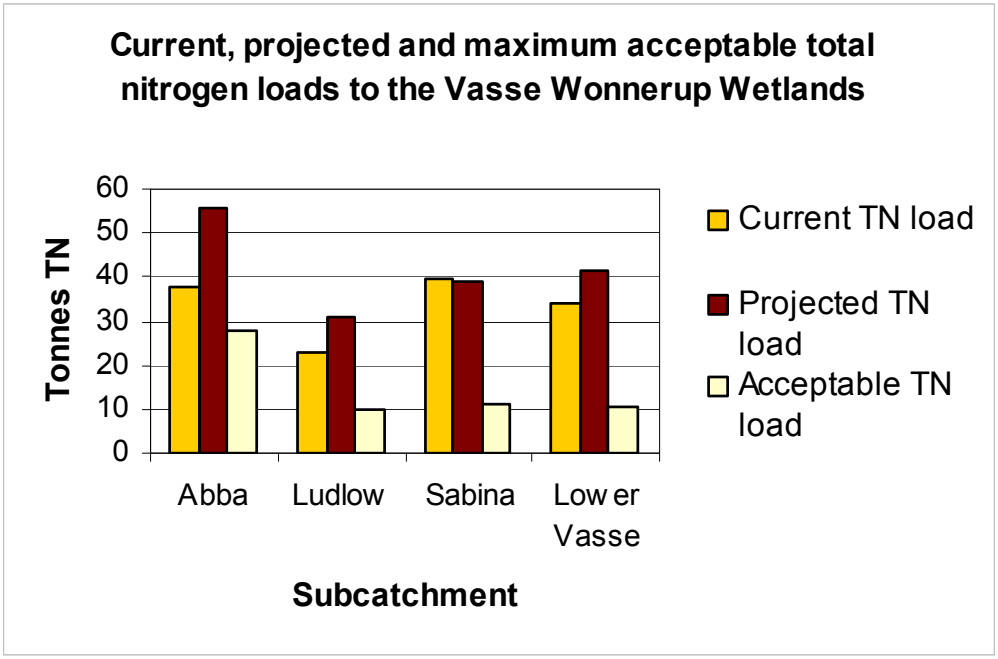


Figure 19: Current, projected and acceptable modelled nitrogen loads to the Vasse Wonnerup Wetlands.

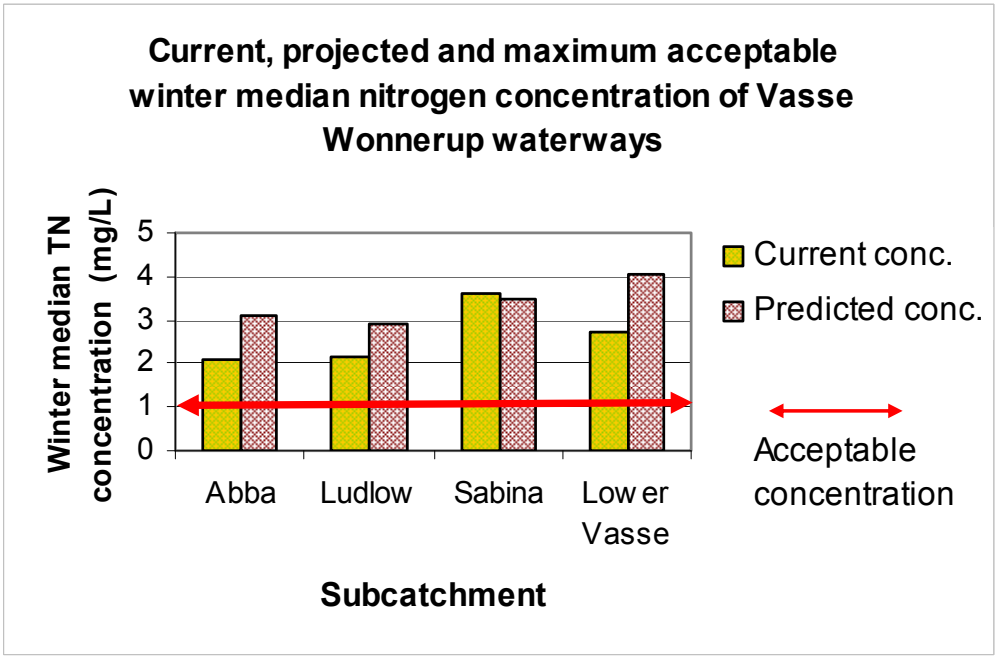


Figure 20: Current, projected and acceptable modelled nitrogen concentration at the drainage point of Vasse Wonnerup reporting catchments.

Water quality objective: Recovery – reduce N and P to targets				
	Current load (tonnes/pa)	Predicted load (tonnes/pa)	Load reduction target (tonnes/pa)	Load reduction target (% of current)
Phosphorus	3.57	3.61	Long term: 2.63 10-yr interim: 0.96	Long term: 74% 10-yr interim: 27%
Nitrogen	39.5	39.1	Long term: 28.2 10-yr interim: 12.6	Long term: 71% 10-yr interim: 32%

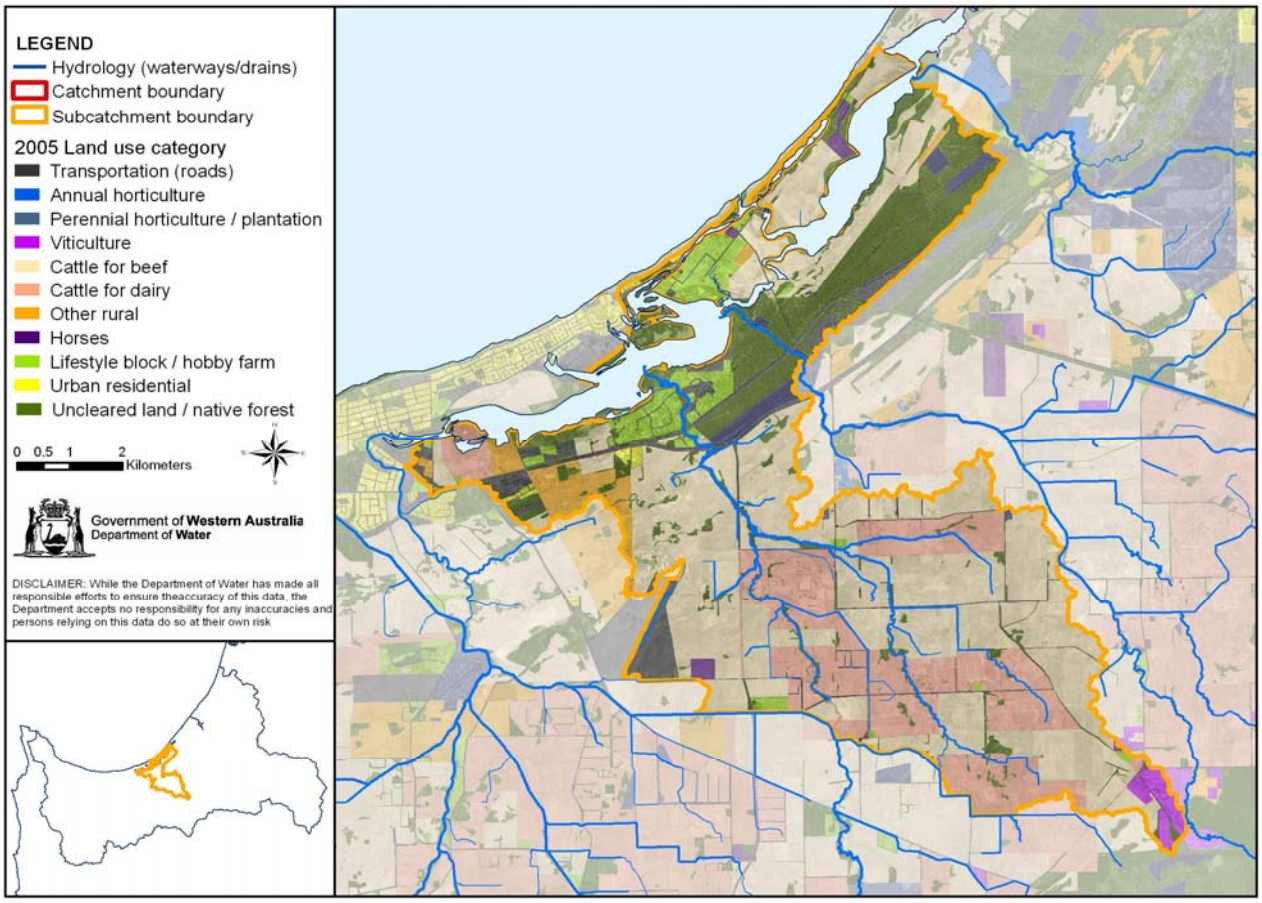
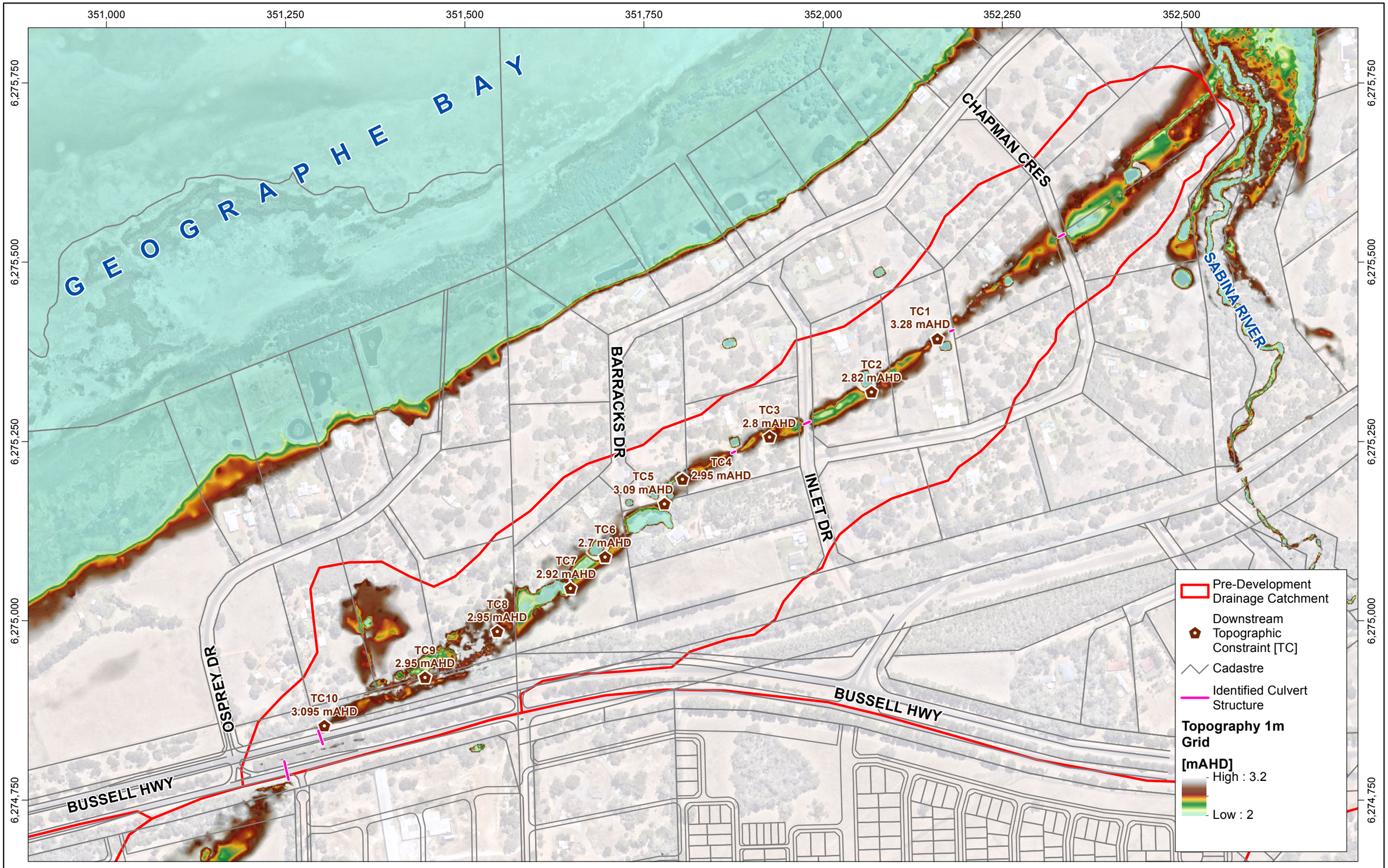


Figure 76: Location and land use of the Lower Sabina River reporting catchment.

APPENDIX G

Predevelopment Modelling (JDA,2019)



Data Source:

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:5,000 @A3

0 250 500 750 1,000 Metres

N

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East Busselton Estate Pty Ltd
Provence: LWMS

Figure 25: Surface Water Drainage, Downstream Topographic Constraints



Data Source: Nearmap Digital Imagery, 19 August 2018;

Coordinate System: GDA 94, Zone 50

JDA Consultant Hydrologists

Job No. J6049
Scale: 1:5,000 @A3

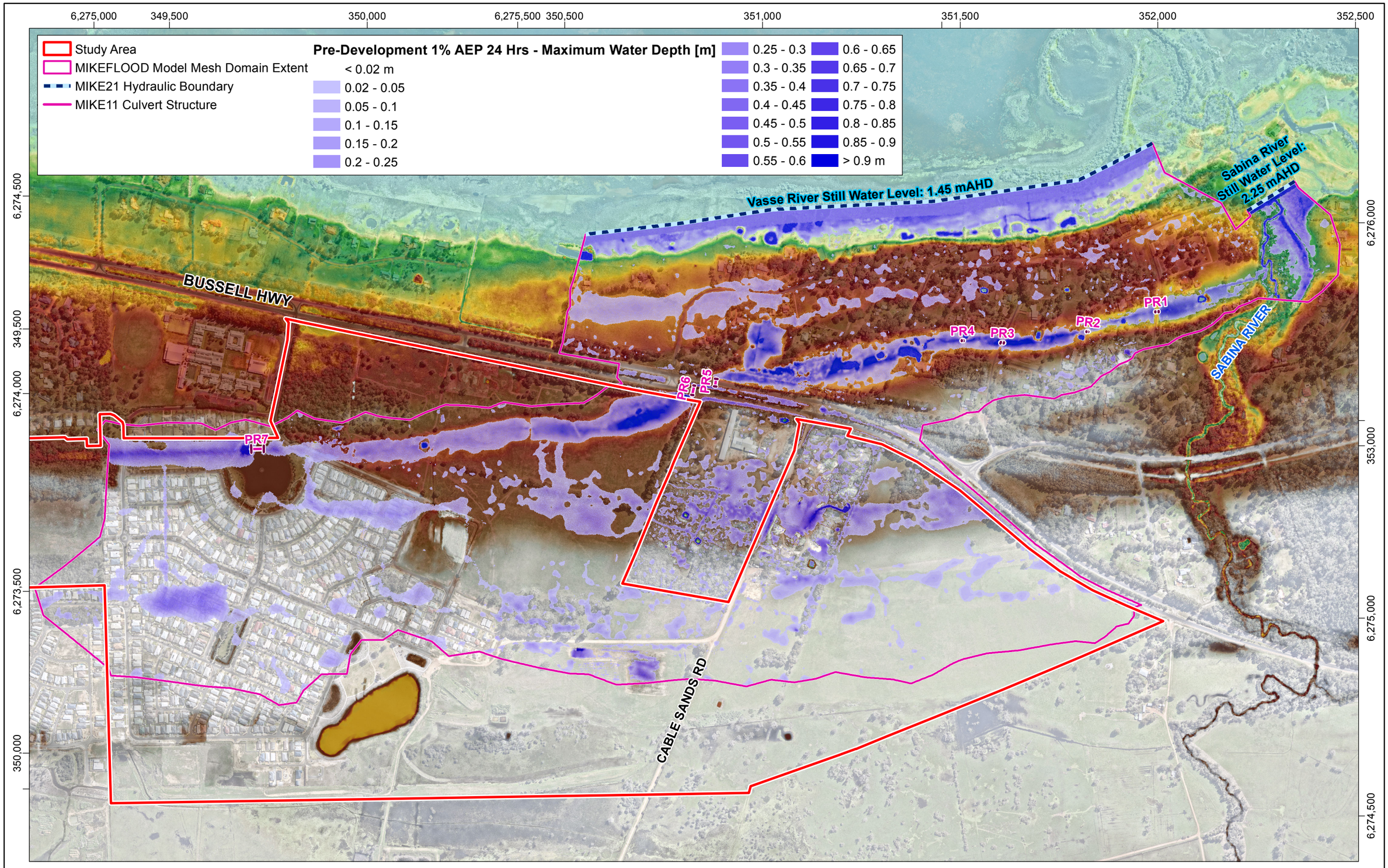
0 250 500 750 1,000 Metres

N

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East Busselton Estate Pty Ltd
Provence: LWMS

Figure 26: Downstream Swale Aerial Imagery, 19 August 2018



Data Source: Nearmap Digital Imagery, 19 August 2018;

Coordinate System: GDA 94, Zone 50

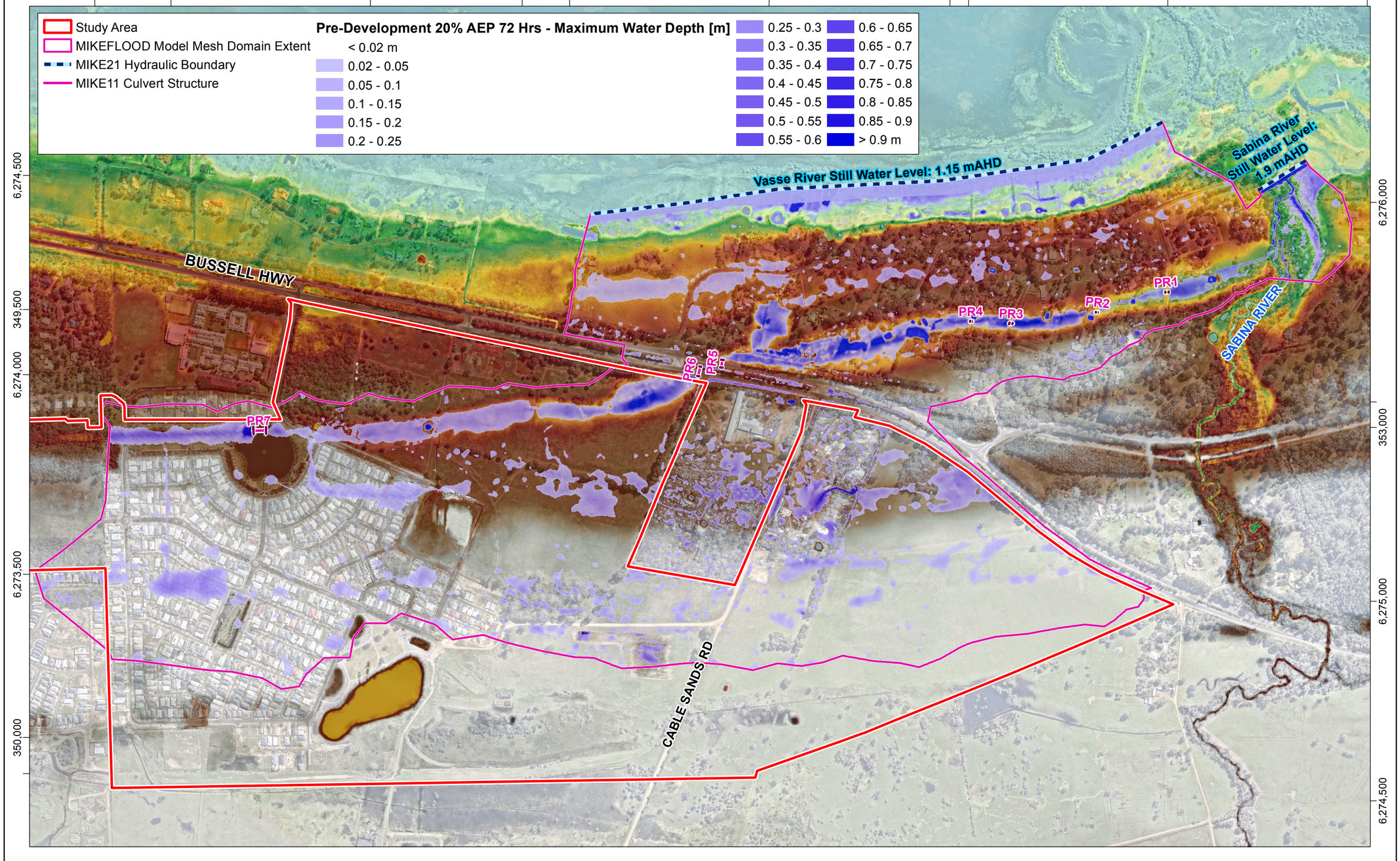
Job No. J6049
Scale: 1:10,000 @A3

0 200 400 600 800 Metres

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East Busselton Estate Pty Ltd
Provence: LWMS

Figure 27: Pre-Development 1% AEP (100 yr ARI) Flood Mapping of Catchment to Sabina River



Data Source: Nearmap Digital Imagery, 19 August 2018;

Coordinate System: GDA 94, Zone 50

Job No. J6049
Scale: 1:10,000 @A3

0 200 400 600 800 Metres

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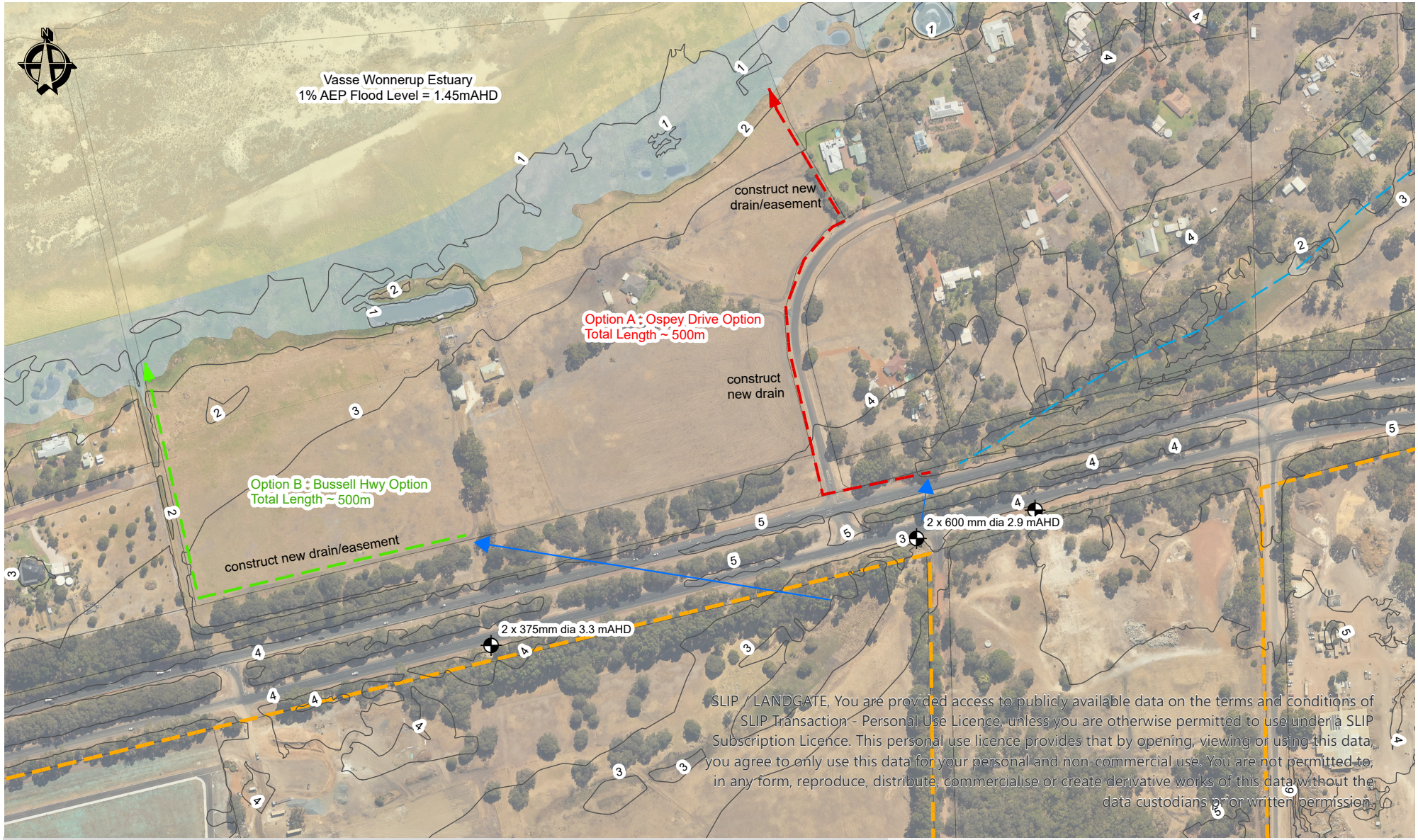
East Busselton Estate Pty Ltd
Provence: LWMS

Figure 28: Pre-Development 20% AEP (5 yr ARI) Flood Mapping of Catchment to Sabina River

APPENDIX H

Alternative Outlet Drainage Proposal

Date: 25/02/2026 Job No. H22018



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Site

Culverts / Monitoring Site

DWER 1m LiDAR Contours Swan Coastal Plain

Floodway

Flood Fringe

Option B : Bussel lHwy Route

Option A : Osprey Drive Route

Existing Reinscourt Flowpath to Sabina River

0 20 40 80 120 160 Meters

hyd2o

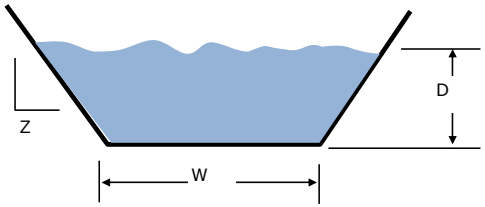
Lot 2, 9032 & 9034 Bussell Hwy Busselton LWMS

Options for Alternative Outflow Routes

Appendix H

Mannings Calculator

Approx. Base Channel Width (w)	3.0	m
Depth of Water (D)	0.5	m
Mainstream Channel Grade (1 in x)	1250.0	m
Side Slope (1 : z)	3.0	m
Mainstream Average Roughness (n)	0.035	
Area (A)	2.250	m^2
Hydraulic Radius (H)	0.365	m
Slope	0.001	m/m
Wettted Perimeter (P)	6.162	m



0.929	Flow (m^3/s)
0.413	Velocity (m/s)

hyd2o HYDROLOGY

Sensitivity Analysis

Depth (% variation to analyse)	30%	Flow (m^3/s)	Change (%)
Lower Bound	0.4	0.48	-48%
	0.5	0.93	0
Upper Bound	0.7	1.53	65%
Width (% variation to analyse)	25%		
Lower Bound	2.3	0.75	-20%
	3.0	0.93	0
Upper Bound	3.8	1.11	20%
Grade (% variation to analyse)	20%		
Lower Bound	1000.0	1.04	12%
	1250.0	0.93	0
Upper Bound	1500.0	0.85	-9%
Manning's n (% variation to analyse)	20%		
Lower Bound	0.042	0.77	-17%
	0.035	0.93	0
Upper Bound	0.028	1.16	25%

Flow Rating Curve

Depth Increment (m) 0.20

Water Depth (m)	Area (m^2)	Perimter (m)	Radius (m)	Flow (m^2/s)
0.00	0.000	3.000	0.000	0.000
0.20	0.720	4.265	0.169	0.178
0.40	1.680	5.530	0.304	0.614
0.60	2.880	6.795	0.424	1.313
0.80	4.320	8.060	0.536	2.304
1.00	6.000	9.325	0.643	3.614
1.20	7.920	10.589	0.748	5.274
1.40	10.080	11.854	0.850	7.311
1.60	12.480	13.119	0.951	9.755
1.80	15.120	14.384	1.051	12.632
2.00	18.000	15.649	1.150	15.969

APPENDIX I

Site Water Quality Monitoring Data

FieldDAE

Field Data Analysis & Evaluation System

Monitoring Sites

	Site	Name / Type	Easting m	Northing m	Nat Surf mAHD	Top of Case mAHD
1	BA1	JDA Bore 1	349620	6274364	2.98	3.45
2	BA2	JDA Bore 2	350554	6274589	3.70	4.52
3	BA3	JDA Bore 3	350722	6274080	4.50	4.95
4	BA4	JDA Bore 4	351599	6273883	6.08	6.89
5	BA5	JDA Bore 5	351588	6274288	5.78	6.21
6	BA6	JDA Bore 6	351557	6274834	4.75	5.26
7	BA7	JDA Bore 7	349960	6273673	5.61	5.92
8	BA8	JDA Bore 8	350185	6273234	5.61	6.07
9	BA9	JDA Bore 9	351130	6274121		
10	BA11	JDA Bore 11	349932	6274018	4.03	4.89
11	BA12	JDA Bore 12	350171	6274144	4.30	5.64
12	BA13	JDA Bore 13	350054	6274156	4.35	5.62
13	BA14	JDA Bore 14	352047	6274342	6.94	7.74
14	BA15	JDA Bore 15	351793	6274905	4.94	5.18
15	BA16	JDA Bore 16	351691	6274433	5.47	6.06
16	BA17	JDA Bore 17	349556	6273827	3.91	4.80
17	BA18	JDA Bore 18	349095	6273642	4.37	4.59
18	BA19	JDA Bore 19	349488	6273218	6.10	6.92
19	BA20	JDA Bore 20	349881	6273365	6.20	6.91
20	BA21	JDA Bore 21	349780	6272908	6.07	6.92
21	FP01	Footprint Lake Monitoring Bore 1	350733	6273607	6.40	6.83
22	FP02	Footprint Lake Monitoring Bore 2	350839	6273607	6.41	7.03
23	FP03	Footprint Lake Monitoring Bore 3	350921	6273568	6.56	7.10
24	FP04	Footprint Lake Monitoring Bore 4	350819	6273423	5.83	6.40
25	MB3	RPS Bore 3	350736.4	6274630.7	3.95	4.55
26	MB4	RPS Bore 4	350610	6274544.8	3.99	4.58
27	MB5	RPS Bore 5	350721.9	6274521.08	4.20	4.80
28	MB7	RPS Bore 7	350833.4	6274605.85	4.12	4.66
29	MB8	RPS Bore 8	350771.9	6274628.46	3.93	4.49
30	MB9	RPS Bore 9	350724.8	6274604.04	3.91	4.48
31	MB10	RPS Bore 10	350685.7	6274598.49	3.87	4.40
32	MB11	RPS Bore 11	350659.4	6274582.03	4.02	4.56
33	MB14	RPS Bore 14	350690.6	6274764.46	3.33	3.89
34	MB15	RPS Bore 15	350794.6	6274877.36	3.44	3.96
35	MB16	RPS Bore 16	350799.5	6274842.04	3.43	3.98
36	MB17	RPS Bore 17	350805.7	6274788.99	3.37	3.95
37	MB18	RPS Bore 18	350912.7	6274817.32	3.60	4.16
38	UK1	Unknown Bore 1	350732	6274607		
39	UK2	Unknown Bore 2	350231	6274491		
40	18S	DWER Bore 18S	348949.5	6273758.72	4.30	4.91
41	19S	DWER Bore 19S	352717.8	6274797.5	5.58	6.31
42	PSW1	JDA Surface Water Site 1				
43	PSW2	JDA Surface Water Site 2				
44	PSW3	JDA Surface Water Site 3				
45	PSW4	JDA Surface Water Site 4				
46	PSW5	JDA Surface Water Site 5				

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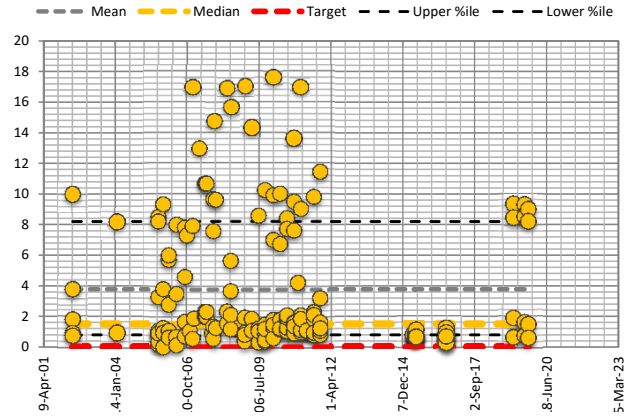
Aggregated Data for All Sites
Groundwater

Data Analysis Period Start Date	1/01/2000
Data Analysis Period End Date	31/12/2022

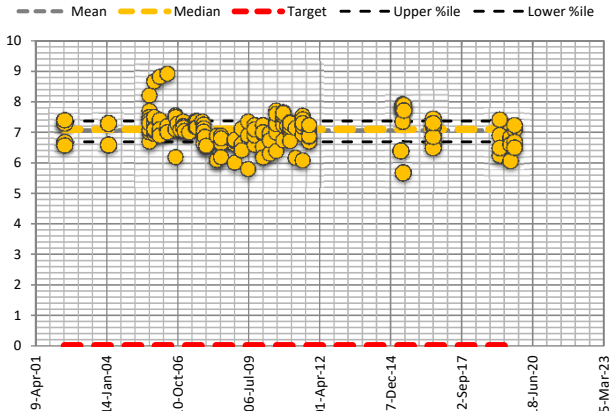
Report Date : 23/02/2023

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	11	2.70	2.76	2.80	**2.80**	2.80	3.01		0
GWL mAHD	Groundwater Level	mAHD	936	0.76	2.57	3.51	**3.46**	4.40	5.98		0
T	Temperature	°C	80	14.90	17.2	19.3	**18.8**	21.1	27.6		0
EC	Electrical Conductivity	mS/cm	166	0.04	0.78	3.77	**1.51**	8.20	17.63		0
pH	pH	pH	166	5.68	6.69	7.06	**7.10**	7.37	8.90		0
TN	Total Nitrogen	mg/L	159	0.10	1.06	7.44	**2.90**	9.46	100.00	1.20	120
TKN	Total Kjeldahl Nitogen	mg/L	135	0.05	0.56	3.03	**1.70**	4.00	26.00		0
NH3-N	Ammonia as N	mg/L	127	0.01	0.02	0.23	**0.10**	0.32	2.70	0.90	7
NO_3-N	Nitrate as N	mg/L	7	0.01	0.07	5.24	**0.58**	12.16	17.00	0.70	3
NO_2-N	Nitrite as N	mg/L	7	0.01	0.01	0.11	**0.07**	0.13	0.42		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	116	0.01	0.04	4.26	**0.33**	6.50	82.00		0
TP	Total Phosphorous	mg/L	154	0.01	0.04	0.24	**0.14**	0.33	3.10		0
FRP	Filterable Reactive Phosphorous	mg/L	85	0.01	0.01	0.07	**0.01**	0.05	0.84		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.05500	0
As	Arsenic	mg/L	7	0.00	0.00	0.01	**0.00**	0.01	0.07	0.02400	1
Cd	Cadmium	mg/L	7	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00020	7
Cr	Chromium	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01	0.00100	7
Cu	Copper	mg/L	7	0.01	0.01	0.01	**0.01**	0.01	0.01	0.00140	7
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	7	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	7	0.01000	0.01000	0.01286	**0.01000**	0.01000	0.03000	0.01100	1
HG	Mercury	mg/L	7	0.00020	0.00020	0.00026	**0.00020**	0.00030	0.00040	0.00060	0
PB	Lead	mg/L	7	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	7
Fe-D	Dissolved Iron	mg/L	12	0.11	0.96	11.56	**10.75**	23.40	25.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	30	225.50	464.80	3212.73	**1400.00**	6000.00	11000.00		0
TSS	Total Suspended Solids	mg/L	3	1200.00	1360.00	1466.67	**1600.00**	1600.00	1600.00		0

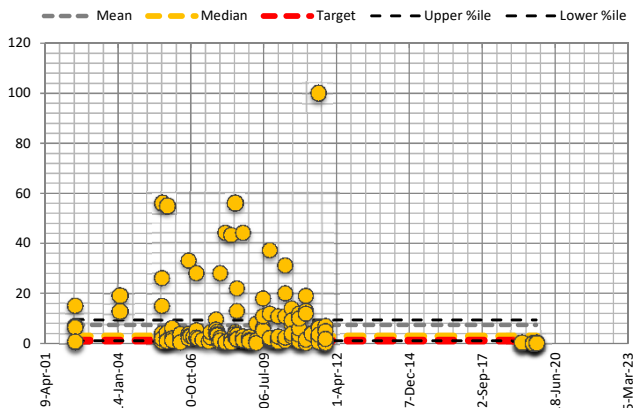
Electrical Conductivity



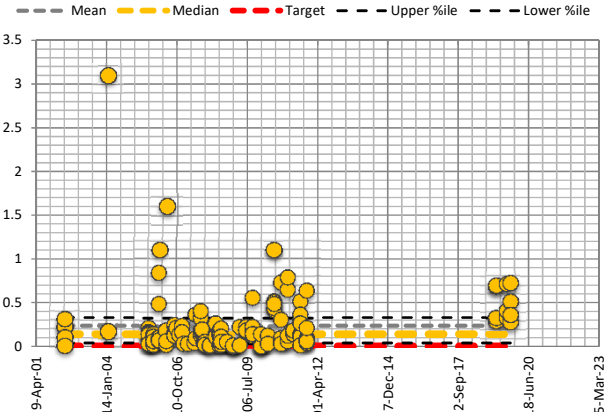
pH



Total Nitrogen



Total Phosphorous



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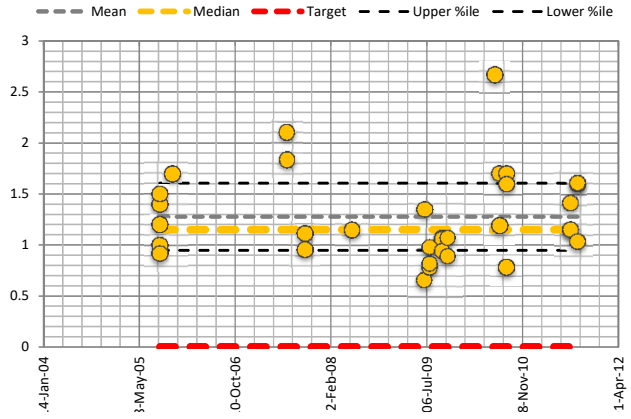
Aggregated Data for All Sites
Surface Water

Data Analysis Period Start Date	1/01/2000
Data Analysis Period End Date	31/12/2022

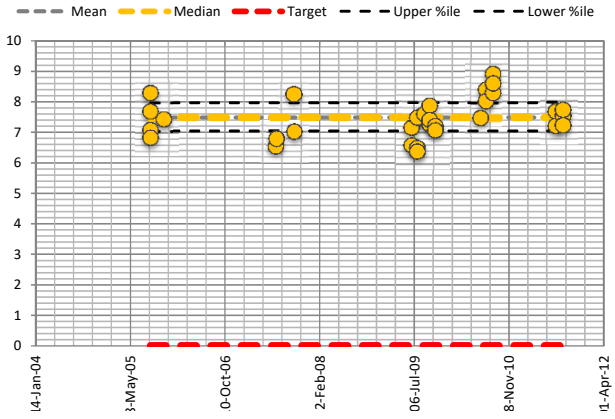
Report Date : 23/02/2023

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
T	Temperature	°C	16	13.80	16.2	19.2	**18.7**	22.1	27.1		0
EC	Electrical Conductivity	mS/cm	33	0.66	0.95	1.28	**1.15**	1.61	2.67		0
pH	pH	pH	33	6.40	7.05	7.49	**7.49**	7.97	8.90		0
TN	Total Nitrogen	mg/L	40	0.24	0.96	2.00	**2.10**	2.90	4.10	1.20	28
TKN	Total Kjeldahl Nitogen	mg/L	36	0.21	0.94	1.73	**1.80**	2.40	4.10		0
NH3-N	Ammonia as N	mg/L	34	0.01	0.01	0.12	**0.06**	0.11	0.91	0.90	1
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	28	0.01	0.01	0.25	**0.03**	0.37	3.10		0
TP	Total Phosphorous	mg/L	34	0.01	0.06	0.20	**0.15**	0.27	1.10		0
FRP	Filterable Reactive Phosphorous	mg/L	31	0.01	0.01	0.07	**0.04**	0.10	0.38		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.05500	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02400	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00020	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00100	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.00140	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	15	0.00	19.20	430.63	**489.50**	588.50	950.00		0
TSS	Total Suspended Solids	mg/L	36	1.00	1.00	8.33	**3.50**	12.00	43.00		0

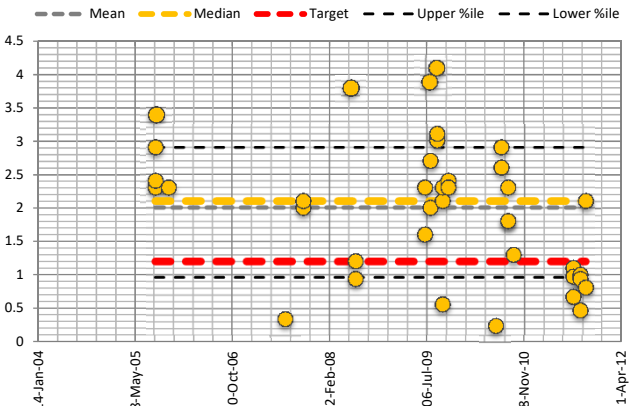
Electrical Conductivity



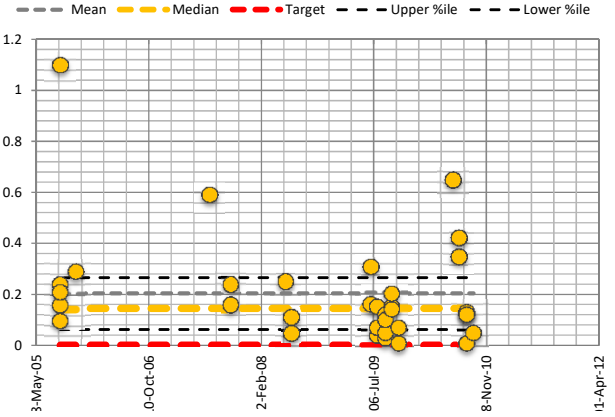
pH



Total Nitrogen



Total Phosphorous



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BA1 JDA Bore 1

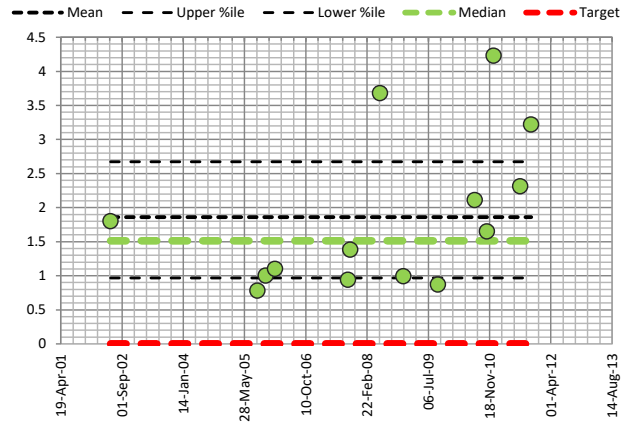
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hyd2o HYDROLOGY

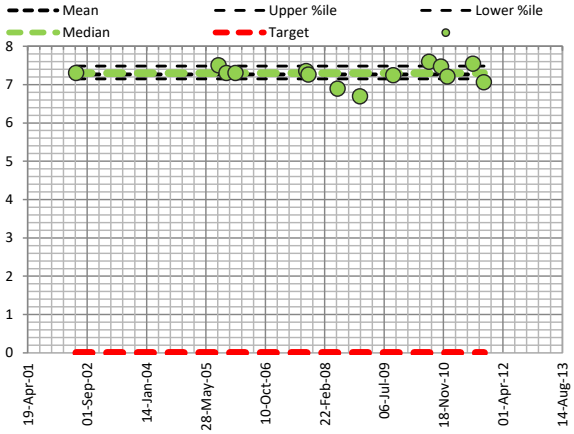
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	59	1.70	1.89	2.30	**2.32**	2.62	3.06		0
T	Temperature	°C	6	15.60	15.80	17.38	**17.20**	19.00	19.50		0
EC	Electrical Conductivity	mS/cm	14	0.78	0.97	1.86	**1.52**	2.67	4.23		0
pH	pH	pH	14	6.69	7.15	7.26	**7.30**	7.48	7.59		0
TN	Total Nitrogen	mg/L	16	1.10	2.20	3.19	**2.85**	4.10	6.80	1.20	15
TKN	Total Kjeldahl Nitogen	mg/L	13	1.10	2.20	3.02	**2.80**	3.88	6.50		0
NH3-N	Ammonia as N	mg/L	11	0.01	0.01	0.07	**0.04**	0.14	0.20	0.90	0
NO_3-N	Nitrate as N	mg/L	1	0.26	0.26	0.26	**0.26**	0.26	0.26	0.70	0
NO_2-N	Nitrite as N	mg/L	1	0.07	0.07	0.07	**0.07**	0.07	0.07		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	10	0.01	0.01	0.04	**0.03**	0.07	0.13		0
TP	Total Phosphorous	mg/L	15	0.02	0.06	0.27	**0.15**	0.24	1.10		0
FRP	Filterable Reactive Phosphorous	mg/L	7	0.01	0.01	0.02	**0.01**	0.03	0.05		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	1
Cr	Chromium	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.001	1
Cu	Copper	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.0014	1
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
HG	Mercury	mg/L	1	0.00030	0.00030	0.00030	**0.00030**	0.00030	0.00030	0.00060	0
PB	Lead	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	1
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	2	478.50	602.80	789.25	**789.25**	975.70	1100.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

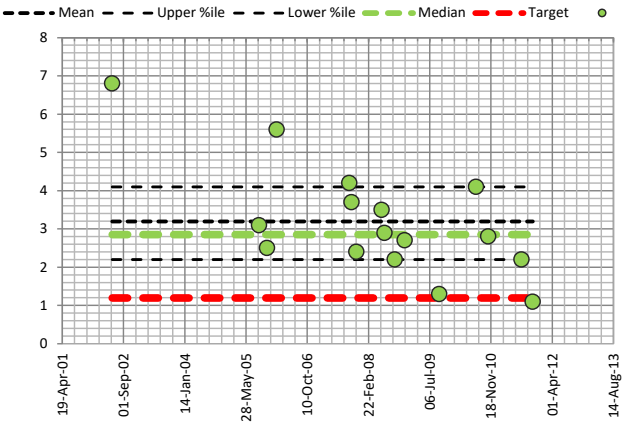
Electrical Conductivity



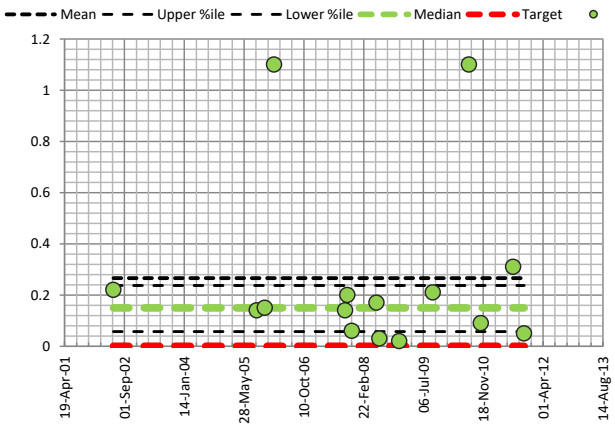
pH



Total Nitrogen



Total Phosphorous



FieldDAE
Field Data Analysis & Evaluation System

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BA3 JDA Bore 3

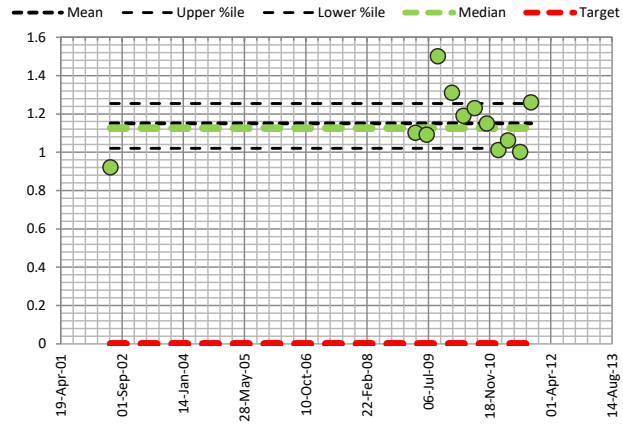
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hyd2o HYDROLOGY

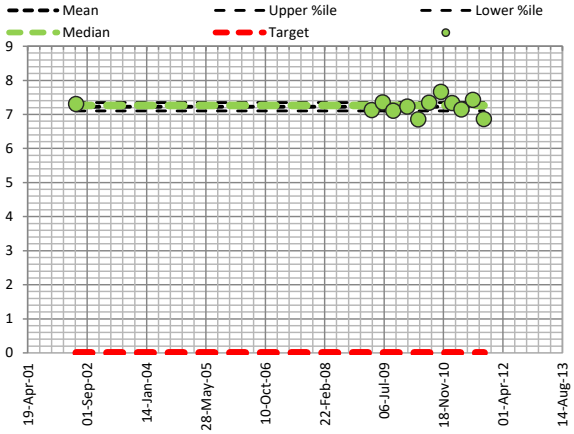
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	44	2.95	3.36	3.69	**3.72**	4.06	4.37		0
T	Temperature	°C	5	17.10	18.38	19.52	**19.50**	20.34	22.50		0
EC	Electrical Conductivity	mS/cm	12	0.92	1.02	1.15	**1.13**	1.25	1.50		0
pH	pH	pH	12	6.85	7.10	7.23	**7.27**	7.35	7.66		0
TN	Total Nitrogen	mg/L	11	0.95	6.40	8.32	**8.00**	11.00	13.00	1.20	10
TKN	Total Kjeldahl Nitogen	mg/L	11	0.11	0.64	1.69	**1.40**	2.20	5.80		0
NH3-N	Ammonia as N	mg/L	11	0.01	0.01	0.08	**0.04**	0.13	0.30	0.90	0
NO_3-N	Nitrate as N	mg/L	1	4.80	4.80	4.80	**4.80**	4.80	4.80	0.70	1
NO_2-N	Nitrite as N	mg/L	1	0.15	0.15	0.15	**0.15**	0.15	0.15		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	10	0.25	4.12	6.66	**6.80**	10.00	10.00		0
TP	Total Phosphorous	mg/L	11	0.01	0.07	0.13	**0.13**	0.19	0.23		0
FRP	Filterable Reactive Phosphorous	mg/L	8	0.01	0.01	0.02	**0.01**	0.03	0.08		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	1
Cr	Chromium	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.001	1
Cu	Copper	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.0014	1
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
HG	Mercury	mg/L	1	0.00040	0.00040	0.00040	**0.00040**	0.00040	0.00040	0.00060	0
PB	Lead	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	1
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	1	550.00	550.00	550.00	**550.00**	550.00	550.00		0
TSS	Total Suspended Solids	mg/L	1	1600.00	1600.00	1600.00	**1600.00**	1600.00	1600.00		0

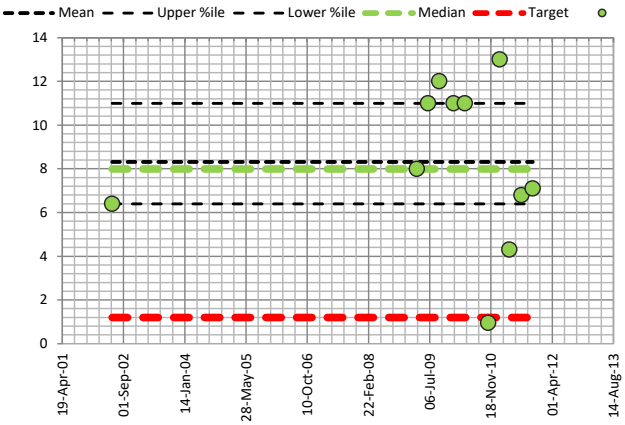
Electrical Conductivity



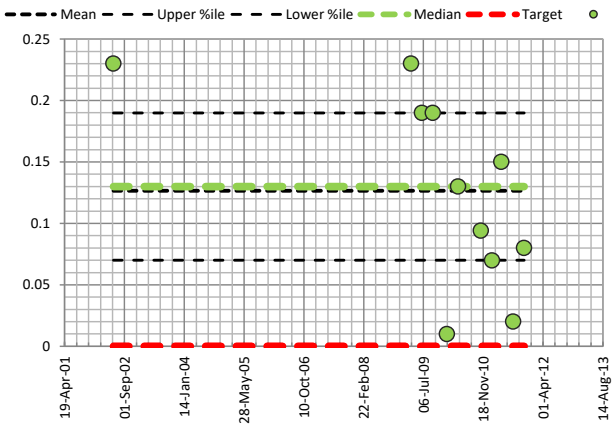
pH



Total Nitrogen



Total Phosphorous



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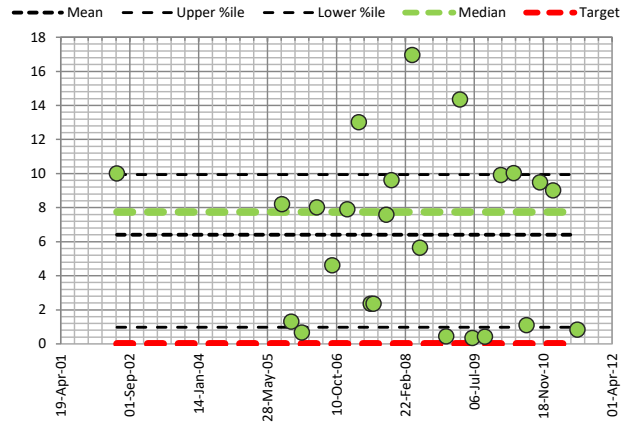
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Northing	6273883	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

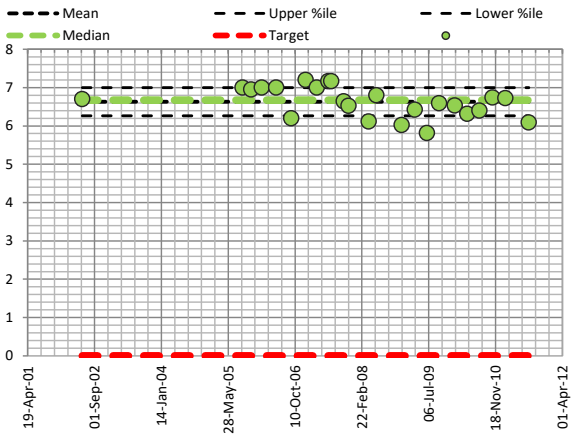
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		✓ 0
GWL mAHD	Groundwater Level	mAHD	80	3.24	3.83	4.14	**4.14**	4.41	4.99		✓ 0
T	Temperature	°C	9	16.50	17.38	19.41	**18.50**	21.44	23.70		✓ 0
EC	Electrical Conductivity	mS/cm	24	0.35	0.99	6.42	**7.74**	9.94	16.95		✓ 0
pH	pH	pH	24	5.81	6.27	6.63	**6.67**	7.00	7.20		✓ 0
TN	Total Nitrogen	mg/L	28	0.37	1.12	4.08	**2.20**	4.76	31.00	1.20	✗ 22
TKN	Total Kjeldahl Nitogen	mg/L	24	0.31	1.07	3.20	**2.15**	4.50	15.00		✓ 0
NH3-N	Ammonia as N	mg/L	24	0.04	0.15	0.49	**0.30**	0.64	2.70	0.90	✗ 3
NO_3-N	Nitrate as N	mg/L	1	0.02	0.02	0.02	**0.02**	0.02	0.02	0.70	✓ 0
NO_2-N	Nitrite as N	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01		✓ 0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		✓ 0
Nox-N	NOX-N	mg/L	19	0.01	0.02	1.56	**0.06**	1.11	16.00		✓ 0
TP	Total Phosphorous	mg/L	27	0.01	0.04	0.19	**0.13**	0.21	1.10		✓ 0
FRP	Filterable Reactive Phosphorous	mg/L	14	0.01	0.01	0.01	**0.01**	0.01	0.03		✓ 0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	✓ 0
As	Arsenic	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	✓ 0
Cd	Cadmium	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	✗ 1
Cr	Chromium	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.001	✗ 1
Cu	Copper	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.0014	✗ 1
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	✓ 0
Ni	Nickel	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	✓ 0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	✓ 0
Zn	Zinc	mg/L	1	0.03000	0.03000	0.03000	**0.03000**	0.03000	0.03000	0.01100	✗ 1
HG	Mercury	mg/L	1	0.00020	0.00020	0.00020	**0.00020**	0.00020	0.00020	0.00060	✓ 0
PB	Lead	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	✗ 1
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		✓ 0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		✓ 0
TDS	Total Dissolved Solids	mg/L	5	225.50	2365.10	4685.10	**4800.00**	7420.00	8300.00		✓ 0
TSS	Total Suspended Solids	mg/L	2	1200.00	1280.00	1400.00	**1400.00**	1520.00	1600.00		✓ 0

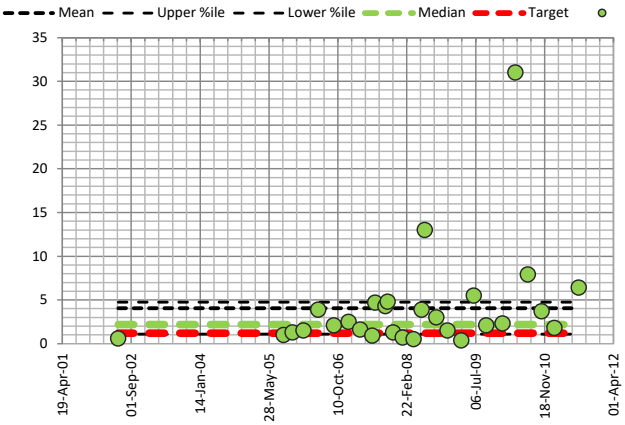
Electrical Conductivity



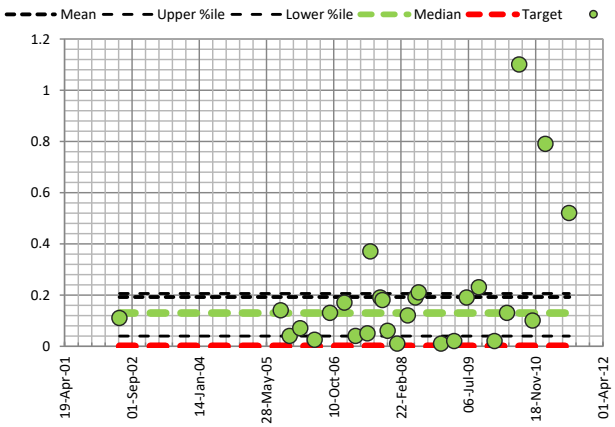
pH



Total Nitrogen



Total Phosphorous



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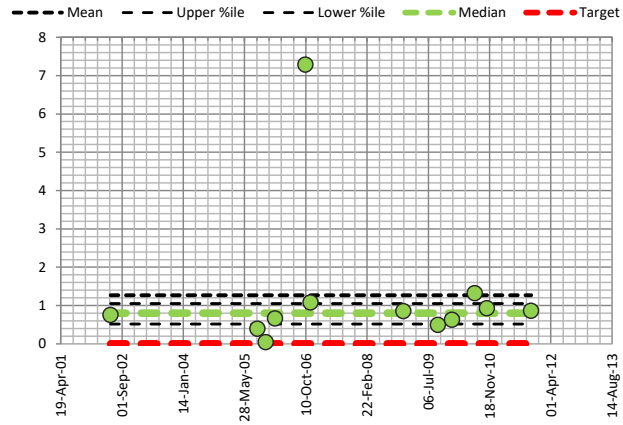
Easting	351557	Data Analysis Period Start Date	01-01-00
Northing	6274834	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

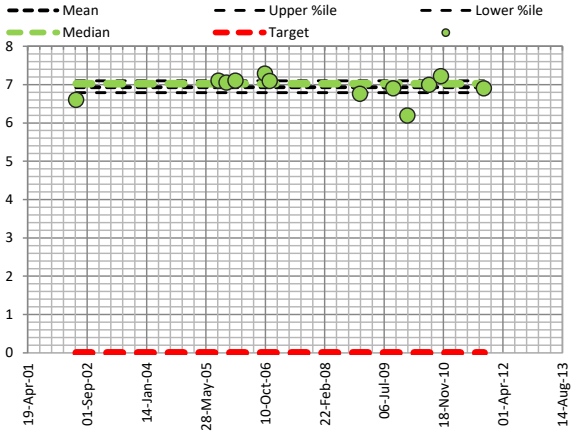
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	55	1.82	1.97	2.30	**2.28**	2.62	2.91		0
T	Temperature	°C	5	17.70	17.86	19.52	**18.40**	20.60	23.80		0
EC	Electrical Conductivity	mS/cm	12	0.04	0.52	1.27	**0.80**	1.05	7.28		0
pH	pH	pH	12	6.19	6.79	6.93	**7.02**	7.10	7.28		0
TN	Total Nitrogen	mg/L	13	0.33	1.03	3.65	**2.40**	5.34	15.00	1.20	9
TKN	Total Kjeldahl Nitogen	mg/L	11	0.14	0.54	1.33	**0.91**	2.60	3.10		0
NH3-N	Ammonia as N	mg/L	9	0.01	0.06	0.21	**0.16**	0.38	0.48	0.90	0
NO_3-N	Nitrate as N	mg/L	1	14.00	14.00	14.00	**14.00**	14.00	14.00	0.70	1
NO_2-N	Nitrite as N	mg/L	1	0.03	0.03	0.03	**0.03**	0.03	0.03		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	8	0.02	0.09	1.73	**0.57**	3.68	5.60		0
TP	Total Phosphorous	mg/L	13	0.01	0.04	0.19	**0.12**	0.27	0.73		0
FRP	Filterable Reactive Phosphorous	mg/L	5	0.01	0.01	0.02	**0.01**	0.02	0.07		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	1
Cr	Chromium	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.001	1
Cu	Copper	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.0014	1
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
HG	Mercury	mg/L	1	0.00020	0.00020	0.00020	**0.00020**	0.00020	0.00020	0.00060	0
PB	Lead	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	1
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	2	269.50	297.60	339.75	**339.75**	381.90	410.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

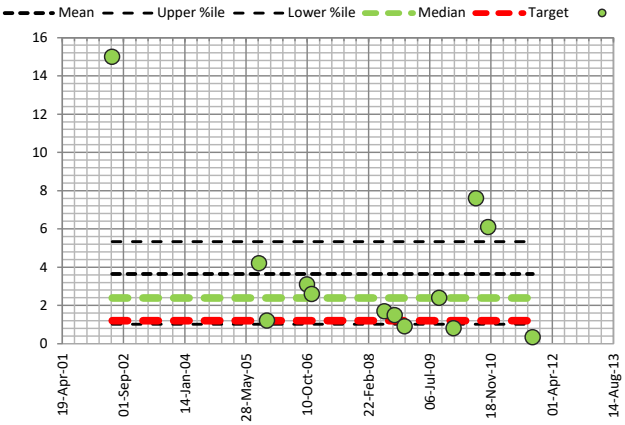
Electrical Conductivity



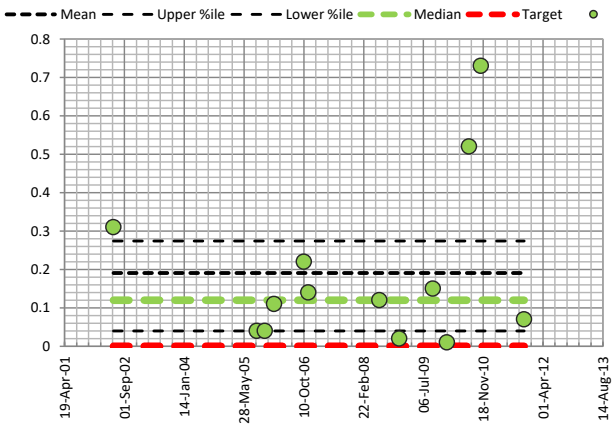
pH



Total Nitrogen



Total Phosphorous



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BA7 JDA Bore 7

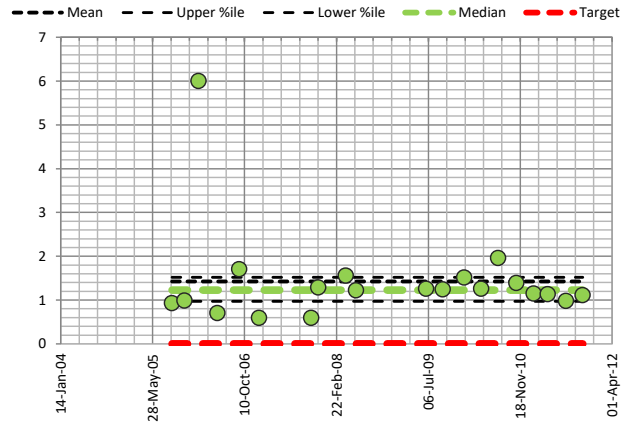
Easting	349960	Data Analysis Period Start Date	01-01-00
Northing	6273673	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

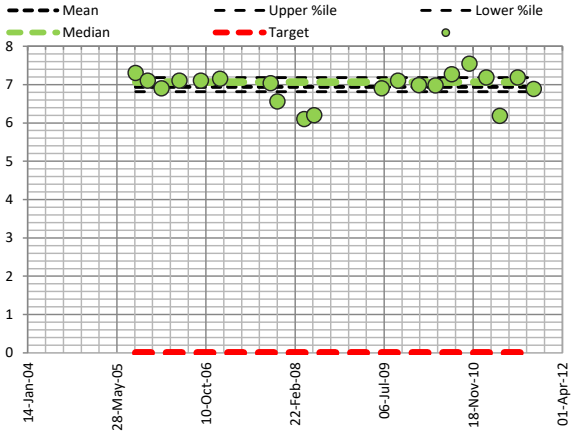
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	61	3.45	3.84	4.21	**4.21**	4.53	4.94		0
T	Temperature	°C	11	17.50	18.00	20.05	**18.90**	22.00	24.60		0
EC	Electrical Conductivity	mS/cm	20	0.59	0.97	1.43	**1.23**	1.52	6.00		0
pH	pH	pH	20	6.10	6.82	6.94	**7.07**	7.18	7.54		0
TN	Total Nitrogen	mg/L	22	2.20	4.12	23.00	**19.00**	41.80	56.00	1.20	22
TKN	Total Kjeldahl Nitogen	mg/L	19	0.14	1.80	7.70	**5.50**	13.40	26.00		0
NH3-N	Ammonia as N	mg/L	16	0.01	0.02	0.16	**0.07**	0.23	0.96	0.90	1
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	16	1.90	3.20	13.44	**12.75**	18.00	31.00		0
TP	Total Phosphorous	mg/L	20	0.02	0.04	0.24	**0.20**	0.43	0.64		0
FRP	Filterable Reactive Phosphorous	mg/L	9	0.01	0.01	0.09	**0.02**	0.05	0.64		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	1	682.00	682.00	682.00	**682.00**	682.00	682.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

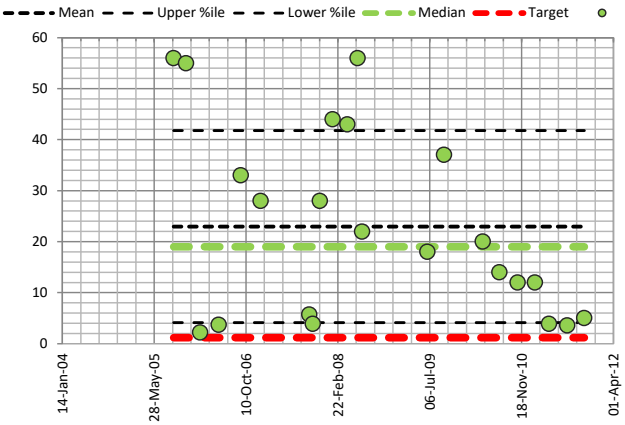
Electrical Conductivity



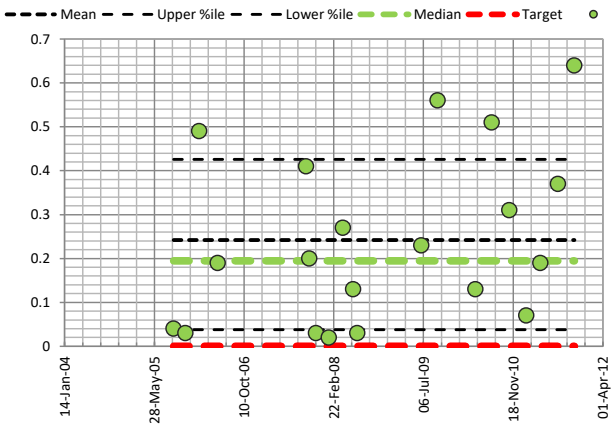
pH



Total Nitrogen



Total Phosphorous



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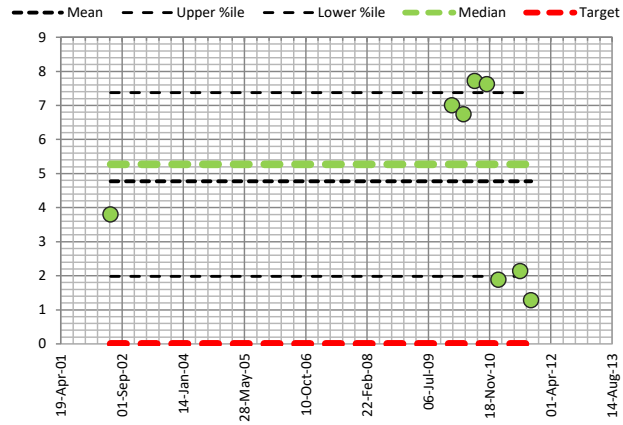
Easting	350185	Data Analysis Period Start Date	01-01-00
Northing	6273234	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

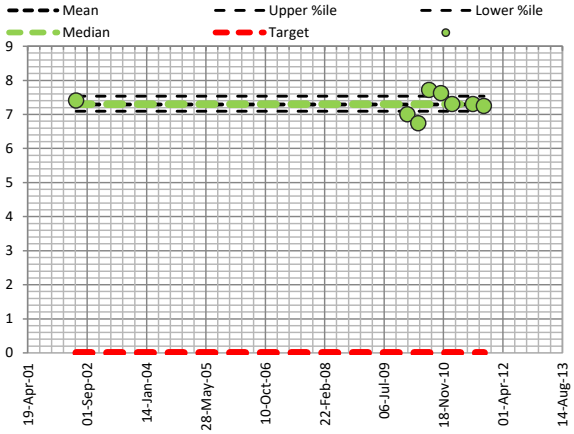
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	74	4.22	4.50	5.00	**4.99**	5.51	5.83		0
T	Temperature	°C	6	17.00	17.30	19.63	**18.05**	19.80	27.60		0
EC	Electrical Conductivity	mS/cm	8	1.28	1.98	4.77	**5.27**	7.37	7.71		0
pH	pH	pH	8	6.74	7.10	7.29	**7.30**	7.53	7.71		0
TN	Total Nitrogen	mg/L	11	0.90	2.00	17.81	**3.40**	19.00	100.00	1.20	10
TKN	Total Kjeldahl Nitogen	mg/L	11	0.12	0.80	3.50	**1.80**	3.40	18.00		0
NH3-N	Ammonia as N	mg/L	11	0.01	0.01	0.07	**0.03**	0.15	0.20	0.90	0
NO_3-N	Nitrate as N	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.70	0
NO_2-N	Nitrite as N	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	9	0.06	1.17	16.45	**6.20**	20.80	82.00		0
TP	Total Phosphorous	mg/L	10	0.01	0.04	0.15	**0.10**	0.23	0.49		0
FRP	Filterable Reactive Phosphorous	mg/L	8	0.01	0.01	0.04	**0.01**	0.03	0.22		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	1
Cr	Chromium	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.001	1
Cu	Copper	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.0014	1
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
HG	Mercury	mg/L	1	0.00030	0.00030	0.00030	**0.00030**	0.00030	0.00030	0.00060	0
PB	Lead	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	1
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	1	1600.00	1600.00	1600.00	**1600.00**	1600.00	1600.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

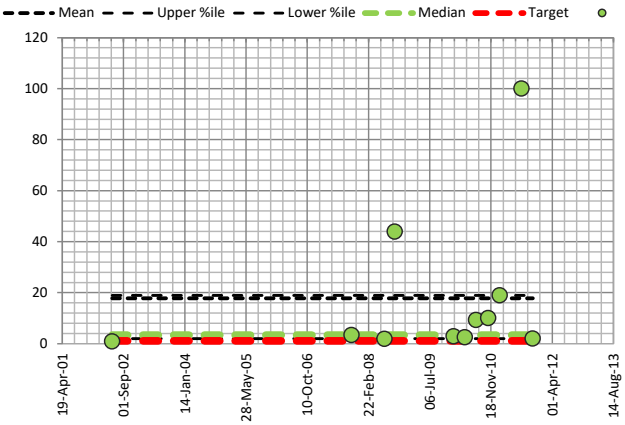
Electrical Conductivity



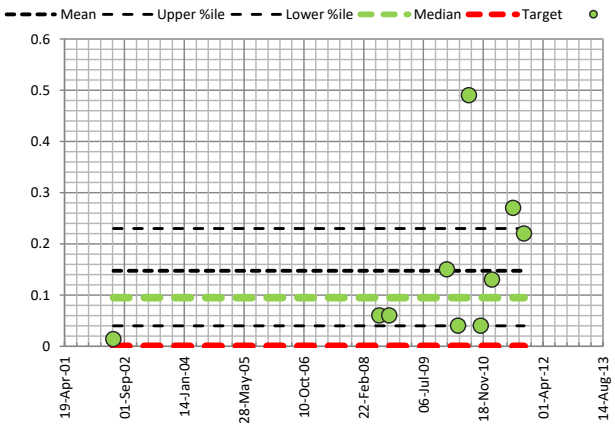
pH



Total Nitrogen



Total Phosphorous



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BA9 JDA Bore 9

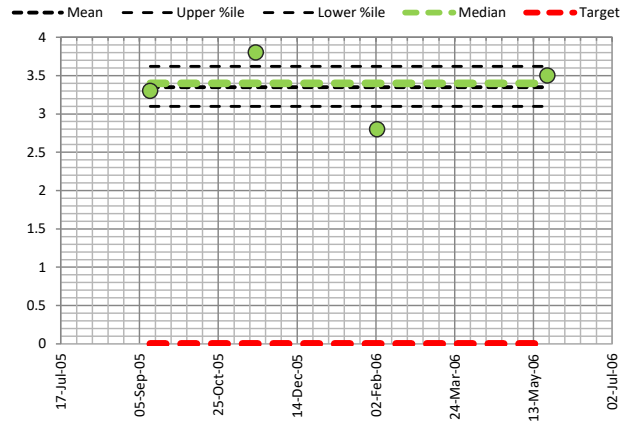
Easting	351130	Data Analysis Period Start Date	01-01-00
Northing	6274121	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

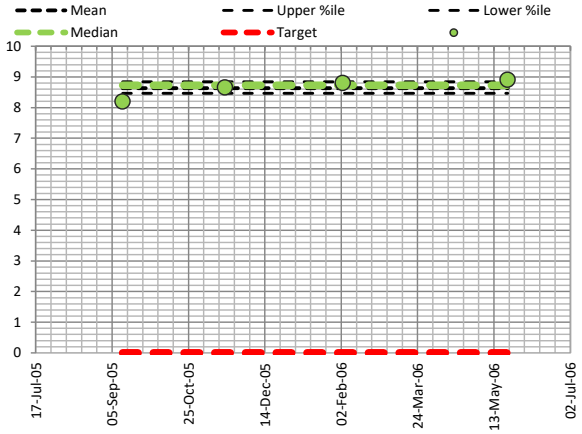
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
T	Temperature	°C	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
EC	Electrical Conductivity	mS/cm	4	2.80	3.10	3.35	**3.40**	3.62	3.80		0
pH	pH	pH	4	8.20	8.47	8.64	**8.73**	8.84	8.90		0
TN	Total Nitrogen	mg/L	4	0.60	0.90	1.30	**1.25**	1.68	2.10	1.20	2
TKN	Total Kjeldahl Nitogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH3-N	Ammonia as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TP	Total Phosphorous	mg/L	4	0.04	0.06	0.07	**0.07**	0.07	0.08		0
FRP	Filterable Reactive Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

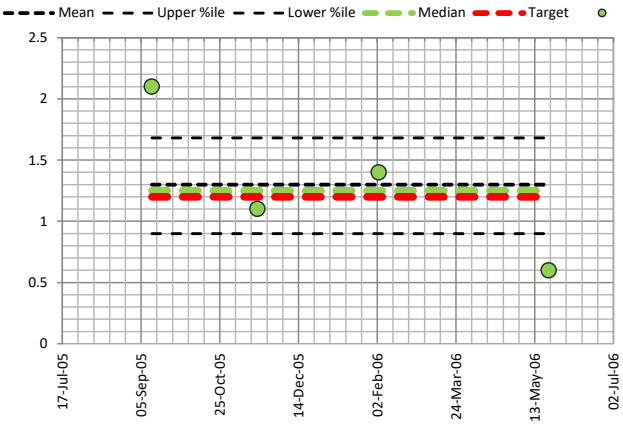
Electrical Conductivity



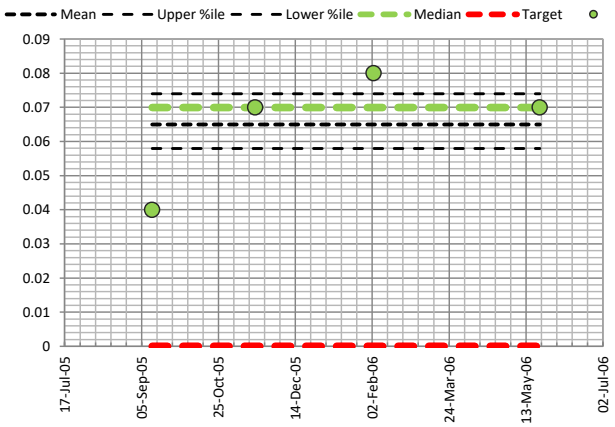
pH



Total Nitrogen



Total Phosphorous



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BA14 JDA Bore 14

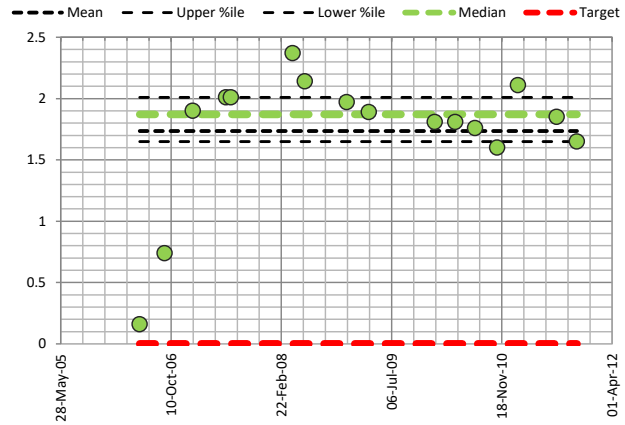
Easting	352047	Data Analysis Period Start Date	01-01-00
Northing	6274342	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

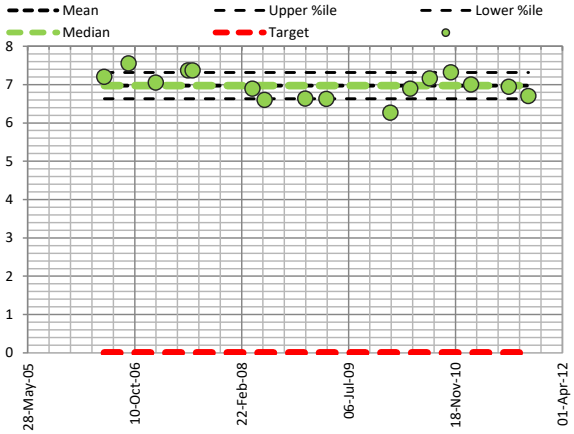
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	56	2.21	2.49	2.75	**2.67**	3.05	3.55		0
T	Temperature	°C	8	18.50	20.94	22.06	**22.95**	23.32	23.60		0
EC	Electrical Conductivity	mS/cm	16	0.16	1.65	1.74	**1.87**	2.01	2.37		0
pH	pH	pH	16	6.26	6.63	6.97	**6.97**	7.32	7.55		0
TN	Total Nitrogen	mg/L	16	0.56	1.10	2.00	**1.95**	3.00	4.10	1.20	10
TKN	Total Kjeldahl Nitogen	mg/L	14	0.05	0.66	1.27	**1.10**	2.07	2.60		0
NH3-N	Ammonia as N	mg/L	14	0.03	0.12	0.24	**0.18**	0.36	0.57	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	15	0.13	0.19	0.78	**0.42**	1.52	2.60		0
TP	Total Phosphorous	mg/L	15	0.01	0.02	0.19	**0.05**	0.16	1.60		0
FRP	Filterable Reactive Phosphorous	mg/L	8	0.01	0.01	0.01	**0.01**	0.01	0.07		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	1	480.00	480.00	480.00	**480.00**	480.00	480.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

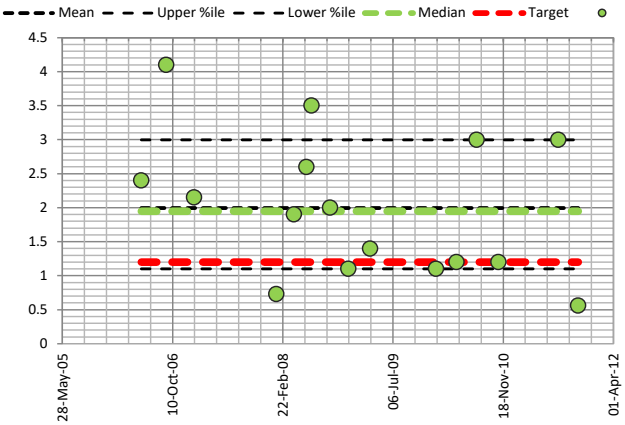
Electrical Conductivity



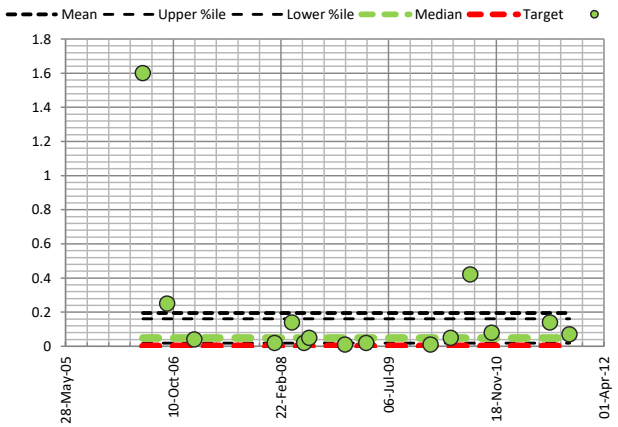
pH



Total Nitrogen



Total Phosphorous



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BA21 JDA Bore 21

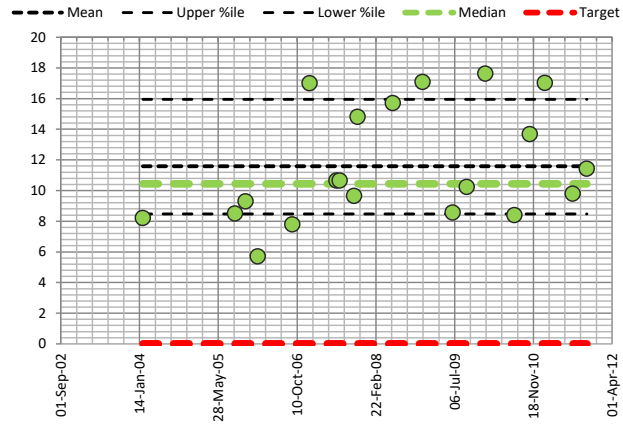
Easting	349780	Data Analysis Period Start Date	01-01-00
Northing	6272908	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

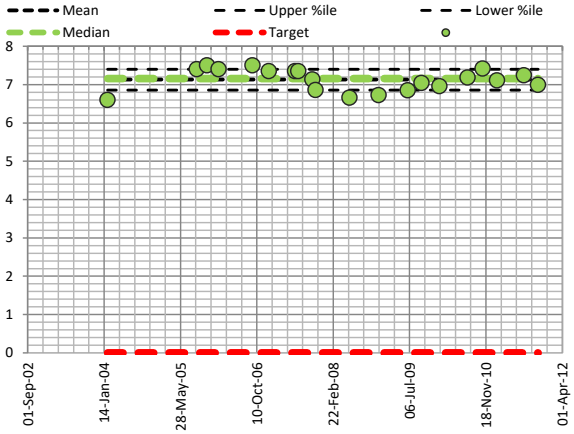
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	80	3.85	4.22	4.79	**4.64**	5.41	5.98		0
T	Temperature	°C	9	17.00	17.38	18.83	**17.70**	20.12	23.90		0
EC	Electrical Conductivity	mS/cm	20	5.70	8.48	11.59	**10.44**	15.96	17.63		0
pH	pH	pH	20	6.60	6.86	7.13	**7.16**	7.40	7.50		0
TN	Total Nitrogen	mg/L	22	0.25	0.96	3.39	**2.45**	5.26	13.00	1.20	16
TKN	Total Kjeldahl Nitogen	mg/L	19	0.22	0.73	2.75	**1.50**	3.52	12.00		0
NH3-N	Ammonia as N	mg/L	18	0.01	0.02	0.34	**0.06**	0.30	2.50	0.90	3
NO_3-N	Nitrate as N	mg/L	1	0.58	0.58	0.58	**0.58**	0.58	0.58	0.70	0
NO_2-N	Nitrite as N	mg/L	1	0.42	0.42	0.42	**0.42**	0.42	0.42		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	17	0.03	0.05	0.49	**0.09**	0.47	4.40		0
TP	Total Phosphorous	mg/L	22	0.01	0.07	0.33	**0.14**	0.31	3.10		0
FRP	Filterable Reactive Phosphorous	mg/L	13	0.01	0.01	0.05	**0.02**	0.06	0.22		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	1	0.07	0.07	0.07	**0.07**	0.07	0.07	0.02	1
Cd	Cadmium	mg/L	1	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	1
Cr	Chromium	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.001	1
Cu	Copper	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01	0.0014	1
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.01100	0
HG	Mercury	mg/L	1	0.00020	0.00020	0.00020	**0.00020**	0.00020	0.00020	0.00060	0
PB	Lead	mg/L	1	0.01000	0.01000	0.01000	**0.01000**	0.01000	0.01000	0.00340	1
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	4	4700.00	5255.90	6931.63	**6013.25**	8240.00	11000.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

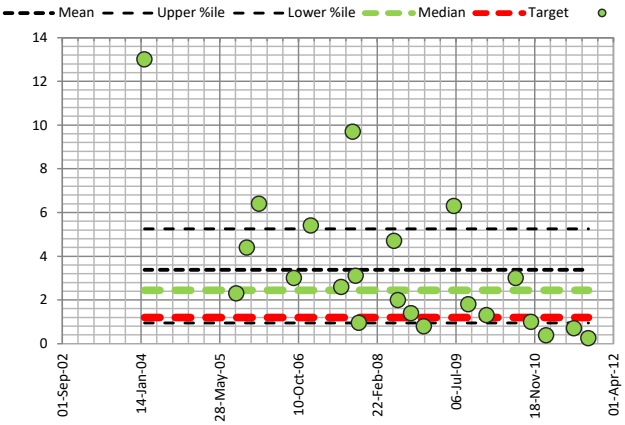
Electrical Conductivity



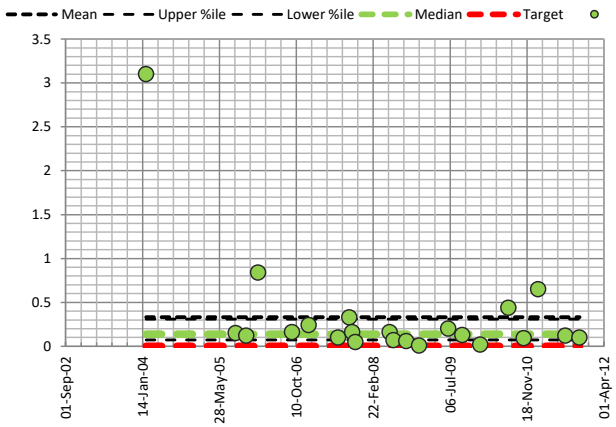
pH



Total Nitrogen



Total Phosphorous



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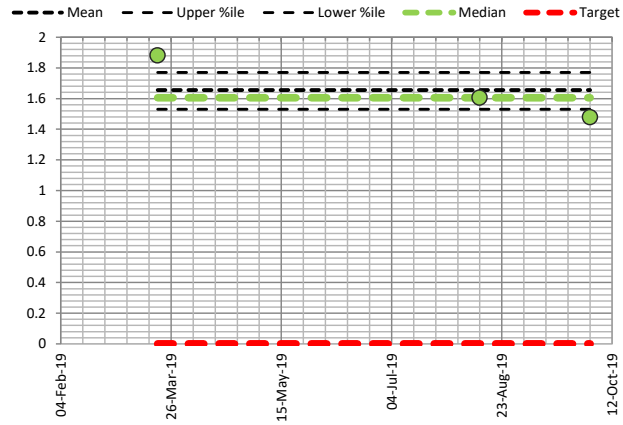
FP01 Footprint Lake Monitoring Bore 1

Easting	350733	Data Analysis Period Start Date	01-01-00
Northing	6273607	Data Analysis Period End Date	31-12-22

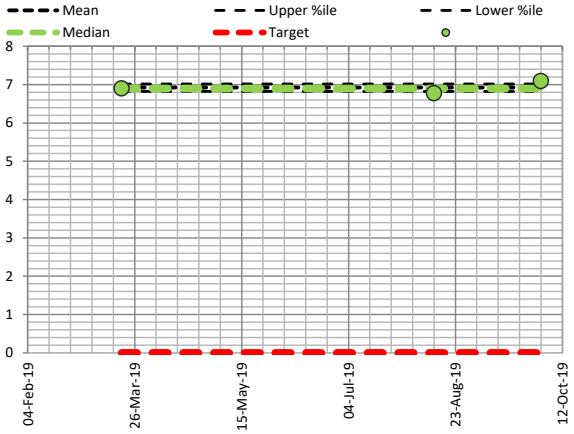
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	4	4.13	4.16	4.42	**4.42**	4.67	4.69		0
T	Temperature	°C	3	19.40	19.40	19.70	**19.40**	19.94	20.30		0
EC	Electrical Conductivity	mS/cm	3	1.48	1.53	1.66	**1.61**	1.77	1.88		0
pH	pH	pH	3	6.77	6.82	6.92	**6.90**	7.01	7.09		0
TN	Total Nitrogen	mg/L	3	0.10	0.14	0.20	**0.20**	0.26	0.30	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	3	0.10	0.10	0.17	**0.10**	0.22	0.30		0
NH3-N	Ammonia as N	mg/L	3	0.01	0.01	0.01	**0.01**	0.01	0.01	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	3	0.01	0.01	0.01	**0.01**	0.01	0.01		0
TP	Total Phosphorous	mg/L	3	0.28	0.31	0.44	**0.35**	0.55	0.68		0
FRP	Filterable Reactive Phosphorous	mg/L	3	0.01	0.07	0.19	**0.15**	0.31	0.42		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	3	1.70	1.82	2.73	**2.00**	3.50	4.50		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	3	910.00	946.00	1036.67	**1000.00**	1120.00	1200.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

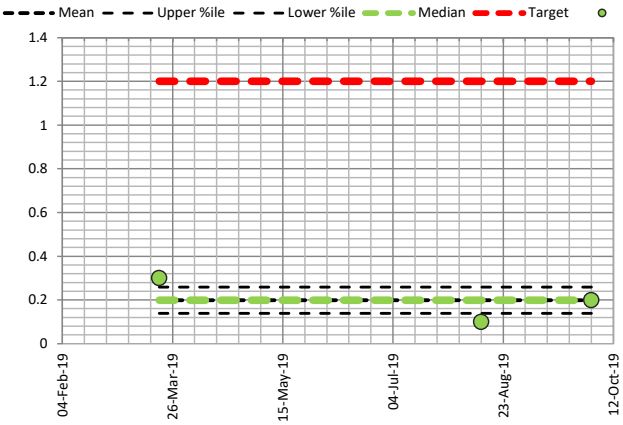
Electrical Conductivity



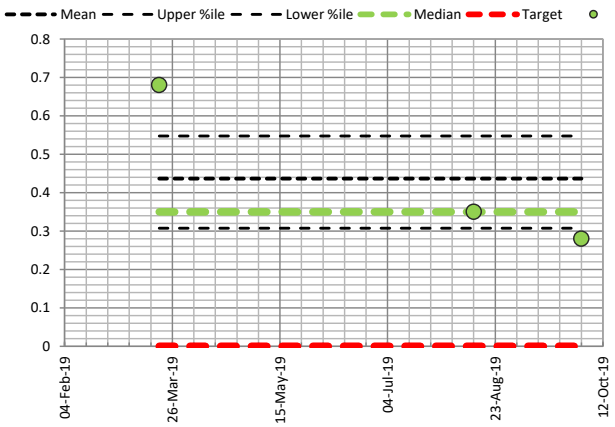
pH



Total Nitrogen



Total Phosphorous



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FP02 Footprint Lake Monitoring Bore 2

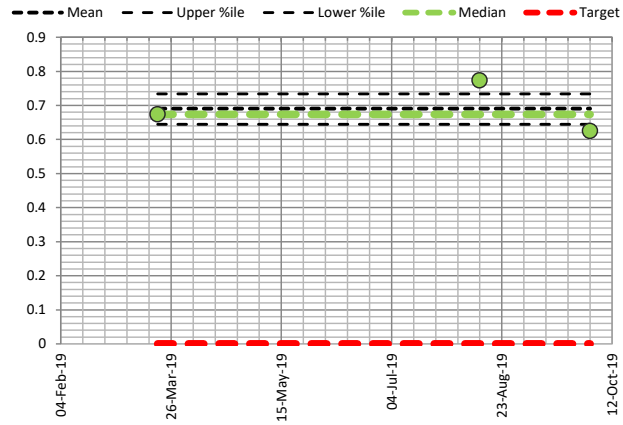
Easting	350839	Data Analysis Period Start Date	01-01-00
Northing	6273607	Data Analysis Period End Date	31-12-22

hydro HYDROLOGY

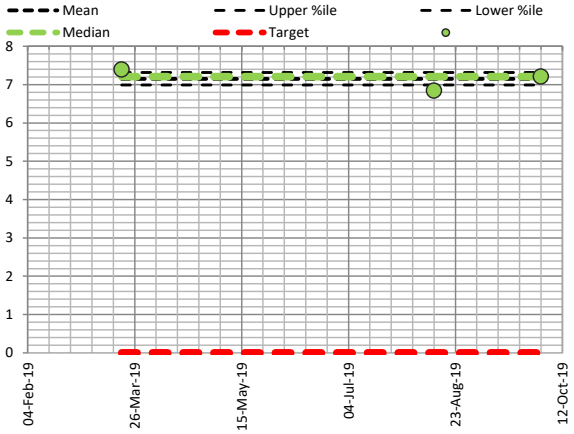
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	5	3.90	3.92	4.16	**4.07**	4.43	4.50		0
T	Temperature	°C	3	19.90	20.10	20.30	**20.40**	20.52	20.60		0
EC	Electrical Conductivity	mS/cm	3	0.63	0.64	0.69	**0.67**	0.73	0.77		0
pH	pH	pH	3	6.84	6.99	7.15	**7.21**	7.32	7.39		0
TN	Total Nitrogen	mg/L	3	0.20	0.24	0.30	**0.30**	0.36	0.40	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	3	0.10	0.14	0.17	**0.20**	0.20	0.20		0
NH3-N	Ammonia as N	mg/L	3	0.02	0.02	0.05	**0.03**	0.08	0.11	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	3	0.03	0.06	0.15	**0.09**	0.24	0.33		0
TP	Total Phosphorous	mg/L	3	0.69	0.70	0.71	**0.71**	0.72	0.72		0
FRP	Filterable Reactive Phosphorous	mg/L	3	0.65	0.66	0.72	**0.67**	0.77	0.84		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	3	0.11	0.34	0.52	**0.68**	0.74	0.78		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	3	350.00	370.00	383.33	**400.00**	400.00	400.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

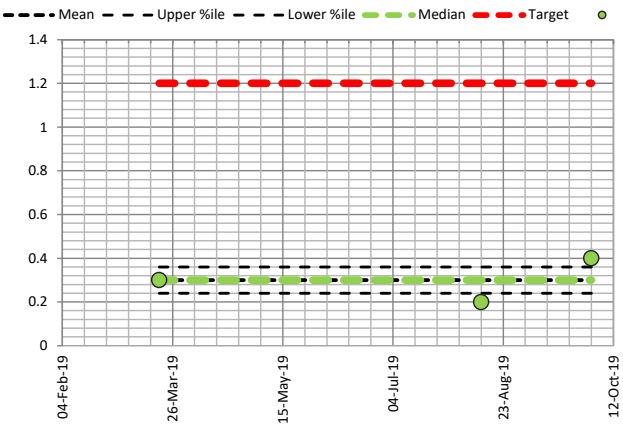
Electrical Conductivity



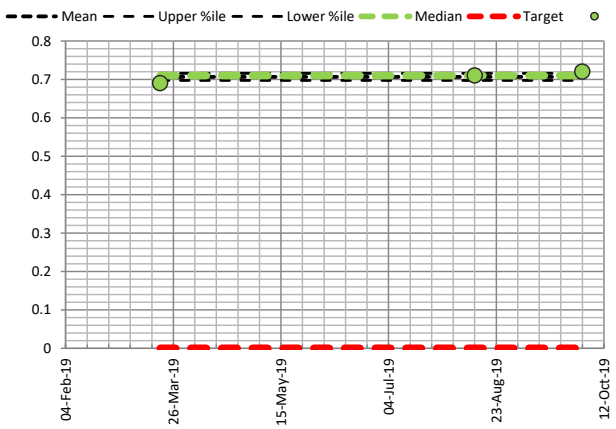
pH



Total Nitrogen



Total Phosphorous



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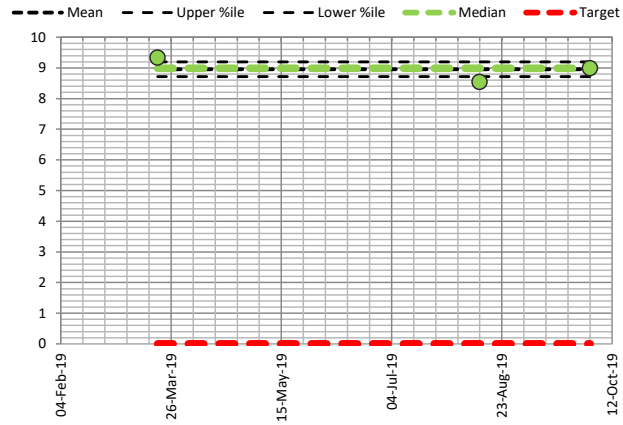
FP03 Footprint Lake Monitoring Bore 3

Easting	350921	Data Analysis Period Start Date	01-01-00
Northing	6273568	Data Analysis Period End Date	31-12-22

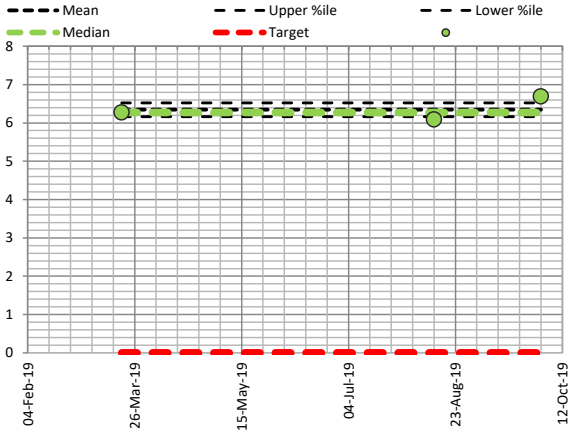
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	4	3.94	4.16	4.43	**4.50**	4.73	4.80		0
T	Temperature	°C	3	18.70	19.22	20.13	**20.00**	21.02	21.70		0
EC	Electrical Conductivity	mS/cm	3	8.54	8.72	8.95	**8.99**	9.19	9.33		0
pH	pH	pH	3	6.09	6.16	6.35	**6.27**	6.52	6.69		0
TN	Total Nitrogen	mg/L	3	0.10	0.14	0.27	**0.20**	0.38	0.50	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	3	0.10	0.14	0.27	**0.20**	0.38	0.50		0
NH3-N	Ammonia as N	mg/L	3	0.02	0.03	0.04	**0.04**	0.05	0.05	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	3	0.01	0.01	0.02	**0.01**	0.03	0.05		0
TP	Total Phosphorous	mg/L	3	0.29	0.31	0.38	**0.33**	0.44	0.51		0
FRP	Filterable Reactive Phosphorous	mg/L	3	0.05	0.11	0.17	**0.19**	0.24	0.28		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	3	18.00	20.40	22.00	**24.00**	24.00	24.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	3	5500.00	5700.00	5833.33	**6000.00**	6000.00	6000.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

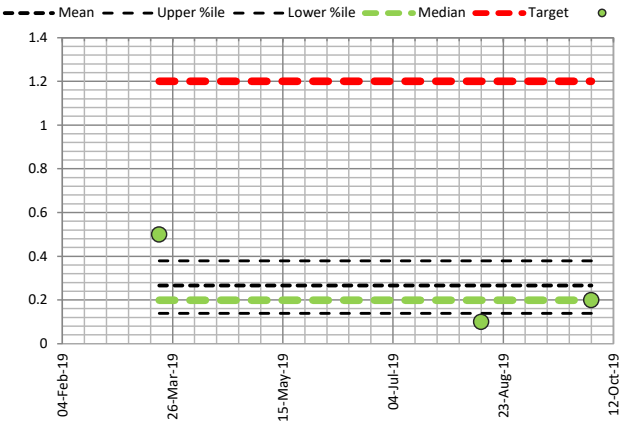
Electrical Conductivity



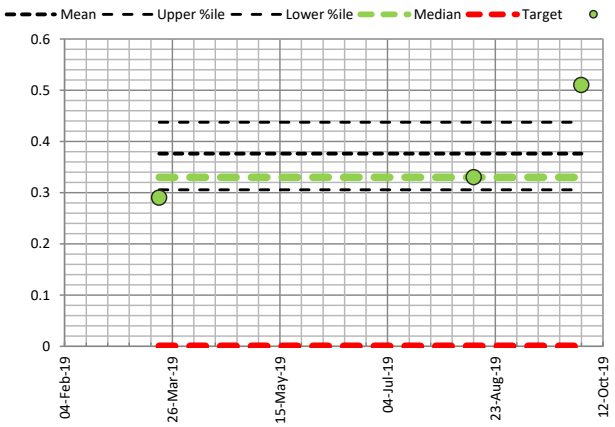
pH



Total Nitrogen



Total Phosphorous



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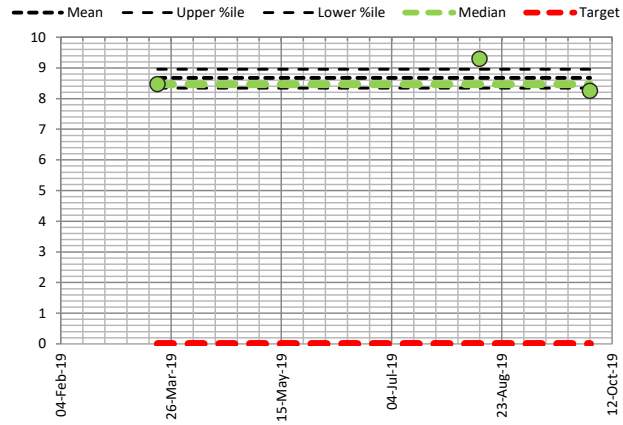
FP04 Footprint Lake Monitoring Bore 4

Easting	350819	Data Analysis Period Start Date	01-01-00
Northing	6273423	Data Analysis Period End Date	31-12-22

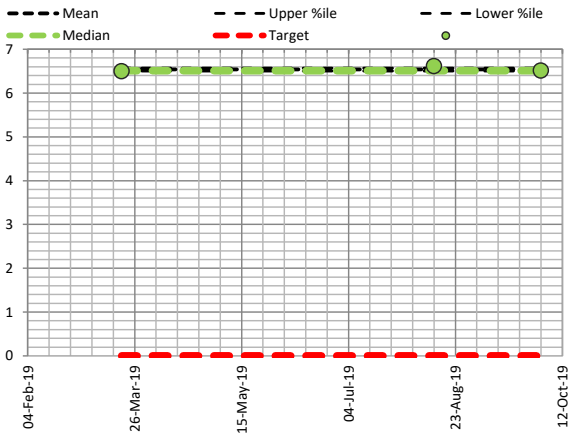
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	4	4.09	4.12	4.62	**4.63**	5.13	5.14		0
T	Temperature	°C	3	19.10	19.50	19.97	**20.10**	20.46	20.70		0
EC	Electrical Conductivity	mS/cm	3	8.25	8.34	8.67	**8.47**	8.96	9.29		0
pH	pH	pH	3	6.50	6.50	6.54	**6.51**	6.57	6.61		0
TN	Total Nitrogen	mg/L	3	0.10	0.14	0.23	**0.20**	0.32	0.40	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	3	0.10	0.14	0.23	**0.20**	0.32	0.40		0
NH3-N	Ammonia as N	mg/L	3	0.02	0.03	0.04	**0.04**	0.04	0.05	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	3	0.01	0.01	0.02	**0.01**	0.03	0.05		0
TP	Total Phosphorous	mg/L	3	0.33	0.34	0.37	**0.36**	0.39	0.41		0
FRP	Filterable Reactive Phosphorous	mg/L	3	0.01	0.02	0.14	**0.05**	0.24	0.36		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	3	17.00	18.60	21.00	**21.00**	23.40	25.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	3	5400.00	5440.00	5633.33	**5500.00**	5800.00	6000.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

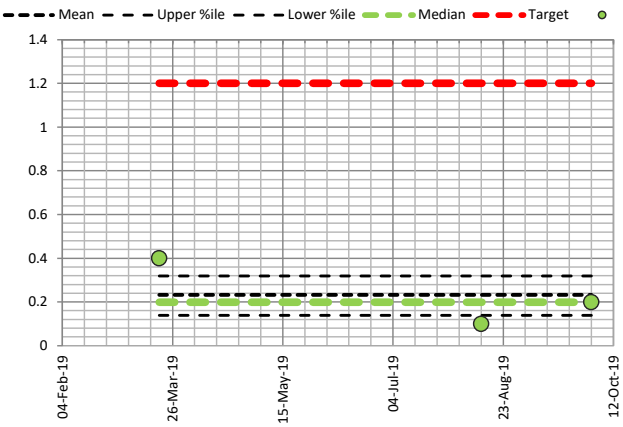
Electrical Conductivity



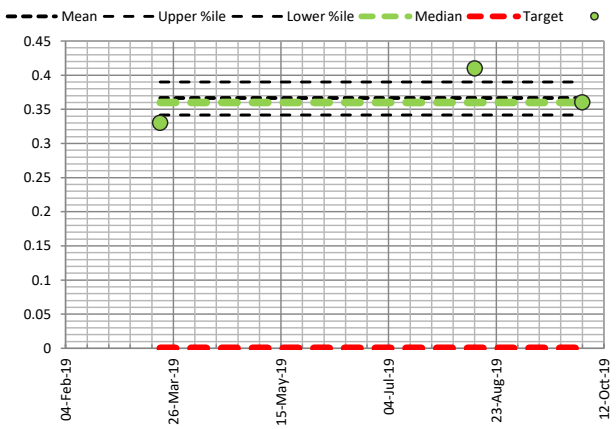
pH



Total Nitrogen



Total Phosphorous



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MB3 RPS Bore 3

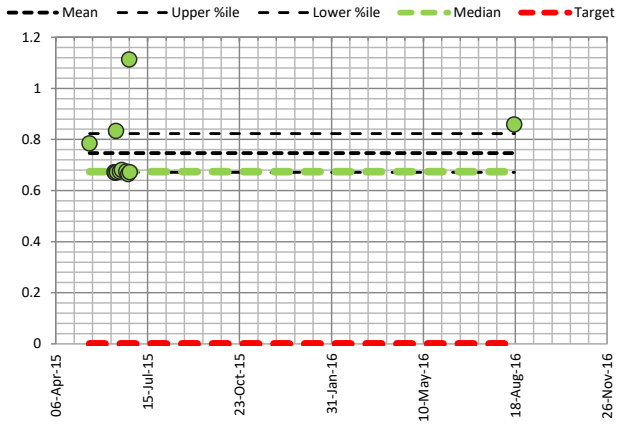
Easting	350736.43	Data Analysis Period Start Date	01-01-00
Northing	6274630.7	Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

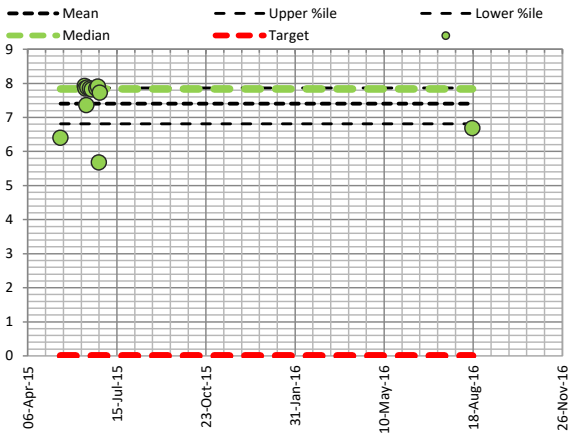
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	11	2.70	2.76	2.80	**2.80**	2.80	3.01		0
GWL mAHD	Groundwater Level	mAHD	12	1.54	1.72	1.74	**1.75**	1.78	1.85		0
T	Temperature	°C	1	16.40	16.40	16.40	**16.40**	16.40	16.40		0
EC	Electrical Conductivity	mS/cm	12	0.66	0.67	0.75	**0.67**	0.82	1.11		0
pH	pH	pH	12	5.68	6.82	7.41	**7.84**	7.87	7.92		0
TN	Total Nitrogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	1.20	0
TKN	Total Kjeldahl Nitogen	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH3-N	Ammonia as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TP	Total Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
FRP	Filterable Reactive Phosphorous	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

Electrical Conductivity



pH



Total Nitrogen

No Data

Total Phosphorous

No Data

H2018 Embark LWMS

PSW1 JDA Surface Water Site 1

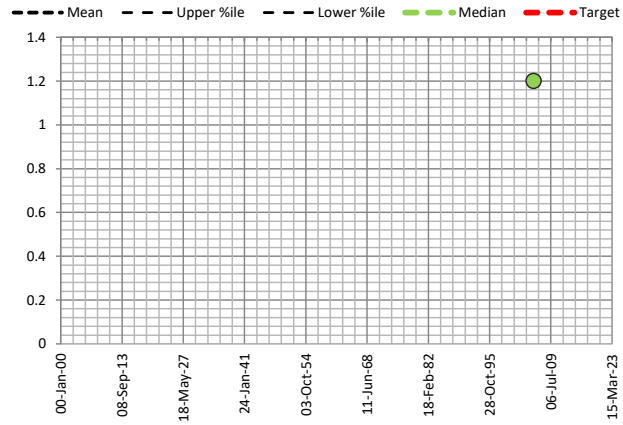
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Northing		Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

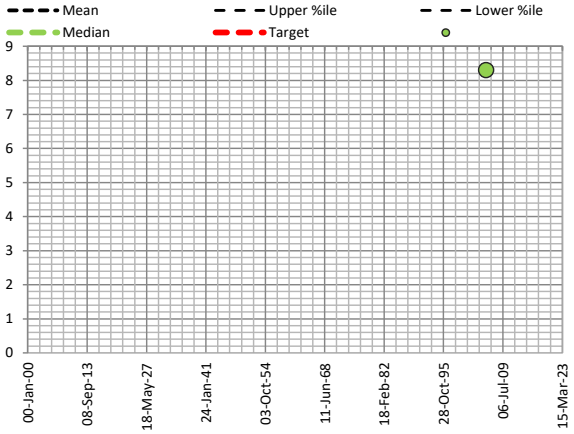
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
T	Temperature	°C	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
EC	Electrical Conductivity	mS/cm	1	1.20	1.20	1.20	**1.20**	1.20	1.20		0
pH	pH	pH	1	8.30	8.30	8.30	**8.30**	8.30	8.30		0
TN	Total Nitrogen	mg/L	1	4.10	4.10	4.10	**4.10**	4.10	4.10	1.20	1
TKN	Total Kjeldahl Nitogen	mg/L	1	4.10	4.10	4.10	**4.10**	4.10	4.10		0
NH3-N	Ammonia as N	mg/L	1	0.09	0.09	0.09	**0.09**	0.09	0.09	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TP	Total Phosphorous	mg/L	4	0.12	0.12	0.19	**0.14**	0.24	0.35		0
FRP	Filterable Reactive Phosphorous	mg/L	1	0.01	0.01	0.01	**0.01**	0.01	0.01		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TSS	Total Suspended Solids	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0

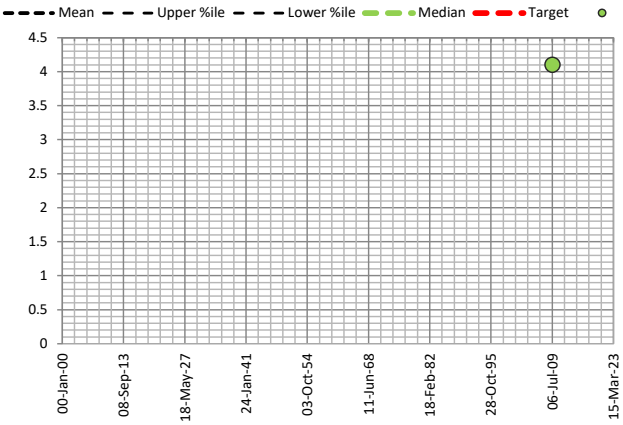
Electrical Conductivity



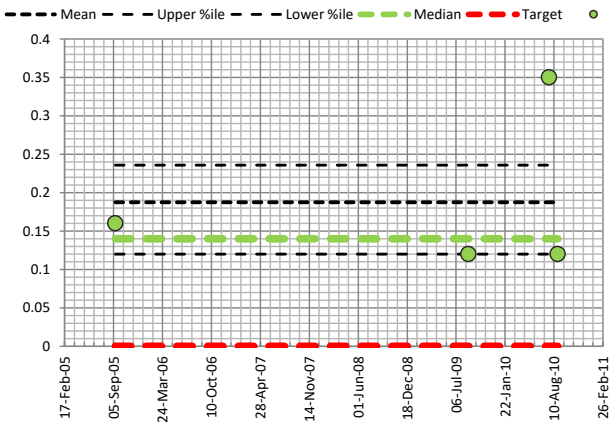
pH



Total Nitrogen



Total Phosphorous



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PSW2 JDA Surface Water Site 2

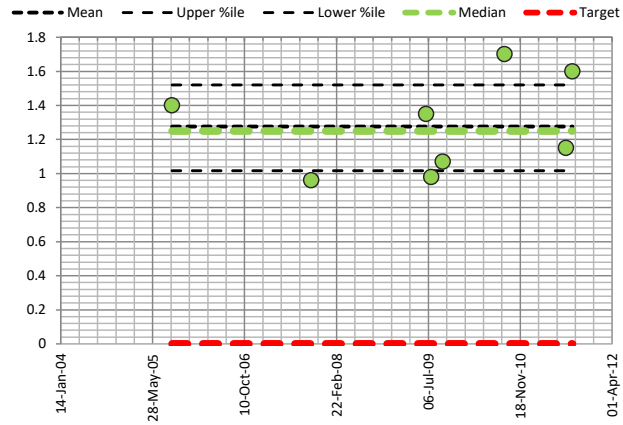
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Northing		Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

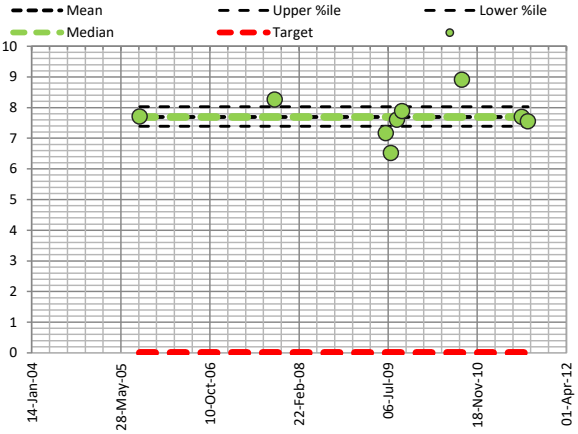
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
T	Temperature	°C	5	13.80	16.12	18.68	**17.10**	22.42	23.70		0
EC	Electrical Conductivity	mS/cm	8	0.96	1.02	1.28	**1.25**	1.52	1.70		0
pH	pH	pH	9	6.51	7.39	7.69	**7.69**	8.03	8.90		0
TN	Total Nitrogen	mg/L	10	0.47	0.89	1.99	**2.05**	2.92	3.90	1.20	7
TKN	Total Kjeldahl Nitogen	mg/L	9	0.46	0.70	1.30	**1.40**	1.76	2.30		0
NH3-N	Ammonia as N	mg/L	8	0.01	0.03	0.20	**0.07**	0.27	0.91	0.90	1
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	7	0.01	0.08	0.75	**0.57**	0.68	3.10		0
TP	Total Phosphorous	mg/L	8	0.01	0.03	0.12	**0.10**	0.21	0.24		0
FRP	Filterable Reactive Phosphorous	mg/L	6	0.01	0.01	0.03	**0.02**	0.07	0.08		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	4	0.00	323.40	491.88	**563.75**	689.10	840.00		0
TSS	Total Suspended Solids	mg/L	9	1.00	1.00	11.11	**2.00**	20.20	43.00		0

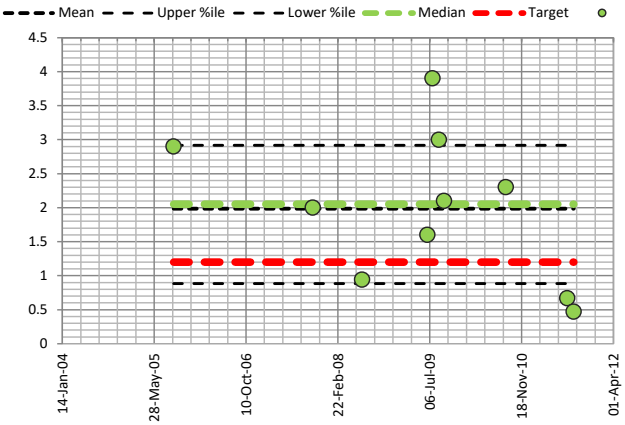
Electrical Conductivity



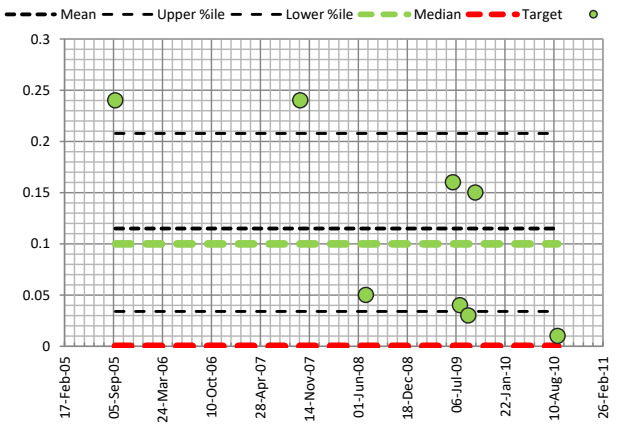
pH



Total Nitrogen



Total Phosphorous



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PSW3 JDA Surface Water Site 3

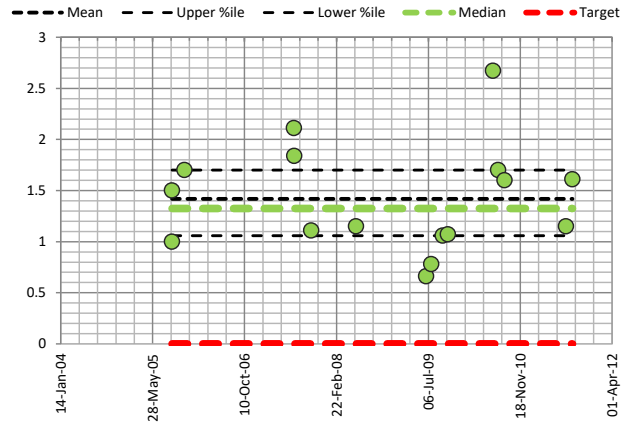
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Northing		Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

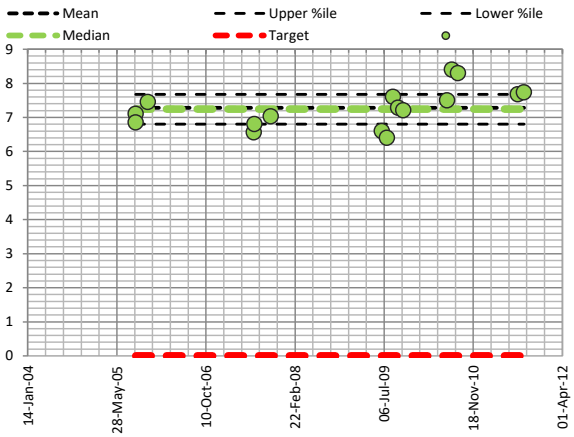
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
T	Temperature	°C	6	14.00	16.20	18.70	**18.50**	21.30	23.70		0
EC	Electrical Conductivity	mS/cm	16	0.66	1.06	1.42	**1.33**	1.70	2.67		0
pH	pH	pH	16	6.40	6.80	7.28	**7.25**	7.68	8.40		0
TN	Total Nitrogen	mg/L	19	0.24	1.06	1.85	**2.10**	2.40	3.80	1.20	13
TKN	Total Kjeldahl Nitogen	mg/L	17	0.21	1.02	1.78	**1.90**	2.40	3.80		0
NH3-N	Ammonia as N	mg/L	16	0.01	0.01	0.12	**0.07**	0.12	0.51	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	14	0.01	0.01	0.03	**0.01**	0.06	0.13		0
TP	Total Phosphorous	mg/L	13	0.05	0.10	0.20	**0.16**	0.27	0.59		0
FRP	Filterable Reactive Phosphorous	mg/L	17	0.01	0.02	0.10	**0.06**	0.12	0.38		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	7	0.00	105.00	433.50	**460.00**	587.40	950.00		0
TSS	Total Suspended Solids	mg/L	18	1.00	1.00	9.28	**4.50**	16.20	39.00		0

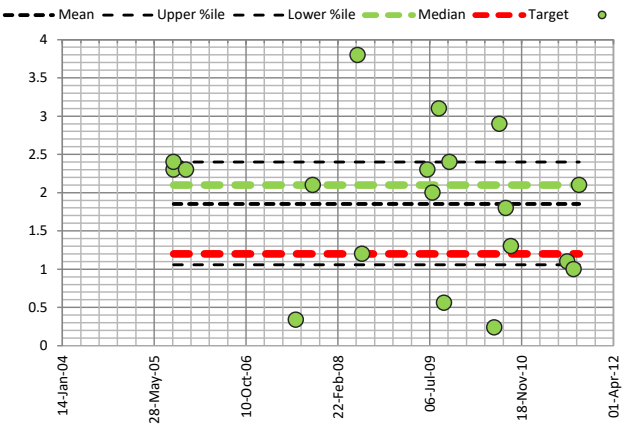
Electrical Conductivity



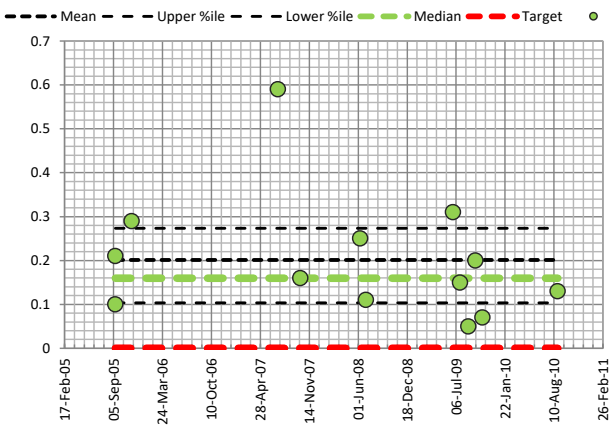
pH



Total Nitrogen



Total Phosphorous



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PSW4 JDA Surface Water Site 4

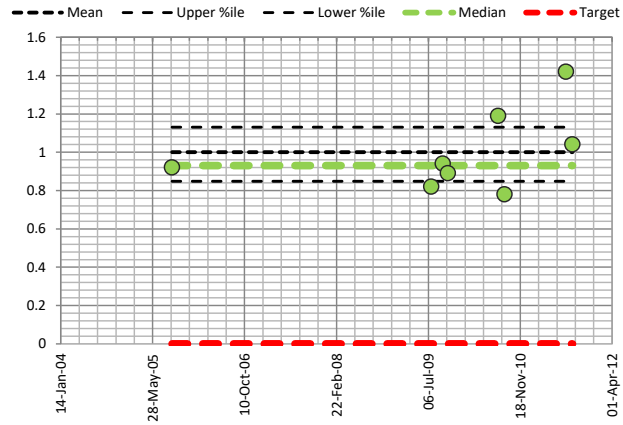
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Northing		Data Analysis Period End Date	31-12-22

hyd2o HYDROLOGY

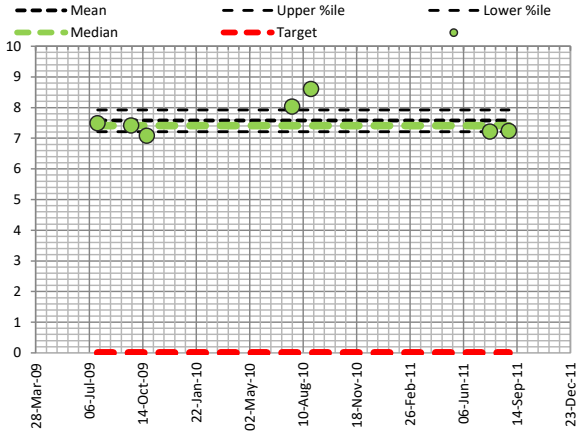
Report Date : 10-01-25

Parameter	Description	Units	Samples	Minimum	Low %ile 20	Mean	Median	High %ile 80	Maximum	Target ANZECC 95%	Times Exceeded
GWL bToC	Groundwater Level	mBToC	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
GWL mAHD	Groundwater Level	mAHD	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
T	Temperature	°C	5	16.20	18.04	20.40	**18.90**	22.46	27.10		0
EC	Electrical Conductivity	mS/cm	8	0.78	0.85	1.00	**0.93**	1.13	1.42		0
pH	pH	pH	7	7.08	7.22	7.58	**7.41**	7.92	8.60		0
TN	Total Nitrogen	mg/L	10	0.81	0.96	2.09	**2.30**	2.78	3.40	1.20	7
TKN	Total Kjeldahl Nitogen	mg/L	9	0.74	0.96	1.82	**1.80**	2.42	3.10		0
NH3-N	Ammonia as N	mg/L	9	0.01	0.01	0.05	**0.04**	0.08	0.15	0.90	0
NO_3-N	Nitrate as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.70	0
NO_2-N	Nitrite as N	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
NH4-N	Ammonium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Nox-N	NOX-N	mg/L	7	0.01	0.01	0.18	**0.01**	0.41	0.67		0
TP	Total Phosphorous	mg/L	9	0.01	0.06	0.30	**0.12**	0.51	1.10		0
FRP	Filterable Reactive Phosphorous	mg/L	7	0.01	0.01	0.05	**0.02**	0.05	0.21		0
Al	Aluminium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.06	0
As	Arsenic	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.02	0
Cd	Cadmium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0002	0
Cr	Chromium	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.001	0
Cu	Copper	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00	0.0014	0
Mn	Manganese	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	1.90000	0
Ni	Nickel	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Se	Selenium	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
Zn	Zinc	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.01100	0
HG	Mercury	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00060	0
PB	Lead	mg/L	0	0.00000	0.00000	0.00000	**0.00000**	0.00000	0.00000	0.00340	0
Fe-D	Dissolved Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
Fe-T	Total Iron	mg/L	0	0.00	0.00	0.00	**0.00**	0.00	0.00		0
TDS	Total Dissolved Solids	mg/L	4	0.00	270.60	364.38	**470.25**	500.50	517.00		0
TSS	Total Suspended Solids	mg/L	9	1.00	1.00	3.67	**3.00**	6.00	9.00		0

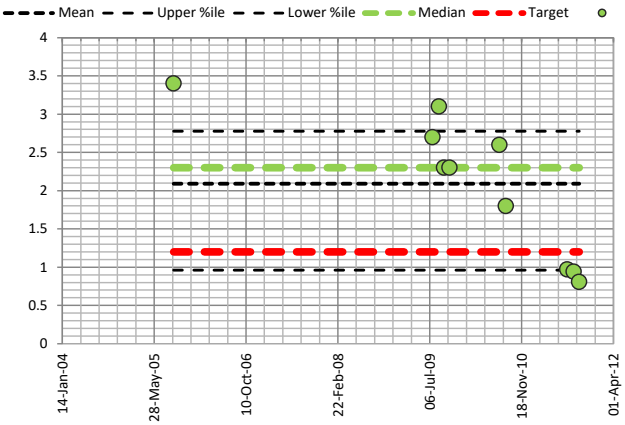
Electrical Conductivity



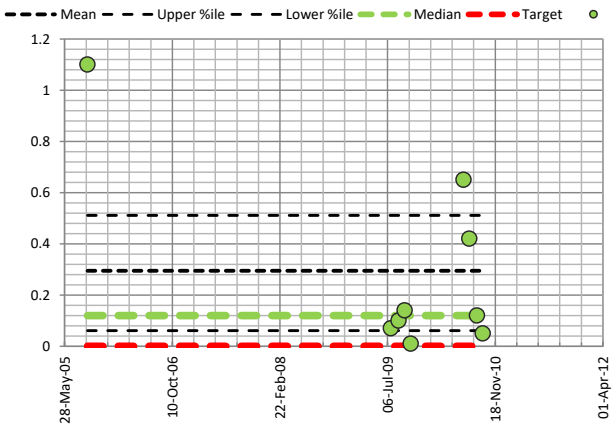
pH



Total Nitrogen



Total Phosphorous

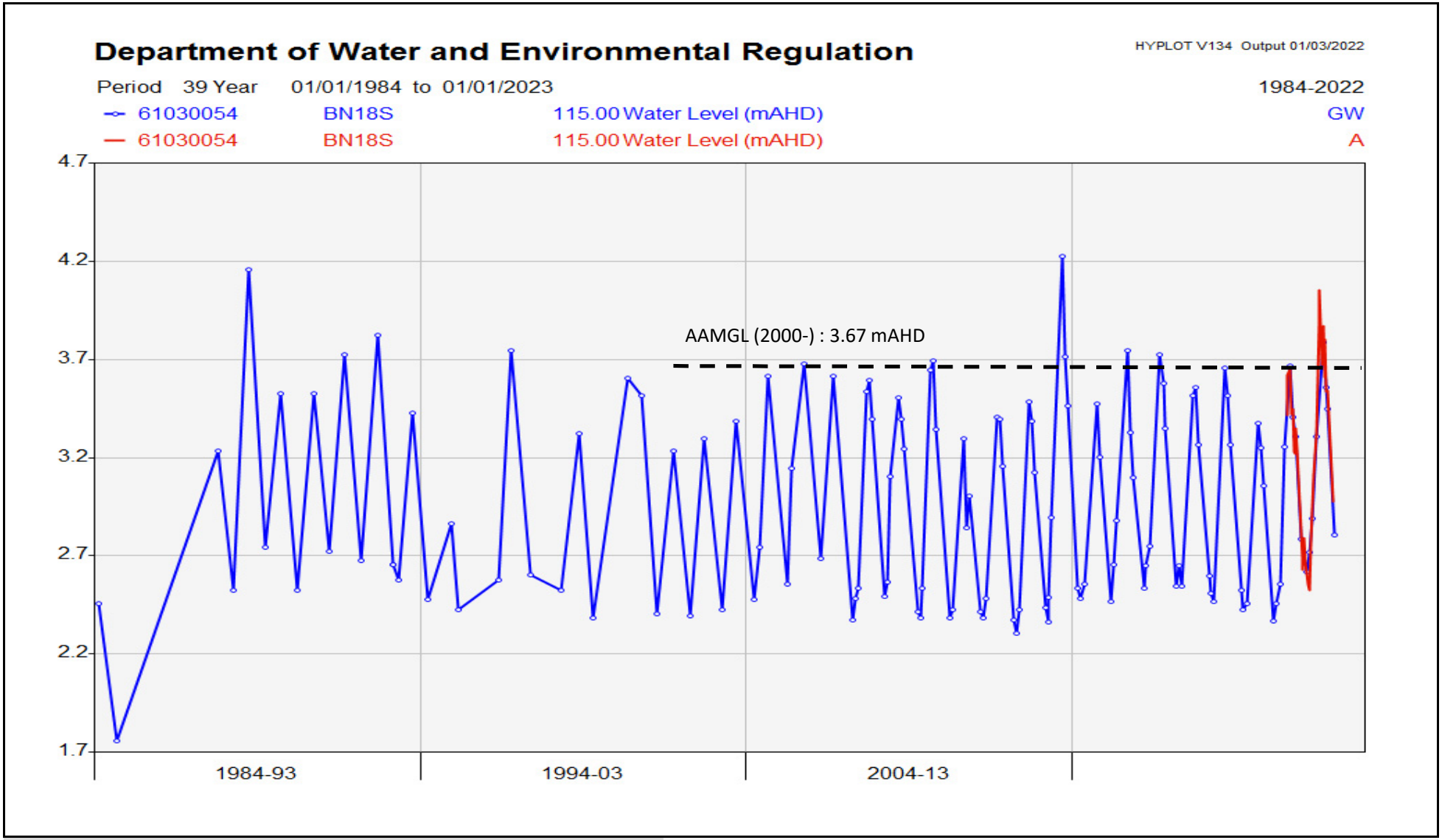


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APPENDIX J

DWER Bores Long Term Hydrographs

Date : 23/2/2023 Job No: H22018



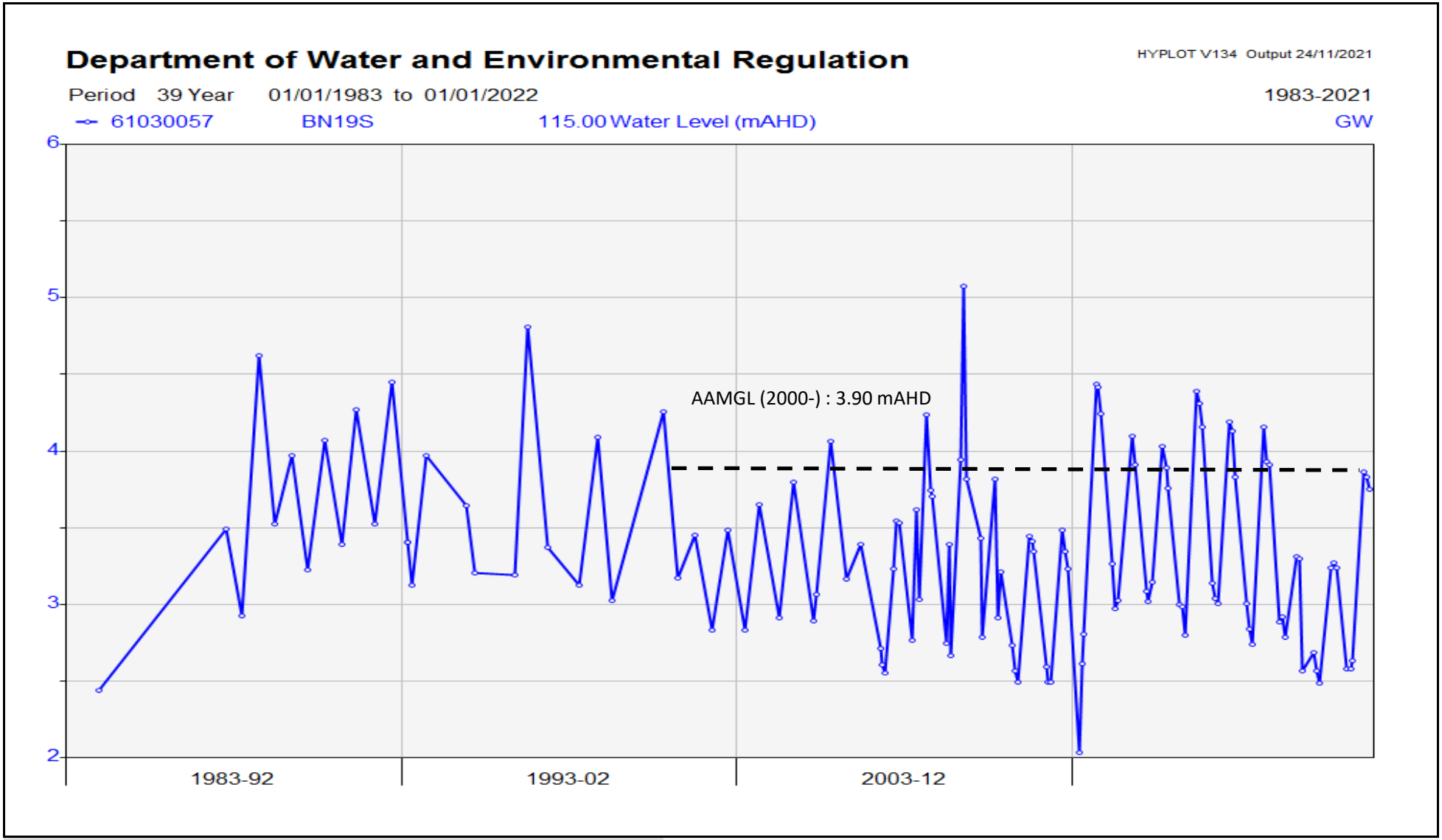
hyd2o

Lo2 2, 9032 & 9034 Bussell Hwy Busselton LWMS

DWER Bore Hydrograph : 18s

Figure I1

Date : 23/2/2023 Job No: H22018



hyd2o

Lo2 2, 9032 & 9034 Bussell Hwy Busselton LWMS

DWER Bore Hydrograph : 19s

Figure I2

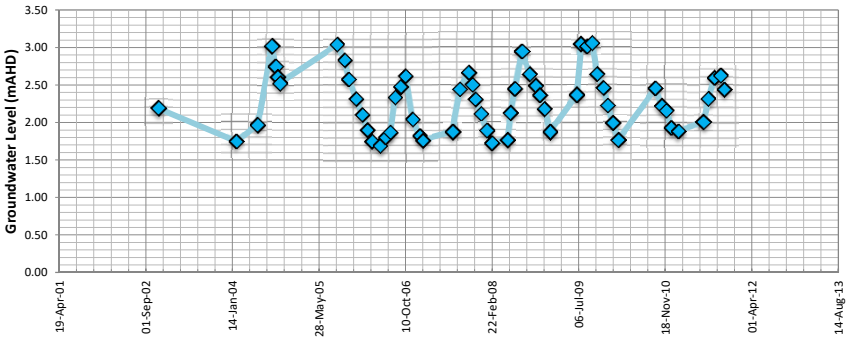
APPENDIX K
Site Groundwater Hydrographs

H2018 Embark LWMS

BA1 JDA Bore 1

Data Analysis Period Start Date	1/01/2000	Easting	349620	Natural Surface (mAHD)	2.98
Data Analysis Period End Date	31/12/2022	Northing	6274364	Top of Casing (m AHD)	3.45
				End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/11/2002		2.19	0.79
6/02/2004		1.75	1.23
9/06/2004		1.97	1.01
30/08/2004		3.02	-0.04
20/09/2004		2.74	0.24
1/10/2004		2.61	0.37
15/10/2004		2.53	0.45
12/09/2005		3.04	-0.06
26/10/2005		2.83	0.15
18/11/2005		2.58	0.40
30/12/2005		2.32	0.66
3/02/2006		2.11	0.87
5/03/2006		1.91	1.07
31/03/2006		1.76	1.22
16/05/2006		1.70	1.28
17/06/2006		1.81	1.17
14/07/2006		1.88	1.10
10/08/2006		2.34	0.64
12/09/2006		2.48	0.50
9/10/2006		2.62	0.36
18/11/2006		2.05	0.93
29/12/2006		1.83	1.15
17/01/2007		1.77	1.21
9/07/2007		1.88	1.10
21/08/2007		2.45	0.53
9/10/2007		2.67	0.31
30/10/2007		2.51	0.47
16/11/2007		2.32	0.66
17/12/2007		2.13	0.85
25/01/2008		1.89	1.09
21/02/2008		1.73	1.25
19/05/2008		1.77	1.21
9/06/2008		2.14	0.84
3/07/2008		2.45	0.53
12/08/2008		2.95	0.03
24/09/2008		2.64	0.34
29/10/2008		2.49	0.49
19/11/2008		2.37	0.61
16/12/2008		2.19	0.79
23/01/2009		1.88	1.10
24/06/2009		2.37	0.61
22/07/2009		3.05	-0.07
25/08/2009		3.02	-0.04
23/09/2009		3.06	-0.08
22/10/2009		2.64	0.34
26/11/2009		2.46	0.52
21/12/2009		2.23	0.75
18/01/2010		1.99	0.99
18/02/2010		1.77	1.21
22/09/2010		2.45	0.53
28/10/2010		2.22	0.76
23/11/2010		2.16	0.82
22/12/2010		1.94	1.04
31/01/2011		1.89	1.09
28/06/2011		2.01	0.97
26/07/2011		2.32	0.66
30/08/2011		2.59	0.39
4/10/2011		2.62	0.36
25/10/2011		2.44	0.54

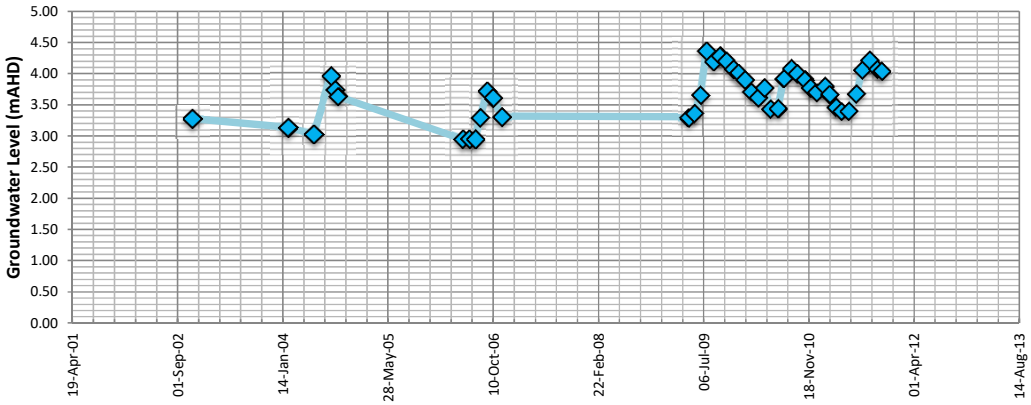
Minimum Recorded Level (mAHD)	1.7
Maximum Recorded Level (mAHD)	3.06

H2018 Embark LWMS

BA3 JDA Bore 3

				Natural Surface (mAHD)	4.50
Data Analysis Period Start Date	1/01/2000	Easting	350722	Top of Casing (m AHD)	4.95
Data Analysis Period End Date	31/12/2022	Northing	6274080	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/11/2002		3.28	1.22
6/02/2004		3.14	1.36
9/06/2004		3.03	1.47
30/08/2004		3.96	0.54
20/09/2004		3.74	0.76
1/10/2004		3.64	0.86
16/05/2006		2.95	1.55
17/06/2006		2.95	1.55
14/07/2006		2.95	1.55
10/08/2006		3.31	1.19
12/09/2006		3.72	0.78
9/10/2006		3.62	0.88
18/11/2006		3.32	1.18
29/04/2009		3.31	1.19
27/05/2009		3.38	1.12
24/06/2009		3.67	0.83
22/07/2009		4.37	0.13
25/08/2009		4.20	0.30
23/09/2009		4.29	0.21
22/10/2009		4.21	0.29
26/11/2009		4.08	0.42
21/12/2009		4.02	0.48
18/01/2010		3.91	0.59
18/02/2010		3.72	0.78
24/03/2010		3.63	0.87
21/04/2010		3.78	0.72
19/05/2010		3.45	1.05
24/06/2010		3.46	1.04
21/07/2010		3.93	0.57
25/08/2010		4.09	0.41
22/09/2010		4.01	0.49
28/10/2010		3.91	0.59
23/11/2010		3.79	0.71
22/12/2010		3.71	0.79
31/01/2011		3.81	0.69
22/02/2011		3.68	0.82
24/03/2011		3.48	1.02
18/04/2011		3.41	1.09
24/05/2011		3.42	1.08
28/06/2011		3.69	0.81
26/07/2011		4.07	0.43
30/08/2011		4.22	0.28
4/10/2011		4.08	0.42
25/10/2011		4.05	0.45

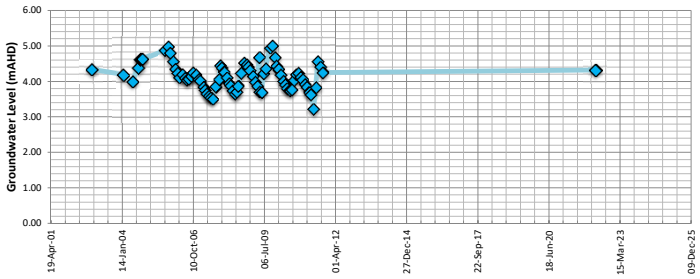
Minimum Recorded Level (mAHD)	2.95
Maximum Recorded Level (mAHD)	4.37

H2018 Embark LWMS

BA4 JDA Bore 4

				Natural Surface (mAHD)	6.08
Data Analysis Period Start Date	1/01/2000	Easting	351599	Top of Casing (m AHD)	6.89
Data Analysis Period End Date	31/12/2022	Northing	6273883	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/11/2002		4.34	1.74
6/02/2004		4.19	1.89
9/06/2004		4.01	2.07
30/08/2004		4.38	1.70
20/09/2004		4.61	1.47
1/10/2004		4.62	1.46
15/10/2004		4.62	1.46
12/09/2005		4.87	1.21
26/10/2005		4.96	1.12
18/11/2005		4.79	1.29
30/12/2005		4.55	1.53
3/02/2006		4.35	1.73
5/03/2006		4.23	1.85
31/03/2006		4.11	1.97
16/05/2006		4.19	1.89
17/06/2006		4.09	1.99
14/07/2006		4.05	2.03
10/08/2006		4.08	2.00
12/09/2006		4.15	1.93
9/10/2006		4.25	1.83
18/11/2006		4.18	1.90
29/12/2006		4.07	2.01
17/01/2007		4.02	2.06
1/03/2007		3.85	2.23
23/03/2007		3.76	2.32
19/04/2007		3.67	2.41
14/05/2007		3.61	2.47
18/06/2007		3.55	2.53
9/07/2007		3.52	2.56
21/08/2007		3.86	2.22
9/10/2007		4.06	2.02
30/10/2007		4.45	1.63
16/11/2007		4.38	1.70
17/12/2007		4.27	1.81
25/01/2008		4.10	1.98
21/02/2008		3.95	2.13
10/03/2008		3.89	2.19
14/04/2008		3.75	2.33
19/05/2008		3.66	2.42
9/06/2008		3.71	2.37
3/07/2008		3.88	2.20
12/08/2008		4.23	1.85
24/09/2008		4.52	1.56
29/10/2008		4.47	1.61
19/11/2008		4.40	1.68
16/12/2008		4.31	1.77
23/01/2009		4.15	1.93
26/02/2009		3.99	2.09
25/03/2009		3.88	2.20
25/04/2009		4.67	1.41
29/04/2009		3.72	2.36
27/05/2009		3.71	2.37
24/06/2009		4.23	1.85
22/07/2009		4.36	1.72
23/09/2009		4.93	1.15
22/10/2009		4.99	1.09
26/11/2009		4.66	1.42
21/12/2009		4.44	1.64
18/01/2010		4.34	1.74
18/02/2010		4.18	1.90
24/03/2010		4.01	2.07
21/04/2010		3.91	2.17
19/05/2010		3.81	2.27
24/06/2010		3.75	2.33
21/07/2010		3.78	2.30
25/08/2010		4.04	2.04
22/09/2010		4.19	1.89
28/10/2010		4.23	1.85
23/11/2010		4.13	1.95
22/12/2010		4.06	2.02
31/01/2011		3.92	2.16
22/02/2011		3.85	2.23
24/03/2011		3.71	2.37
18/04/2011		3.64	2.44
24/05/2011		3.24	2.84
28/06/2011		3.83	2.25
26/07/2011		4.55	1.53
30/08/2011		4.40	1.68
4/10/2011		4.25	1.83
4/04/2022		4.32	1.76

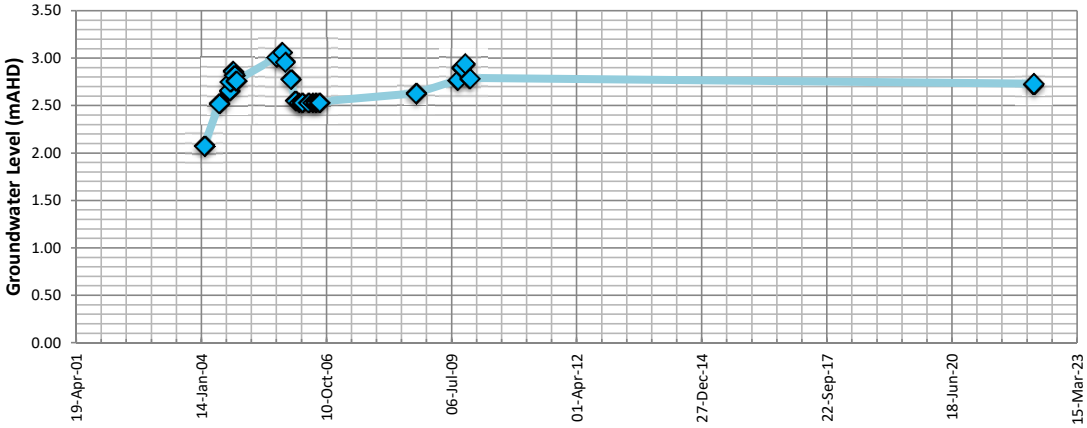
Minimum Recorded Level (mAHD)	3.24
Maximum Recorded Level (mAHD)	4.99

H2018 Embark LWMS

BA5 JDA Bore 5

				Natural Surface (mAHD)	5.78
Data Analysis Period Start Date	1/01/2000	Easting	351588	Top of Casing (m AHD)	6.21
Data Analysis Period End Date	31/12/2022	Northing	6274288	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		2.08	3.70
9/06/2004		2.53	3.25
23/08/2004		2.66	3.12
30/08/2004		2.75	3.03
20/09/2004		2.86	2.92
1/10/2004		2.82	2.96
15/10/2004		2.76	3.02
12/09/2005		3.01	2.77
26/10/2005		3.06	2.72
18/11/2005		2.96	2.82
30/12/2005		2.78	3.00
3/02/2006		2.56	3.22
5/03/2006		2.54	3.24
31/03/2006		2.54	3.24
16/05/2006		2.54	3.24
17/06/2006		2.54	3.24
14/07/2006		2.54	3.24
10/08/2006		2.54	3.24
24/09/2008		2.63	3.15
25/08/2009		2.77	3.01
23/09/2009		2.90	2.88
22/10/2009		2.94	2.84
26/11/2009		2.79	2.99
4/04/2022		2.73	3.05

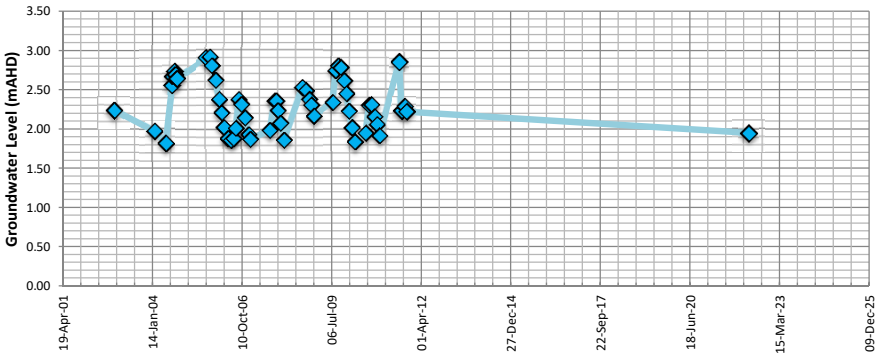
Minimum Recorded Level (mAHD)	2.08
Maximum Recorded Level (mAHD)	3.06

H2018 Embark LWMS

BA6 JDA Bore 6

				Natural Surface (mAHD)	4.75
Data Analysis Period Start Date	1/01/2000	Easting	351557	Top of Casing (m AHD)	5.26
Data Analysis Period End Date	31/12/2022	Northing	6274834	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/11/2002		2.24	2.51
6/02/2004		1.97	2.78
9/06/2004		1.82	2.93
23/08/2004		2.56	2.19
30/08/2004		2.67	2.08
20/09/2004		2.73	2.02
1/10/2004		2.69	2.06
15/10/2004		2.64	2.11
12/09/2005		2.90	1.85
26/10/2005		2.91	1.84
18/11/2005		2.80	1.95
30/12/2005		2.62	2.13
3/02/2006		2.38	2.37
5/03/2006		2.21	2.54
31/03/2006		2.03	2.72
16/05/2006		1.89	2.86
17/06/2006		1.87	2.88
14/07/2006		1.89	2.86
10/08/2006		2.02	2.73
12/09/2006		2.38	2.37
9/10/2006		2.32	2.43
18/11/2006		2.15	2.60
29/12/2006		1.94	2.81
17/01/2007		1.88	2.87
21/08/2007		1.99	2.76
9/10/2007		2.36	2.39
30/10/2007		2.36	2.39
16/11/2007		2.24	2.51
17/12/2007		2.08	2.67
25/01/2008		1.87	2.88
12/08/2008		2.53	2.22
24/09/2008		2.49	2.26
29/10/2008		2.38	2.37
19/11/2008		2.31	2.44
16/12/2008		2.17	2.58
22/07/2009		2.34	2.41
25/08/2009		2.74	2.01
23/09/2009		2.80	1.95
22/10/2009		2.78	1.97
26/11/2009		2.61	2.14
21/12/2009		2.45	2.30
18/01/2010		2.23	2.52
18/02/2010		2.02	2.73
24/03/2010		1.84	2.91
21/07/2010		1.95	2.80
25/08/2010		2.30	2.45
22/09/2010		2.31	2.44
28/10/2010		2.16	2.59
23/11/2010		2.06	2.69
22/12/2010		1.92	2.83
26/07/2011		2.86	1.89
30/08/2011		2.23	2.52
4/10/2011		2.28	2.47
25/10/2011		2.22	2.53
4/04/2022		1.95	2.80

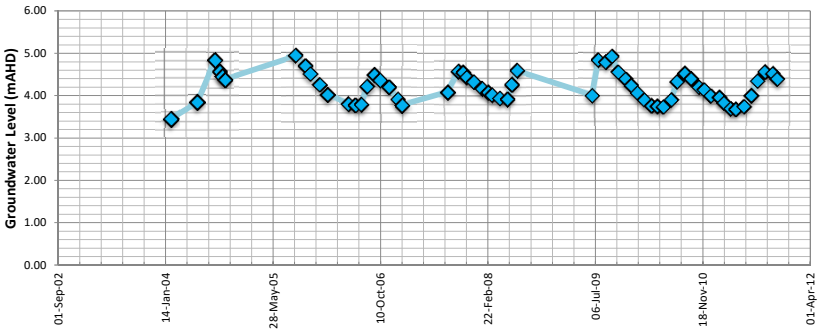
Minimum Recorded Level (mAHD)	1.82
Maximum Recorded Level (mAHD)	2.91

H2018 Embark LWMS

BA7 JDA Bore 7

Data Analysis Period Start Date	1/01/2000	Easting	349960	Natural Surface (mAHD)	5.61
Data Analysis Period End Date	31/12/2022	Northing	6273673	Top of Casing (m AHD)	5.92
				End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		3.45	2.16
9/06/2004		3.84	1.77
30/08/2004		4.83	0.78
20/09/2004		4.57	1.04
1/10/2004		4.47	1.14
15/10/2004		4.39	1.22
12/09/2005		4.94	0.67
26/10/2005		4.70	0.91
18/11/2005		4.51	1.10
30/12/2005		4.26	1.35
3/02/2006		4.03	1.58
16/05/2006		3.82	1.79
17/06/2006		3.79	1.82
14/07/2006		3.80	1.81
10/08/2006		4.22	1.39
12/09/2006		4.48	1.13
9/10/2006		4.36	1.25
18/11/2006		4.20	1.41
29/12/2006		3.92	1.69
17/01/2007		3.78	1.83
21/08/2007		4.09	1.52
9/10/2007		4.57	1.04
30/10/2007		4.54	1.07
16/11/2007		4.44	1.17
17/12/2007		4.33	1.28
25/01/2008		4.17	1.44
21/02/2008		4.09	1.52
10/03/2008		4.03	1.58
14/04/2008		3.95	1.66
19/05/2008		3.93	1.68
9/06/2008		4.27	1.34
3/07/2008		4.59	1.02
24/06/2009		4.01	1.60
22/07/2009		4.84	0.77
25/08/2009		4.79	0.82
23/09/2009		4.92	0.69
22/10/2009		4.56	1.05
26/11/2009		4.39	1.22
21/12/2009		4.25	1.36
18/01/2010		4.07	1.54
18/02/2010		3.91	1.70
24/03/2010		3.77	1.84
21/04/2010		3.76	1.85
19/05/2010		3.74	1.87
24/06/2010		3.91	1.70
21/07/2010		4.33	1.28
25/08/2010		4.53	1.08
22/09/2010		4.40	1.21
28/10/2010		4.21	1.40
23/11/2010		4.14	1.47
22/12/2010		4.00	1.61
31/01/2011		3.97	1.64
22/02/2011		3.83	1.78
24/03/2011		3.70	1.91
18/04/2011		3.69	1.92
24/05/2011		3.75	1.86
28/06/2011		4.01	1.60
26/07/2011		4.35	1.26
30/08/2011		4.56	1.05
4/10/2011		4.52	1.09
25/10/2011		4.39	1.22

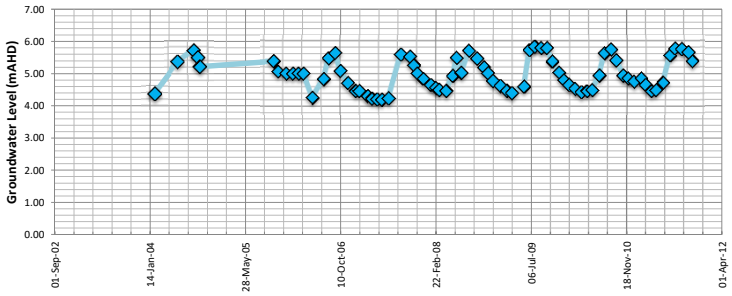
Minimum Recorded Level (mAHD)	3.45
Maximum Recorded Level (mAHD)	4.94

H2018 Embark LWMS

BA8 JDA Bore 8

				Natural Surface (mAHD)	5.61
Data Analysis Period Start Date	1/01/2000	Easting	350185	Top of Casing (m AHD)	6.07
Data Analysis Period End Date	31/12/2022	Northing	6273234	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		4.37	1.24
9/06/2004		5.37	0.24
30/08/2004		5.71	-0.10
20/09/2004		5.50	0.11
1/10/2004		5.22	0.39
26/10/2005		5.39	0.22
18/11/2005		5.08	0.53
30/12/2005		5.02	0.59
3/02/2006		5.02	0.59
5/03/2006		5.02	0.59
31/03/2006		5.02	0.59
16/05/2006		4.28	1.33
14/07/2006		4.85	0.76
10/08/2006		5.48	0.13
12/09/2006		5.64	-0.03
9/10/2006		5.10	0.51
18/11/2006		4.73	0.88
29/12/2006		4.49	1.12
17/01/2007		4.49	1.12
1/03/2007		4.33	1.28
23/03/2007		4.25	1.36
19/04/2007		4.23	1.38
14/05/2007		4.22	1.39
18/06/2007		4.26	1.35
21/08/2007		5.59	0.02
9/10/2007		5.53	0.08
30/10/2007		5.26	0.35
16/11/2007		5.02	0.59
17/12/2007		4.86	0.75
25/01/2008		4.67	0.94
21/02/2008		4.58	1.03
10/03/2008		4.52	1.09
14/04/2008		4.49	1.12
19/05/2008		4.95	0.66
9/06/2008		5.49	0.12
3/07/2008		5.04	0.57
12/08/2008		5.71	-0.10
24/09/2008		5.47	0.14
29/10/2008		5.21	0.40
19/11/2008		5.03	0.58
16/12/2008		4.79	0.82
23/01/2009		4.64	0.97
26/02/2009		4.49	1.12
25/03/2009		4.42	1.19
27/05/2009		4.62	0.99
24/06/2009		5.73	-0.12
22/07/2009		5.83	-0.22
25/08/2009		5.79	-0.18
23/09/2009		5.79	-0.18
22/10/2009		5.38	0.23
26/11/2009		5.05	0.56
21/12/2009		4.82	0.79
18/01/2010		4.67	0.94
18/02/2010		4.55	1.06
24/03/2010		4.45	1.16
21/04/2010		4.48	1.13
19/05/2010		4.51	1.10
24/06/2010		4.96	0.65
21/07/2010		5.63	-0.02
25/08/2010		5.75	-0.14
22/09/2010		5.41	0.20
28/10/2010		4.96	0.65
23/11/2010		4.87	0.74
22/12/2010		4.77	0.84
31/01/2011		4.87	0.74
22/02/2011		4.67	0.94
24/03/2011		4.48	1.13
18/04/2011		4.51	1.10
24/05/2011		4.74	0.87
28/06/2011		5.56	0.05
26/07/2011		5.78	-0.17
30/08/2011		5.76	-0.15
4/10/2011		5.66	-0.05
25/10/2011		5.39	0.22

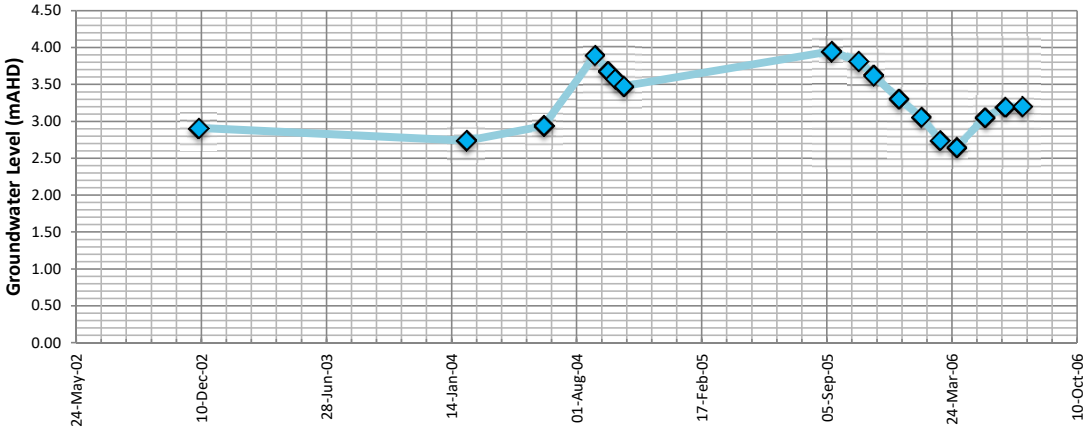
Minimum Recorded Level (mAHD)	4.22
Maximum Recorded Level (mAHD)	5.83

H2018 Embark LWMS

BA11 JDA Bore 11

				Natural Surface (mAHD)	4.03
Data Analysis Period Start Date	1/01/2000	Easting	349932	Top of Casing (m AHD)	4.89
Data Analysis Period End Date	31/12/2022	Northing	6274018	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/12/2002		2.91	1.12
6/02/2004		2.74	1.29
9/06/2004		2.94	1.09
30/08/2004		3.89	0.14
20/09/2004		3.68	0.35
1/10/2004		3.58	0.45
15/10/2004		3.48	0.55
12/09/2005		3.95	0.08
26/10/2005		3.81	0.22
18/11/2005		3.63	0.40
30/12/2005		3.30	0.73
3/02/2006		3.06	0.97
5/03/2006		2.75	1.28
31/03/2006		2.66	1.37
16/05/2006		3.05	0.98
17/06/2006		3.19	0.84
14/07/2006		3.20	0.83

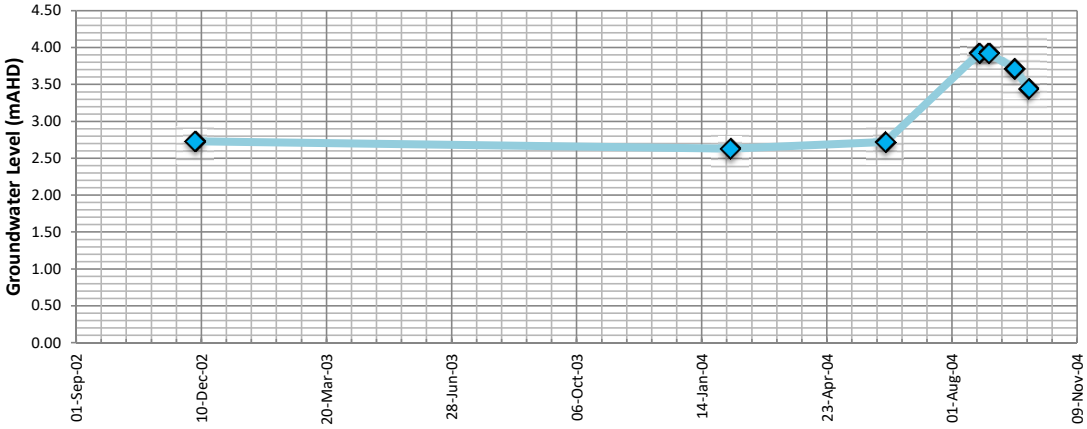
Minimum Recorded Level (mAHD)	2.66
Maximum Recorded Level (mAHD)	3.95

H2018 Embark LWMS

BA12 JDA Bore 12

				Natural Surface (mAHD)	4.30
Data Analysis Period Start Date	1/01/2000	Easting	350171	Top of Casing (m AHD)	5.64
Data Analysis Period End Date	31/12/2022	Northing	6274144	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/12/2002		2.73	1.57
6/02/2004		2.63	1.67
9/06/2004		2.72	1.58
23/08/2004		3.93	0.37
30/08/2004		3.93	0.37
20/09/2004		3.71	0.59
1/10/2004		3.45	0.85

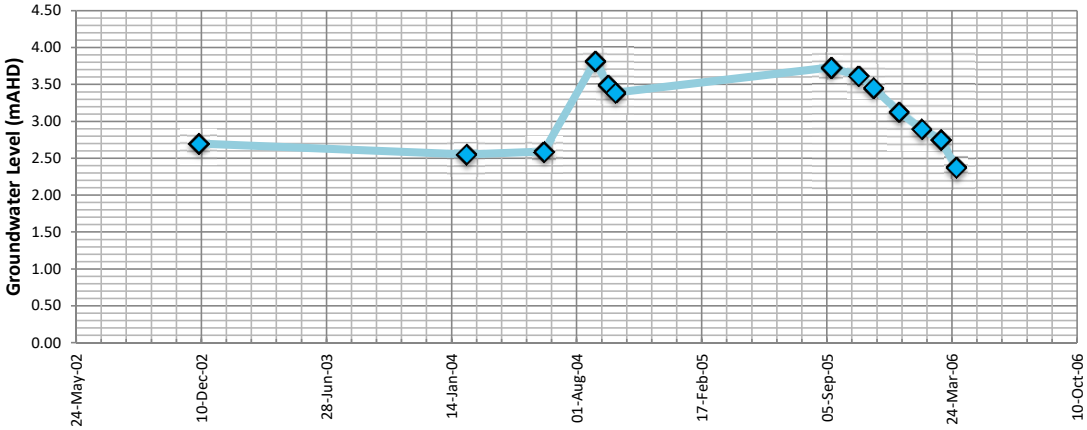
Minimum Recorded Level (mAHD)	2.63
Maximum Recorded Level (mAHD)	3.93

H2018 Embark LWMS

BA13 JDA Bore 13

				Natural Surface (mAHD)	4.35
Data Analysis Period Start Date	1/01/2000	Easting	350054	Top of Casing (m AHD)	5.62
Data Analysis Period End Date	31/12/2022	Northing	6274156	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
5/12/2002		2.70	1.65
6/02/2004		2.55	1.80
9/06/2004		2.59	1.76
30/08/2004		3.81	0.54
20/09/2004		3.49	0.86
1/10/2004		3.39	0.96
12/09/2005		3.73	0.62
26/10/2005		3.61	0.74
18/11/2005		3.46	0.89
30/12/2005		3.12	1.23
3/02/2006		2.90	1.45
5/03/2006		2.76	1.59
31/03/2006		2.37	1.98

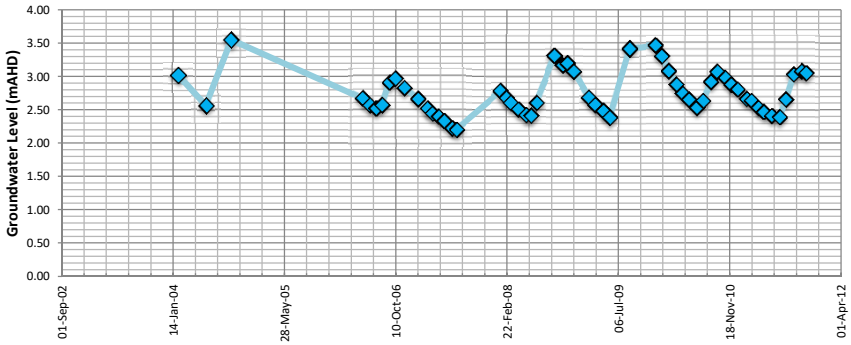
Minimum Recorded Level (mAHD)	2.37
Maximum Recorded Level (mAHD)	3.81

H2018 Embark LWMS

BA14 JDA Bore 14

				Natural Surface (mAHD)	6.94
Data Analysis Period Start Date	1/01/2000	Easting	352047	Top of Casing (m AHD)	7.74
Data Analysis Period End Date	31/12/2022	Northing	6274342	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		3.02	3.92
9/06/2004		2.57	4.37
1/10/2004		3.55	3.39
16/05/2006		2.67	4.27
17/06/2006		2.57	4.37
14/07/2006		2.52	4.42
10/08/2006		2.57	4.37
12/09/2006		2.90	4.04
9/10/2006		2.96	3.98
18/11/2006		2.82	4.12
17/01/2007		2.66	4.28
1/03/2007		2.52	4.42
23/03/2007		2.45	4.49
19/04/2007		2.40	4.54
14/05/2007		2.34	4.60
18/06/2007		2.23	4.71
9/07/2007		2.21	4.73
25/01/2008		2.78	4.16
21/02/2008		2.68	4.26
10/03/2008		2.61	4.33
14/04/2008		2.51	4.43
19/05/2008		2.43	4.51
9/06/2008		2.42	4.52
3/07/2008		2.61	4.33
24/09/2008		3.31	3.63
29/10/2008		3.17	3.77
19/11/2008		3.20	3.74
16/12/2008		3.08	3.86
26/02/2009		2.68	4.26
25/03/2009		2.58	4.36
29/04/2009		2.49	4.45
27/05/2009		2.39	4.55
25/08/2009		3.42	3.52
21/12/2009		3.46	3.48
18/01/2010		3.30	3.64
18/02/2010		3.08	3.86
24/03/2010		2.88	4.06
21/04/2010		2.75	4.19
19/05/2010		2.66	4.28
24/06/2010		2.54	4.40
21/07/2010		2.64	4.30
25/08/2010		2.92	4.02
22/09/2010		3.07	3.87
28/10/2010		2.98	3.96
23/11/2010		2.88	4.06
22/12/2010		2.81	4.13
31/01/2011		2.67	4.27
22/02/2011		2.64	4.30
24/03/2011		2.54	4.40
18/04/2011		2.48	4.46
24/05/2011		2.42	4.52
28/06/2011		2.40	4.54
26/07/2011		2.66	4.28
30/08/2011		3.03	3.91
4/10/2011		3.08	3.86
25/10/2011		3.05	3.89

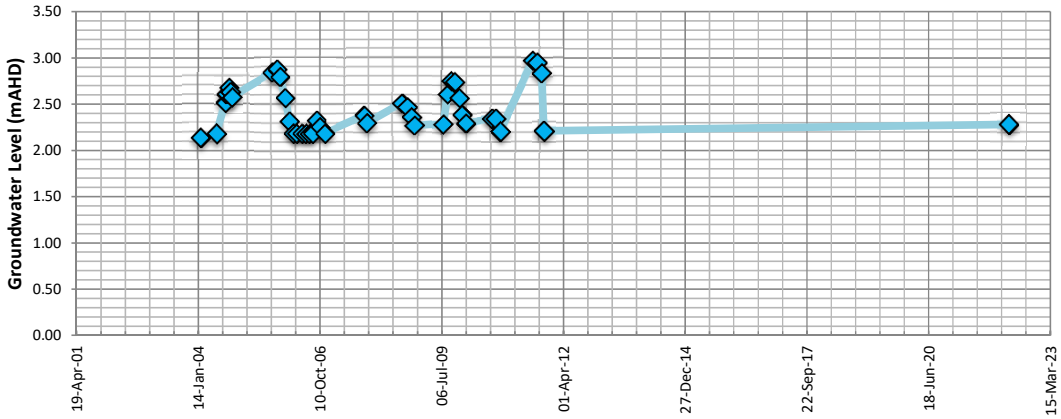
Minimum Recorded Level (mAHD)	2.21
Maximum Recorded Level (mAHD)	3.55

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BA15 JDA Bore 15

				Natural Surface (mAHD)	4.94
Data Analysis Period Start Date	1/01/2000	Easting	351793	Top of Casing (m AHD)	5.18
Data Analysis Period End Date	31/12/2022	Northing	6274905	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		2.14	2.80
9/06/2004		2.18	2.76
23/08/2004		2.52	2.42
30/08/2004		2.61	2.33
20/09/2004		2.68	2.26
1/10/2004		2.63	2.31
15/10/2004		2.58	2.36
12/09/2005		2.84	2.10
26/10/2005		2.87	2.07
18/11/2005		2.79	2.15
30/12/2005		2.57	2.37
3/02/2006		2.32	2.62
5/03/2006		2.19	2.75
31/03/2006		2.19	2.75
16/05/2006		2.19	2.75
17/06/2006		2.19	2.75
14/07/2006		2.19	2.75
10/08/2006		2.19	2.75
12/09/2006		2.33	2.61
9/10/2006		2.26	2.68
18/11/2006		2.19	2.75
9/10/2007		2.38	2.56
30/10/2007		2.30	2.64
12/08/2008		2.51	2.43
24/09/2008		2.47	2.47
29/10/2008		2.36	2.58
19/11/2008		2.27	2.67
22/07/2009		2.29	2.65
25/08/2009		2.61	2.33
23/09/2009		2.75	2.19
22/10/2009		2.74	2.20
26/11/2009		2.57	2.37
21/12/2009		2.39	2.55
18/01/2010		2.30	2.64
25/08/2010		2.34	2.60
22/09/2010		2.34	2.60
28/10/2010		2.21	2.73
26/07/2011		2.97	1.97
30/08/2011		2.95	1.99
4/10/2011		2.84	2.10
25/10/2011		2.21	2.73
4/04/2022		2.28	2.66

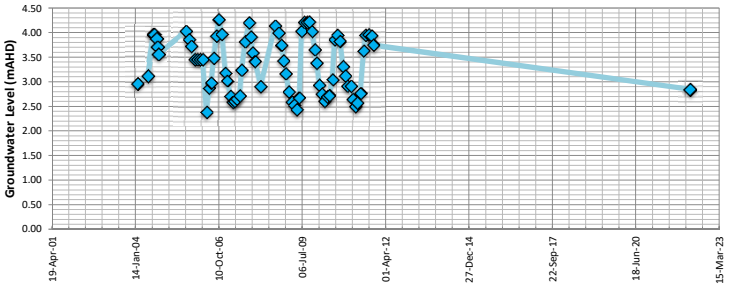
Minimum Recorded Level (mAHD)	2.14
Maximum Recorded Level (mAHD)	2.97

H2018 Embark LWMS

BA17 JDA Bore 17

Data Analysis Period Start Date	1/01/2000	Easting	349556	Natural Surface (mAHD)	3.91
Data Analysis Period End Date	31/12/2022	Northing	6273827	Top of Casing (m AHD)	4.80
				End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		2.97	0.94
9/06/2004		3.12	0.79
23/08/2004		3.95	-0.04
30/08/2004		3.95	-0.04
20/09/2004		3.87	0.04
1/10/2004		3.71	0.20
15/10/2004		3.57	0.34
12/09/2005		4.03	-0.12
26/10/2005		3.86	0.05
18/11/2005		3.72	0.19
30/12/2005		3.46	0.45
3/02/2006		3.46	0.45
5/03/2006		3.46	0.45
31/03/2006		3.46	0.45
16/05/2006		2.40	1.51
17/06/2006		2.88	1.03
14/07/2006		2.99	0.92
10/08/2006		3.49	0.42
12/09/2006		3.93	-0.02
9/10/2006		4.27	-0.36
18/11/2006		3.97	-0.06
29/12/2006		3.19	0.72
17/01/2007		3.03	0.88
1/03/2007		2.72	1.19
23/03/2007		2.60	1.31
19/04/2007		2.62	1.29
14/05/2007		2.66	1.25
18/06/2007		2.73	1.18
9/07/2007		3.25	0.66
21/08/2007		3.82	0.09
9/10/2007		4.20	-0.29
30/10/2007		3.92	-0.01
16/11/2007		3.59	0.32
17/12/2007		3.42	0.49
21/02/2008		2.92	0.99
12/08/2008		4.13	-0.22
24/09/2008		3.99	-0.08
29/10/2008		3.75	0.16
19/11/2008		3.43	0.48
16/12/2008		3.18	0.73
23/01/2009		2.81	1.10
26/02/2009		2.60	1.31
25/03/2009		2.54	1.37
29/04/2009		2.45	1.46
27/05/2009		2.69	1.22
24/06/2009		4.03	-0.12
22/07/2009		4.21	-0.30
25/08/2009		4.21	-0.30
23/09/2009		4.22	-0.31
22/10/2009		4.03	-0.12
26/11/2009		3.66	0.25
21/12/2009		3.39	0.52
18/01/2010		2.94	0.97
18/02/2010		2.77	1.14
24/03/2010		2.62	1.29
21/04/2010		2.71	1.20
19/05/2010		2.73	1.18
24/06/2010		3.06	0.85
21/07/2010		3.86	0.05
25/08/2010		3.95	-0.04
22/09/2010		3.83	0.08
28/10/2010		3.32	0.59
23/11/2010		3.13	0.78
22/12/2010		2.93	0.98
31/01/2011		2.92	0.99
22/02/2011		2.66	1.25
24/03/2011		2.51	1.40
18/04/2011		2.58	1.33
24/05/2011		2.78	1.13
28/06/2011		3.63	0.28
26/07/2011		3.95	-0.04
30/08/2011		3.96	-0.05
4/10/2011		3.94	-0.03
25/10/2011		3.75	0.16
4/04/2022		2.85	1.06

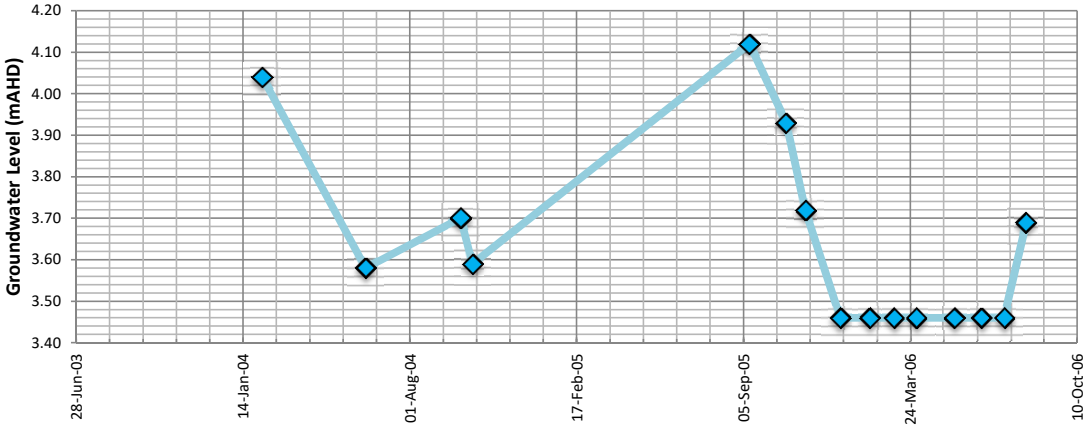
Minimum Recorded Level (mAHD)	2.4
Maximum Recorded Level (mAHD)	4.27

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BA18 JDA Bore 18

				Natural Surface (mAHD)	4.37
Data Analysis Period Start Date	1/01/2000	Easting	349095	Top of Casing (m AHD)	4.59
Data Analysis Period End Date	31/12/2022	Northing	6273642	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		4.04	0.33
9/06/2004		3.58	0.79
1/10/2004		3.70	0.67
15/10/2004		3.59	0.78
12/09/2005		4.12	0.25
26/10/2005		3.93	0.44
18/11/2005		3.72	0.65
30/12/2005		3.46	0.91
3/02/2006		3.46	0.91
5/03/2006		3.46	0.91
31/03/2006		3.46	0.91
16/05/2006		3.46	0.91
17/06/2006		3.46	0.91
14/07/2006		3.46	0.91
10/08/2006		3.69	0.68

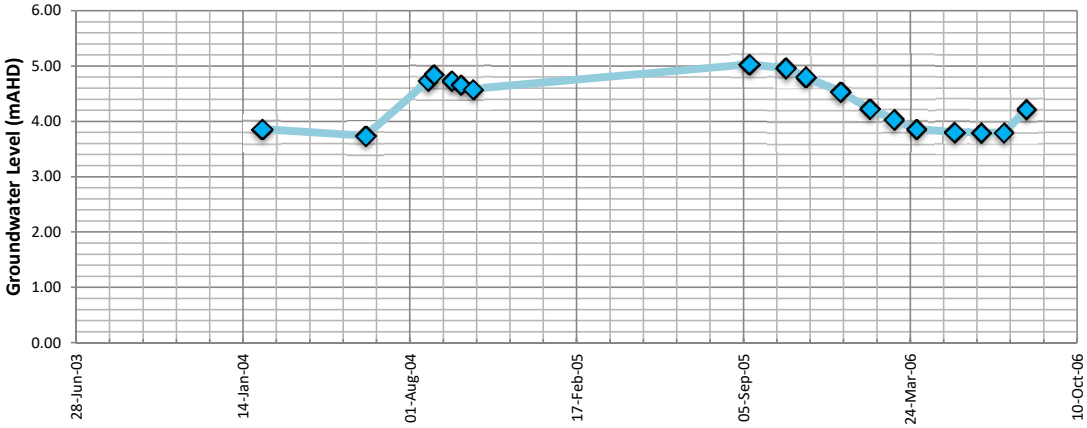
Minimum Recorded Level (mAHD)	3.46
Maximum Recorded Level (mAHD)	4.12

H2018 Embark LWMS

BA19 JDA Bore 19

				Natural Surface (mAHD)	6.10
Data Analysis Period Start Date	1/01/2000	Easting	349488	Top of Casing (m AHD)	6.92
Data Analysis Period End Date	31/12/2022	Northing	6273218	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		3.86	2.24
9/06/2004		3.74	2.36
23/08/2004		4.74	1.36
30/08/2004		4.85	1.25
20/09/2004		4.74	1.36
1/10/2004		4.67	1.43
15/10/2004		4.59	1.51
12/09/2005		5.03	1.07
26/10/2005		4.96	1.14
18/11/2005		4.81	1.29
30/12/2005		4.53	1.57
3/02/2006		4.23	1.87
5/03/2006		4.03	2.07
31/03/2006		3.86	2.24
16/05/2006		3.81	2.29
17/06/2006		3.81	2.29
14/07/2006		3.81	2.29
10/08/2006		4.22	1.88

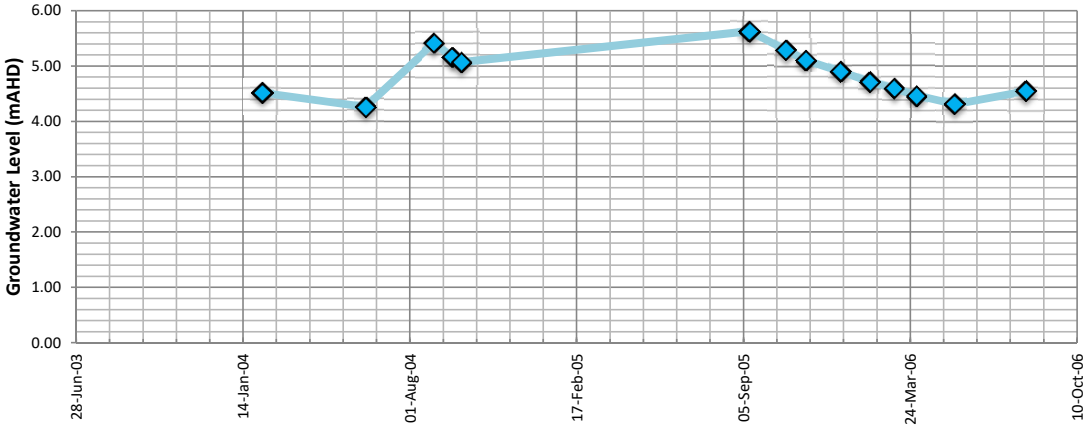
Minimum Recorded Level (mAHD)	3.74
Maximum Recorded Level (mAHD)	5.03

H2018 Embark LWMS

BA20 JDA Bore 20

				Natural Surface (mAHD)	6.20
Data Analysis Period Start Date	1/01/2000	Easting	349881	Top of Casing (m AHD)	6.91
Data Analysis Period End Date	31/12/2022	Northing	6273365	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		4.52	1.68
9/06/2004		4.26	1.94
30/08/2004		5.41	0.79
20/09/2004		5.16	1.04
1/10/2004		5.07	1.13
12/09/2005		5.63	0.57
26/10/2005		5.29	0.91
18/11/2005		5.11	1.09
30/12/2005		4.90	1.30
3/02/2006		4.72	1.48
5/03/2006		4.60	1.60
31/03/2006		4.47	1.73
16/05/2006		4.31	1.89
10/08/2006		4.55	1.65

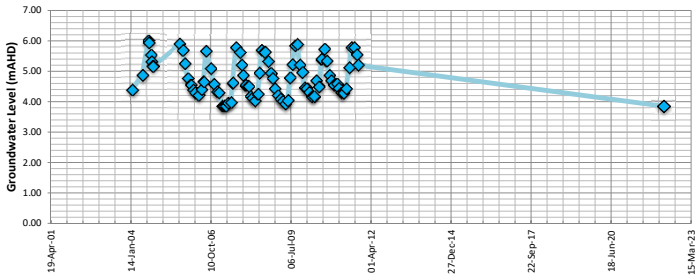
Minimum Recorded Level (mAHD)	4.26
Maximum Recorded Level (mAHD)	5.63

H2018 Embark LWMS

BA21 JDA Bore 21

				Natural Surface (mAHD)	6.07
Data Analysis Period Start Date	1/01/2000	Easting	349780	Top of Casing (m AHD)	6.92
Data Analysis Period End Date	31/12/2022	Northing	6272908	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		4.40	1.67
9/06/2004		4.86	1.21
23/08/2004		5.98	0.09
30/08/2004		5.90	0.17
20/09/2004		5.51	0.56
1/10/2004		5.29	0.78
15/10/2004		5.16	0.91
12/09/2005		5.88	0.19
26/10/2005		5.67	0.40
18/11/2005		5.25	0.82
30/12/2005		4.76	1.31
3/02/2006		4.56	1.51
5/03/2006		4.40	1.67
31/03/2006		4.30	1.77
16/05/2006		4.22	1.85
17/06/2006		4.41	1.66
14/07/2006		4.66	1.41
10/08/2006		5.65	0.42
9/10/2006		5.08	0.99
18/11/2006		4.59	1.48
29/12/2006		4.33	1.74
17/01/2007		4.30	1.77
1/03/2007		3.87	2.20
23/03/2007		3.87	2.20
19/04/2007		3.87	2.20
14/05/2007		3.98	2.09
18/06/2007		3.99	2.08
9/07/2007		4.62	1.45
21/08/2007		5.76	0.31
9/10/2007		5.60	0.47
30/10/2007		5.20	0.87
16/11/2007		4.87	1.20
17/12/2007		4.55	1.52
25/01/2008		4.51	1.56
21/02/2008		4.19	1.88
10/03/2008		4.12	1.95
14/04/2008		4.04	2.03
19/05/2008		4.25	1.82
9/06/2008		4.94	1.13
3/07/2008		5.67	0.40
12/08/2008		5.62	0.45
24/09/2008		5.31	0.76
29/10/2008		4.93	1.14
19/11/2008		4.77	1.30
16/12/2008		4.44	1.63
23/01/2009		4.21	1.86
26/02/2009		4.09	1.98
25/03/2009		4.02	2.05
29/04/2009		3.93	2.14
27/05/2009		4.05	2.02
24/06/2009		4.79	1.28
22/07/2009		5.22	0.85
25/08/2009		5.82	0.25
23/09/2009		5.87	0.20
22/10/2009		5.20	0.87
26/11/2009		4.96	1.11
21/12/2009		4.46	1.61
18/01/2010		4.44	1.63
18/02/2010		4.31	1.76
24/03/2010		4.18	1.89
21/04/2010		4.18	1.89
19/05/2010		4.69	1.38
24/06/2010		4.49	1.58
21/07/2010		5.38	0.69
25/08/2010		5.71	0.36
22/09/2010		5.32	0.75
28/10/2010		4.86	1.21
23/11/2010		4.69	1.38
22/12/2010		4.55	1.52
31/01/2011		4.59	1.48
22/02/2011		4.45	1.62
24/03/2011		4.29	1.78
18/04/2011		4.29	1.78
24/05/2011		4.43	1.64
28/06/2011		5.11	0.96
26/07/2011		5.77	0.30
30/08/2011		5.77	0.30
4/10/2011		5.52	0.55
25/10/2011		5.20	0.87
4/04/2022		3.85	2.22

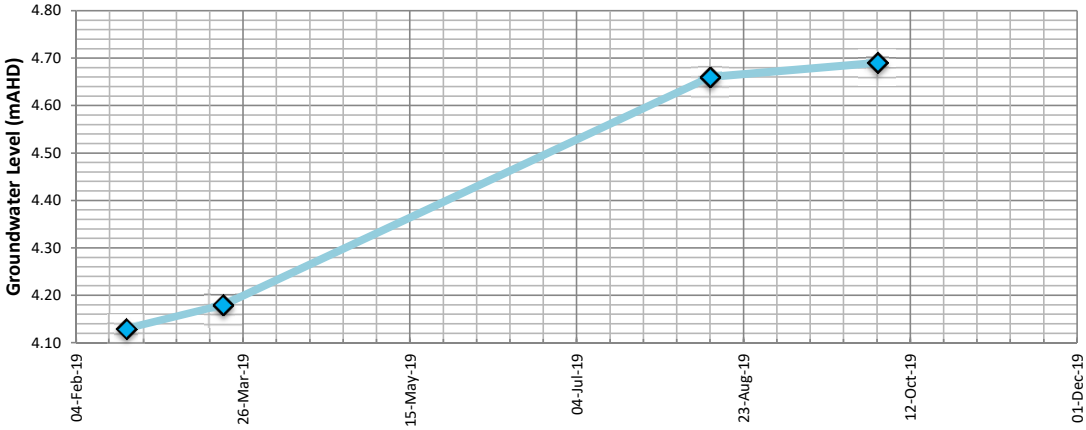
Minimum Recorded Level (mAHD)	3.85
Maximum Recorded Level (mAHD)	5.98

H2018 Embark LWMS

FP01 Footprint Lake Monitoring Bore 1

				Natural Surface (mAHD)	6.40
Data Analysis Period Start Date	1/01/2000	Easting	350733	Top of Casing (m AHD)	6.83
Data Analysis Period End Date	31/12/2022	Northing	6273607	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
19/02/2019		4.13	2.27
20/03/2019		4.18	2.22
13/08/2019		4.66	1.74
2/10/2019		4.69	1.71

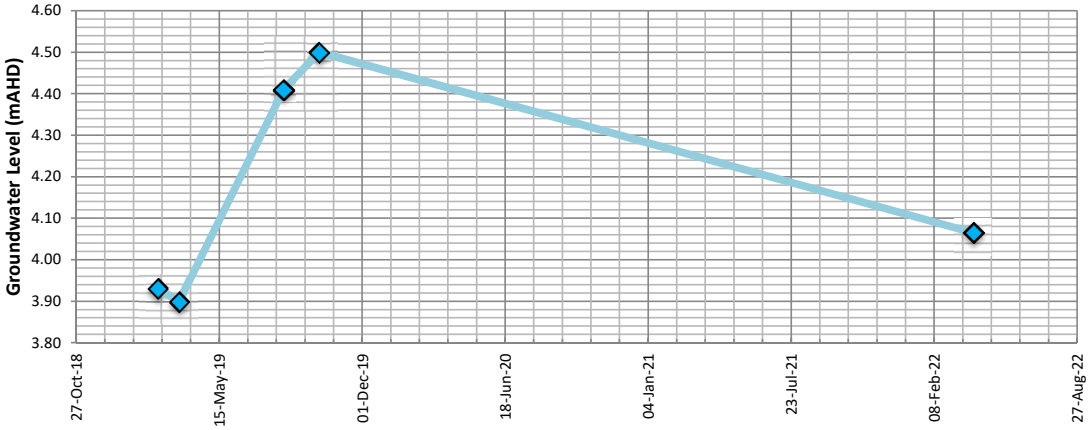
Minimum Recorded Level (mAHD)	4.13
Maximum Recorded Level (mAHD)	4.69

H2018 Embark LWMS

FP02 Footprint Lake Monitoring Bore 2

				Natural Surface (mAHD)	6.41
Data Analysis Period Start Date	1/01/2000	Easting	350839	Top of Casing (m AHD)	7.03
Data Analysis Period End Date	31/12/2022	Northing	6273607	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
19/02/2019		3.93	2.48
20/03/2019		3.90	2.51
13/08/2019		4.41	2.00
2/10/2019		4.50	1.91
4/04/2022		4.07	2.34

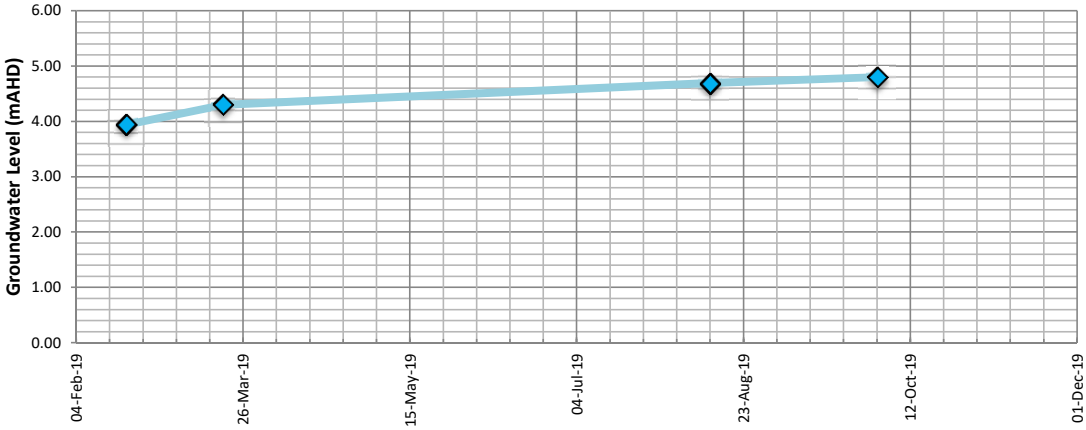
Minimum Recorded Level (mAHD)	3.9
Maximum Recorded Level (mAHD)	4.5

H2018 Embark LWMS

FP03 Footprint Lake Monitoring Bore 3

				Natural Surface (mAHD)	6.56
Data Analysis Period Start Date	1/01/2000	Easting	350921	Top of Casing (m AHD)	7.10
Data Analysis Period End Date	31/12/2022	Northing	6273568	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
19/02/2019		3.94	2.62
20/03/2019		4.30	2.26
13/08/2019		4.69	1.87
2/10/2019		4.80	1.76

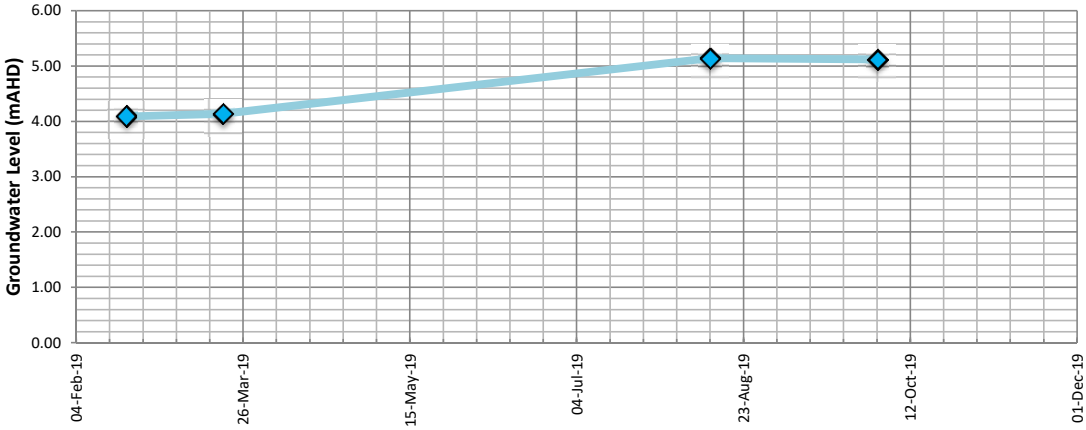
Minimum Recorded Level (mAHD)	3.94
Maximum Recorded Level (mAHD)	4.8

H2018 Embark LWMS

FP04 Footprint Lake Monitoring Bore 4

				Natural Surface (mAHD)	5.83
Data Analysis Period Start Date	1/01/2000	Easting	350819	Top of Casing (m AHD)	6.40
Data Analysis Period End Date	31/12/2022	Northing	6273423	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
19/02/2019		4.09	1.74
20/03/2019		4.14	1.69
13/08/2019		5.14	0.69
2/10/2019		5.12	0.71

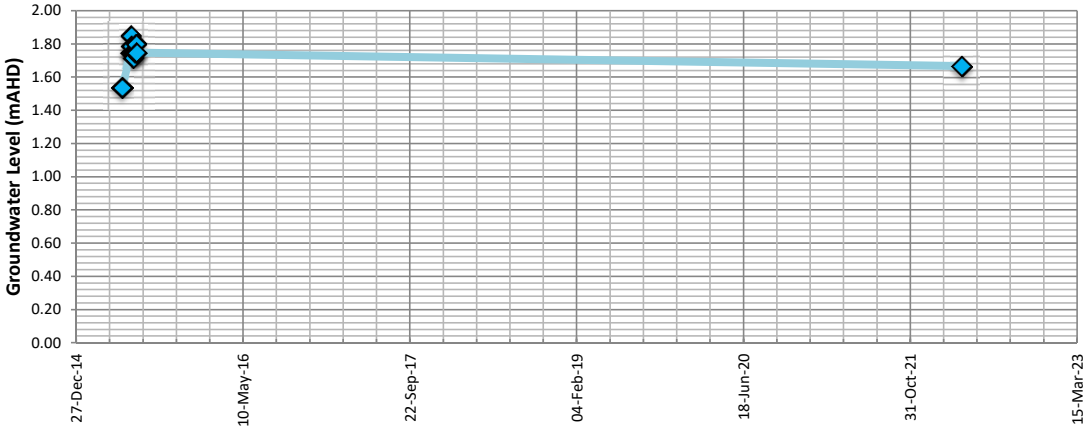
Minimum Recorded Level (mAHD)	4.09
Maximum Recorded Level (mAHD)	5.14

H2018 Embark LWMS

MB3 RPS Bore 3

				Natural Surface (mAHD)	3.95
Data Analysis Period Start Date	1/01/2000	Easting	350736.43	Top of Casing (m AHD)	4.55
Data Analysis Period End Date	31/12/2022	Northing	6274630.7	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
13/05/2015	3.01	1.54	2.41
9/06/2015	2.80	1.75	2.20
10/06/2015	2.70	1.85	2.10
11/06/2015	2.76	1.79	2.16
12/06/2015	2.80	1.75	2.20
15/06/2015	2.80	1.75	2.20
17/06/2015	2.83	1.72	2.23
22/06/2015	2.80	1.75	2.20
24/06/2015	2.80	1.75	2.20
25/06/2015	2.75	1.80	2.15
26/06/2015	2.80	1.75	2.20
4/04/2022		1.67	2.28

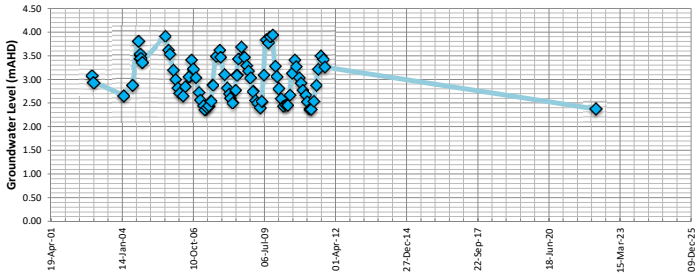
Minimum Recorded Level (mAHD)	1.537
Maximum Recorded Level (mAHD)	1.847

H2018 Embark LWMS

18S DWER Bore 18S

				Natural Surface (mAHD)	4.30
Data Analysis Period Start Date	1/01/2000	Easting	348949.51	Top of Casing (m AHD)	4.91
Data Analysis Period End Date	31/12/2022	Northing	6273758.72	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
11/11/2002		3.08	1.22
5/12/2002		2.94	1.36
6/02/2004		2.66	1.64
9/06/2004		2.87	1.43
30/08/2004		3.80	0.50
20/09/2004		3.54	0.76
1/10/2004		3.45	0.85
15/10/2004		3.37	0.93
12/09/2005		3.90	0.40
26/10/2005		3.62	0.68
18/11/2005		3.53	0.77
30/12/2005		3.20	1.10
3/02/2006		3.00	1.30
5/03/2006		2.82	1.48
31/03/2006		2.71	1.59
16/05/2006		2.65	1.65
17/06/2006		2.85	1.45
10/08/2006		3.05	1.25
12/09/2006		3.41	0.89
9/10/2006		3.21	1.09
18/11/2006		3.04	1.26
29/12/2006		2.73	1.57
17/01/2007		2.57	1.73
1/03/2007		2.45	1.85
23/03/2007		2.37	1.93
19/04/2007		2.41	1.89
14/05/2007		2.45	1.85
18/06/2007		2.55	1.75
9/07/2007		2.88	1.42
21/08/2007		3.48	0.82
9/10/2007		3.61	0.69
30/10/2007		3.46	0.84
17/12/2007		3.10	1.20
25/01/2008		2.83	1.47
21/02/2008		2.70	1.60
10/03/2008		2.61	1.69
14/04/2008		2.51	1.79
19/05/2008		2.77	1.53
9/06/2008		3.09	1.21
3/07/2008		3.43	0.87
12/08/2008		3.68	0.62
24/09/2008		3.46	0.84
29/10/2008		3.29	1.01
19/11/2008		3.17	1.13
16/12/2008		3.03	1.27
23/01/2009		2.75	1.55
26/02/2009		2.56	1.74
25/03/2009		2.51	1.79
29/04/2009		2.41	1.89
27/05/2009		2.54	1.76
24/06/2009		3.10	1.20
22/07/2009		3.83	0.47
25/08/2009		3.77	0.53
23/09/2009		3.89	0.41
22/10/2009		3.93	0.37
26/11/2009		3.28	1.02
21/12/2009		3.06	1.24
18/01/2010		2.81	1.49
18/02/2010		2.60	1.70
24/03/2010		2.44	1.86
21/04/2010		2.46	1.84
19/05/2010		2.46	1.84
24/06/2010		2.68	1.62
21/07/2010		3.13	1.17
25/08/2010		3.41	0.89
22/09/2010		3.27	1.03
28/10/2010		3.04	1.26
23/11/2010		2.93	1.37
22/12/2010		2.78	1.52
31/01/2011		2.67	1.63
22/02/2011		2.53	1.77
24/03/2011		2.38	1.92
18/04/2011		2.38	1.92
24/05/2011		2.55	1.75
28/06/2011		2.88	1.42
26/07/2011		3.21	1.09
30/08/2011		3.50	0.80
4/10/2011		3.42	0.88
25/10/2011		3.26	1.04
4/04/2022		2.38	1.93

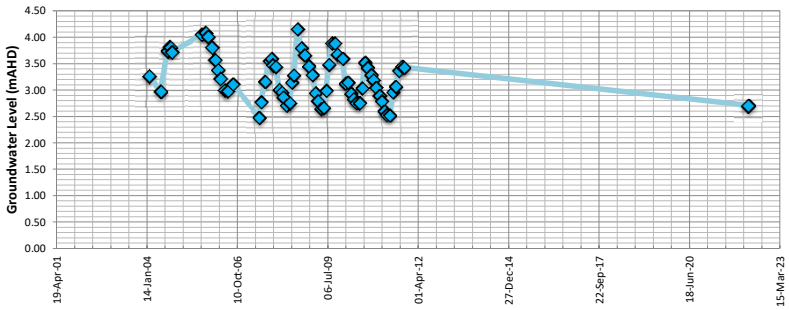
Minimum Recorded Level (mAHD)	2.37
Maximum Recorded Level (mAHD)	3.93

H2018 Embark LWMS

19S DWER Bore 19S

				Natural Surface (mAHD)	5.58
Data Analysis Period Start Date	1/01/2000	Easting	352717.82	Top of Casing (m AHD)	6.31
Data Analysis Period End Date	31/12/2022	Northing	6274797.5	End of Hole (mAHD)	

Report Date : 23/02/2023



Date	Groundwater bTOC	Groundwater mAHD	Depth Below NS m
6/02/2004		3.26	2.32
9/06/2004		2.98	2.60
30/08/2004		3.75	1.83
20/09/2004		3.83	1.75
1/10/2004		3.81	1.77
15/10/2004		3.73	1.85
12/09/2005		4.04	1.54
26/10/2005		4.07	1.51
18/11/2005		4.00	1.58
30/12/2005		3.80	1.78
3/02/2006		3.57	2.01
5/03/2006		3.38	2.20
31/03/2006		3.22	2.36
16/05/2006		3.01	2.57
17/06/2006		2.99	2.59
10/08/2006		3.12	2.46
18/06/2007		2.49	3.09
9/07/2007		2.78	2.80
21/08/2007		3.16	2.42
9/10/2007		3.55	2.03
30/10/2007		3.59	1.99
16/11/2007		3.47	2.11
17/12/2007		3.44	2.14
25/01/2008		3.01	2.57
21/02/2008		2.96	2.62
10/03/2008		2.87	2.71
14/04/2008		2.72	2.86
19/05/2008		2.76	2.82
9/06/2008		3.15	2.43
3/07/2008		3.28	2.30
12/08/2008		4.15	1.43
24/09/2008		3.79	1.79
29/10/2008		3.66	1.92
16/12/2008		3.45	2.13
23/01/2009		3.29	2.29
26/02/2009		2.95	2.63
25/03/2009		2.80	2.78
29/04/2009		2.66	2.92
27/05/2009		2.67	2.91
24/06/2009		3.00	2.58
22/07/2009		3.48	2.10
25/08/2009		3.88	1.70
23/09/2009		3.88	1.70
22/10/2009		3.67	1.91
21/12/2009		3.60	1.98
18/01/2010		3.13	2.45
18/02/2010		3.15	2.43
24/03/2010		2.94	2.64
21/04/2010		2.84	2.74
19/05/2010		2.76	2.82
24/06/2010		2.76	2.82
21/07/2010		3.04	2.54
25/08/2010		3.52	2.06
22/09/2010		3.42	2.16
28/10/2010		3.29	2.29
23/11/2010		3.19	2.39
22/12/2010		3.05	2.53
31/01/2011		2.90	2.68
22/02/2011		2.80	2.78
24/03/2011		2.61	2.97
18/04/2011		2.54	3.04
24/05/2011		2.53	3.05
28/06/2011		2.97	2.61
26/07/2011		3.07	2.51
30/08/2011		3.37	2.21
4/10/2011		3.45	2.13
25/10/2011		3.43	2.15
4/04/2022		2.71	2.87

Minimum Recorded Level (mAHD)	2.49
Maximum Recorded Level (mAHD)	4.15

APPENDIX L
Landscape Concept Plan



PHASE 0. **LANDSCAPE STRATEGY**

LD TOTAL

FOR YOLK PROPERTY GROUP

DECEMBER 2024

Project	EMBARK
Report Title	EMBARK Phase 0 - Landscape Strategy
Author(s)	LD Total - Landscape Architectural Department
Review By	Sheldon Day - Strategic Planning & Development Manager
For Client	Yolk Property Group Level 2 Atwell Arcade, 3 Cantonment St, Fremantle WA 6160
Issue Date	13.10.2024
File Location	U:\0PROJECTS\Embark (All Projects)\10.7096 Provence Estate - Phase 0\ 4 Tech work area\4.6 Embark_Phase0

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Document to be printed at A3 landscape double sided with binding to short side.

REVISION	ISSUE FOR	DATE
REV A	DRAFT - For Review	2.12.2022
REV B	DRAFT - For Review	16.12.2022
REV C	For Submission	18.01.2023
REV D	Amendments to POS 10	19.04.2023
REV E	Revised Lot layout and updated drainage volumes	14.10.2024

STRATEGY 0. INTRODUCTION
Framework + Objectives

STRATEGY 1. BACKGROUND
Local Context
Existing Site Character

STRATEGY 2. LANDSCAPE VISION + MASTER PLAN
Vision: Landscape Objectives + Place Drivers
Master Plan
Site Diagrams: Analysis + Strategies
CoB POS Hierarchy + Assets
Stormwater + Drainage

STRATEGY 3. IRRIGATION SCHEDULE
Bore and Mainline Strategy
Overall Irrigation Schedule



The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.

Marcel Proust







Embark is an established estate located approx. 4km from Busselton, and 175km south from Perth Metropolitan Area.

The 178 hectare site, is one of the region's strategic urban infill sites with impressive lake views, and adjacent forests, coastal wetlands and the Busselton coast line. The development is an extension of existing Provence Estate, established and expanding new amenities for growing communities.

This Landscape Strategy sets a framework for Embark journey ahead, represents a relaunch of the estate under new management.

Unique site with existing trees results in the evolution of strong timeless guidelines.

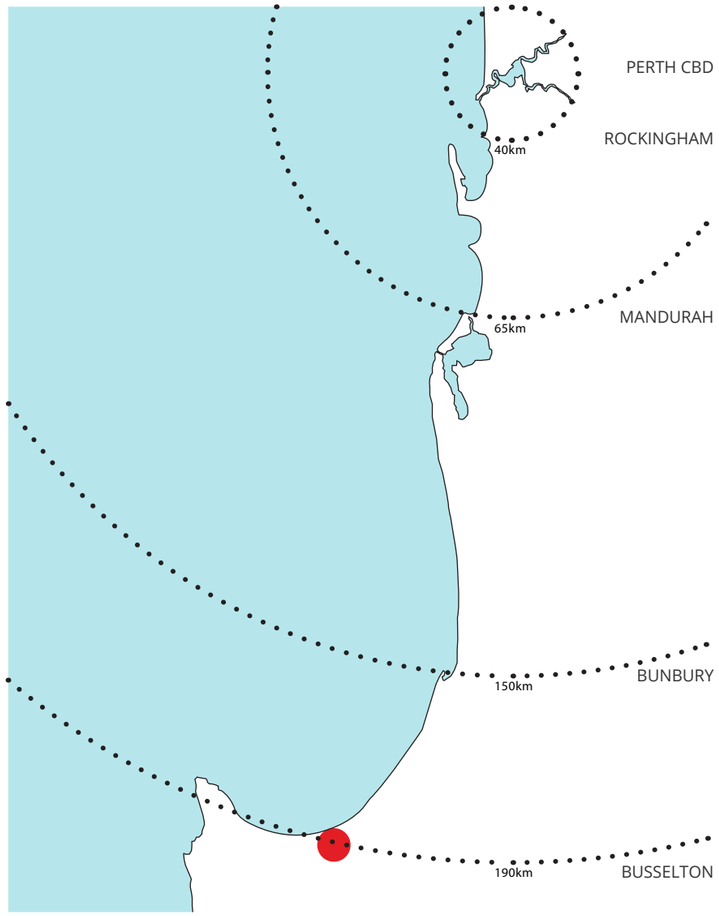
OBJECTIVES

Embark Landscape Strategy is intended to be an overall guide to create a unique sense of place, focusing on engagement with natural wealth of the "Down South" Region, while retaining connections with existing form and function of the site.

FRAMEWORK + OBJECTIVES

STRATEGY 0. INTRODUCTION

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SOUTH WEST CONTEXT



LOCAL CONTEXT

LOCAL CONTEXT

STRATEGY 1. BACKGROUND

LD TOTAL

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Embark will be a new strategic development within the City of Busselton. It is composed of significant public open spaces that will create a range of new social and community infrastructure to the region.

FLORA



FAUNA









EXISTING SITE CHARACTER

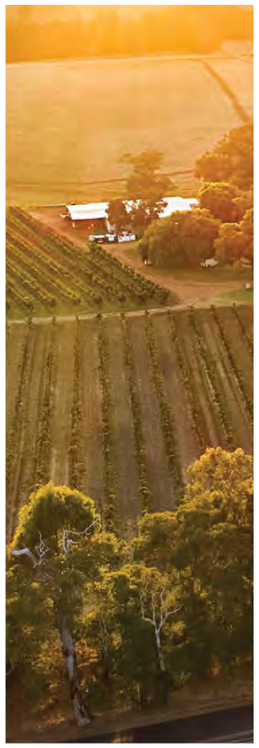
STRATEGY 1. BACKGROUND

LD TOTAL

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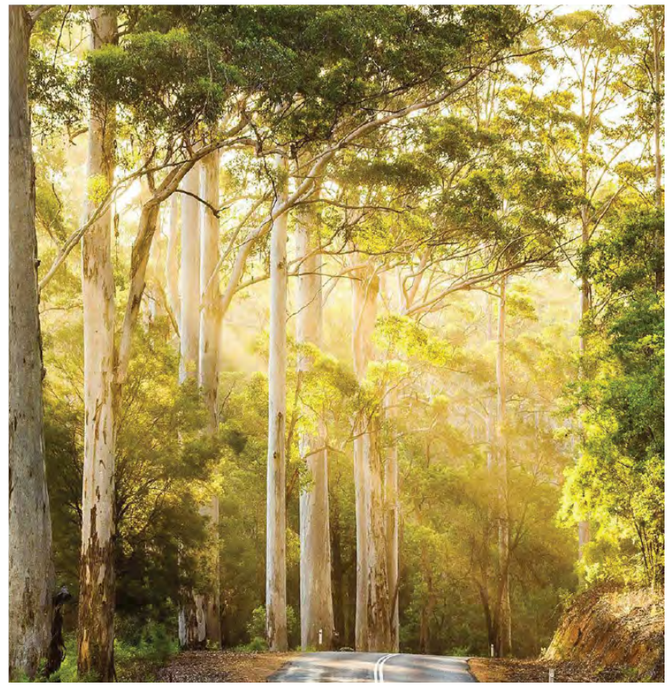












VISION: LANDSCAPE OBJECTIVES + PLACE DRIVERS

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Landscape Master Plan

Embark, Busselton



embark
BUSSELTON

Legend

1. Existing Public Open Space
2. Future Public Open Space
3. Southern buffer - Revegetated noise bund and access trail
3. Northern Corridor - 45m Revegetated vegetation buffer
4. Conservation Public Open Space
5. Open Water Body (Existing)
6. Sewer Pump Station
7. Creek and Seasonal Drainage Flow Corridor (opportunity for pedestrian network and crossings in Wetland and Conservation POS)

Land Use

- Proposed Future Residential Lots
- (A) Supermarket/Specialties (Commercial)
- (B) Townsquare (Commercial)
- (C) Retirement Village
- (D) Primary School (Public Purpose)
- (D) Future Pump house

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton.
Road reserve boundary and existing trees to be confirmed with additional feature survey.

YOLK PROPERTY GROUP

LD TOTAL

CLIENT **YOLK PROPERTY GROUP** PROJECT NO **10.7096** REVISION **F** DATE **17.10.2024** SCALE **1:5000 @ A1**

0 50 100 250m

NORTH

CONSERVATION AREAS AND POSSUM HABITAT

Embark
Busselton



DIAGRAM 4. WESTERN RINGTAIL POSSUM CORRIDORS

- Western Ringtail Possum Habitat Corridor/POS
- Key Connected Street Tree Corridor
- Public Open Space
- POS areas with Enclosed habitat

KEY POSSUM HABITAT AND CORRIDOR ACTIVITIES
The key activities to creating and maintaining the Possum habitat are to be carried out as per the WRPMP prepared by RPS group. The key activities within the landscape establishment are below:

- Areas have been Identified where existing western ringtail possum habitat occurs and additional habitat areas are proposed to be incorporated into or adjacent these areas to preserve and increase connectivity of the western ringtail possum habitat.
- These habitat areas and corridors will be maintained by the developer for 2 years after installation and then by council ongoing
- Clearing or modification of natural vegetation and/or trees will not be permitted unless approved by the City of Busselton, or other governmental statutory authority
- Street and POS tree plantings will be predominantly of Peppermint and Eucalyptus trees
- The following habitat corridors to allow the movement of western ringtail possums:
  - East–west habitat corridor linking western POS area and western ringtail possum habitat located to the west of the structure plan.
  - 30m vegetated buffer (plus a vegetated 15 m road reserve) along the northern boundary of the site adjacent Bussell Highway.
  - 30 m vegetated buffer along the southern boundary of the site.
  - North–south corridors will be provided throughout the site through a combination of street plantings, road and verge treatments, lot design and landscaping on future lots, using predominantly native peppermint tree (Agonis flexuosa).
- Implement appropriate weed control within habitat and POS areas.
- Dead trees and fallen logs will not be removed from the POS areas.
- Provide enclosure via appropriate fencing for habitat areas

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REVEGETATION AND CONSERVATION AREAS

Embark
Busselton

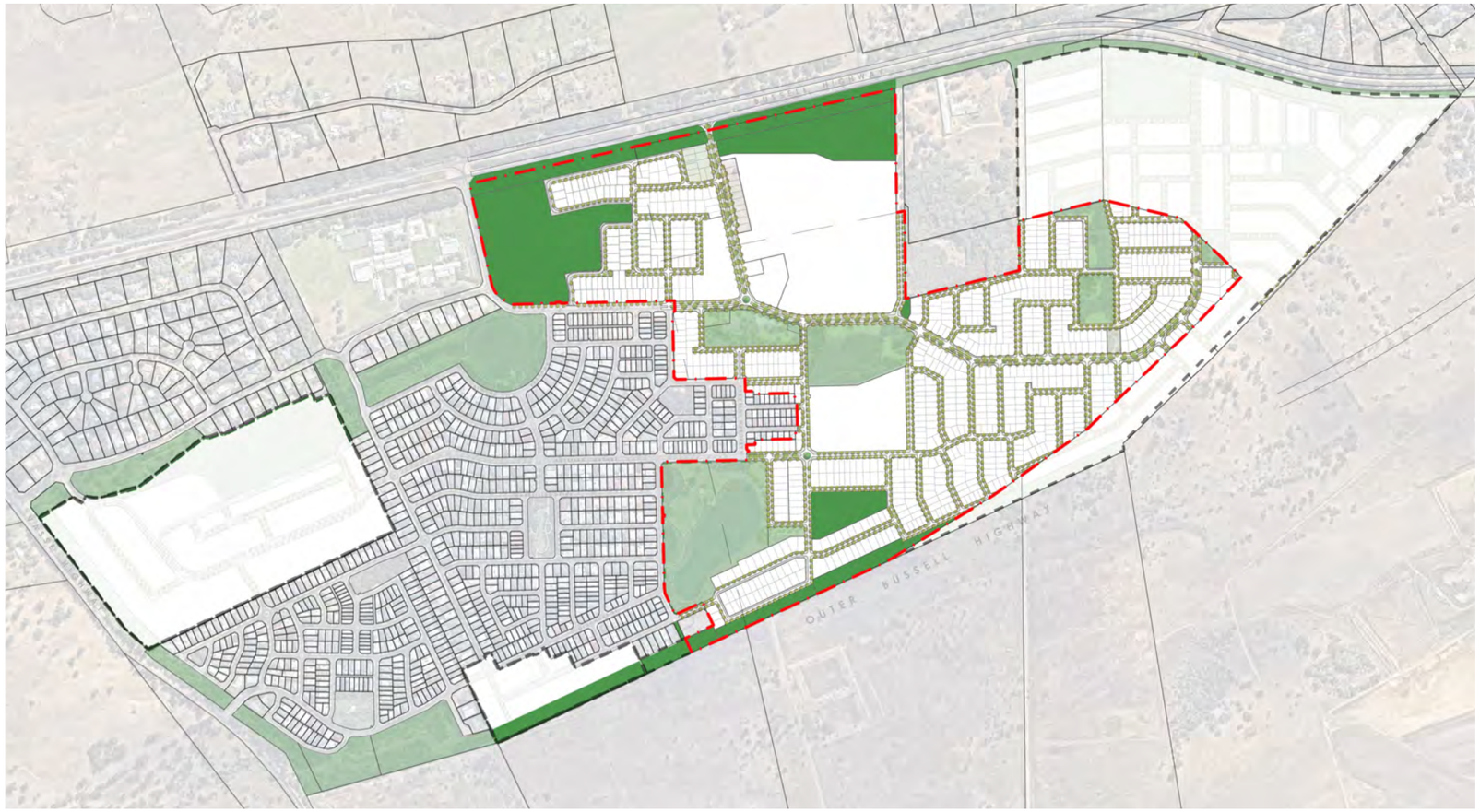


DIAGRAM 5. WESTERN RINGTAIL POSSUM CORRIDORS

Revegetation areas - works commenced as of 2024 to be carried out staged as per development areas

Key Connected Street Tree Corridor- works commenced as of 2024 to be carried out staged as per development areas

The key activities and principles for revegetation activities are below:
These activities have the overarching emphasis on providing successful habitat to the Western Ringtail population and provide residents connection to a natural environment. Detailed documentation to the City of Busseltons standards and requirements will be supplied for review and approval for each area as the staged roll out is carried out.

- The planting species selection across is proposed - these species are locally endemic and to be sourced from local provenance.
- Planting stock are to be planted at the earliest time in Autumn/winter to make the most of the rain season. Supplementary watering is proposed during warmer months for establishment to ensure viability.
- Temporary/permanent Kangaroo fencing and rabbit guards are to be employed to ensure stock survival
- Conservation fencing to be employed in the conservation habitat areas to discourage regular access and prevent vehicles and domestic pets accessing the area.
- Maintenance and seasonal top up planting will occur to the city's satisfaction to ensure adequate survival and coverage rates are met.

Proposed planting list for revegetation areas
The below species are to be installed at the following rates:
Tubestock - 1/m2
Reeds and wetland species - 2/m2
Trees - 1/10m2

BOTANICAL NAME	COMMON NAME	MATURE HT (m)
TREES		
Acacia saligna		
Agonis flexuosa		
Corymbia calophylla		
Eucalyptus cornuta		
Eucalyptus decipiens		
Eucalyptus gomphocephala		
Eucalyptus marginata		
Eucalyptus rudis		
Melaleuca cuticilaris		
Melaleuca hueglii		
Melaleuca preissiana		
Xylomelum occidentale		
SHRUBS & GROUND COVERS		
Acacia applanata		
Acacia cochlearis		
Acacia cyclops		
Acacia extensa		
Acacia incurva		
Acacia lasiocarpa		
Acacia littorea		
Acacia pulchella		
Acacia stenoptera		
Adenanthos obovatus		
Allocasuarina humilis		
Atriplex cinerea		
Banksia attenuata		
Banksia nivea		
Baumea arthrophylla		
Beaufortia sparsa		
Billardiera variifolia		
Calothamnus lateralis		
Calothamnus sanguineus		
Dampiera linearis		
Daviesia physodes		
Diplolaena dampieri		
Dryandra nivea		
Eremophila glabra		
Euchilopsis linearis		
Eutaxia virgata		
Gompholobium capitatum		
Gompholobium confertum		
Gompholobium tomentosum		
Grevillea obtusifolia		
Grevillea vestita		
Hakea ceratophylla		
Hakea lissocarpha		
Hakea ruscifolia		
Hakea sulcata		
Hakea varia		
Hardenbergia comptoniana		
Hemiandra pungens		
Hibbertia amplexicaulis		
Hovea trisperma		
Hovea trisperma var. trisperma		
Hypocalymma angustifolium		
Hypocalymma robustum		
Kennedia carinata		
Kennedia coccinea		
Kennedia prostrata		
Kunzea micrantha		
Melaleuca incana		
Melaleuca pauciflora		
Melaleuca thymoides		
Melaleuca uncinata		
Melaleuca viminea		
Myoporum parvifolium		
Nemcia capitata		
Olearia axillaris		
Pericalymma ellipticum		
Philotheca spicata		
Phyllanthus calycinus		
Pimelea ferruginea		
Pimelea rosea		
Pultenaea reticulata		
Regelia ciliata		
Scaevola crassifolia		
Scaevola nitida		
Solya heterophylla		
Sphaerolobium medium		
Taxandria parviceps		
Viminaria juncea		
REEDS / SEDGES		
Austrostipa semibarbata		
Baumea juncea		
Baumea riparia		
Baumea vaginalis		
Burchardia multiflora		
Carpobrotus virescens		
Conostylis aculeata		
Conostylis candicans		
Dianella revoluta var. divaricata		
Dichopogon preissii		
Ficinia nodosa		
Gahnia trifida		
Haemodorum sparsifolium		
Isolepis cernua		
Juncus kraussii		
Juncus pallidus		
Juncus pauciflorus		
Juncus subsecundas		
Lepidosperma gladiatum		
Lepidosperma squamatum		
Lobelia alata		
Myriophyllum echinatum		
Patersonia occidentalis		
Patersonia umbrosa var. xanthin		
Spinifex longifolius		
Stylidium schoenoides		
Tetrarrhena laevis		
Thysanotus multiflorus		

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SITE DIAGRAMS: ANALYSIS + STRATEGIES

Embark
Busselton



DIAGRAM 1. STREET HIERARCHY + CONNECTIVITY

- Existing high traffic roads
- Existing bus stop
- Neighborhood connector roads
- Local access streets
- Existing neighborhood connector roads
- Key green boulevard/link for pedestrian and cycling access

WAYFINDING AND ENTRIES

- Entry statement - main gateway
- Entry statement - artwork/landmark
- Entry statement - wall + signage

LAND-USE

- Commercial/Town centre
- Aged care
- Primary School co-located with DOS
- Public open space

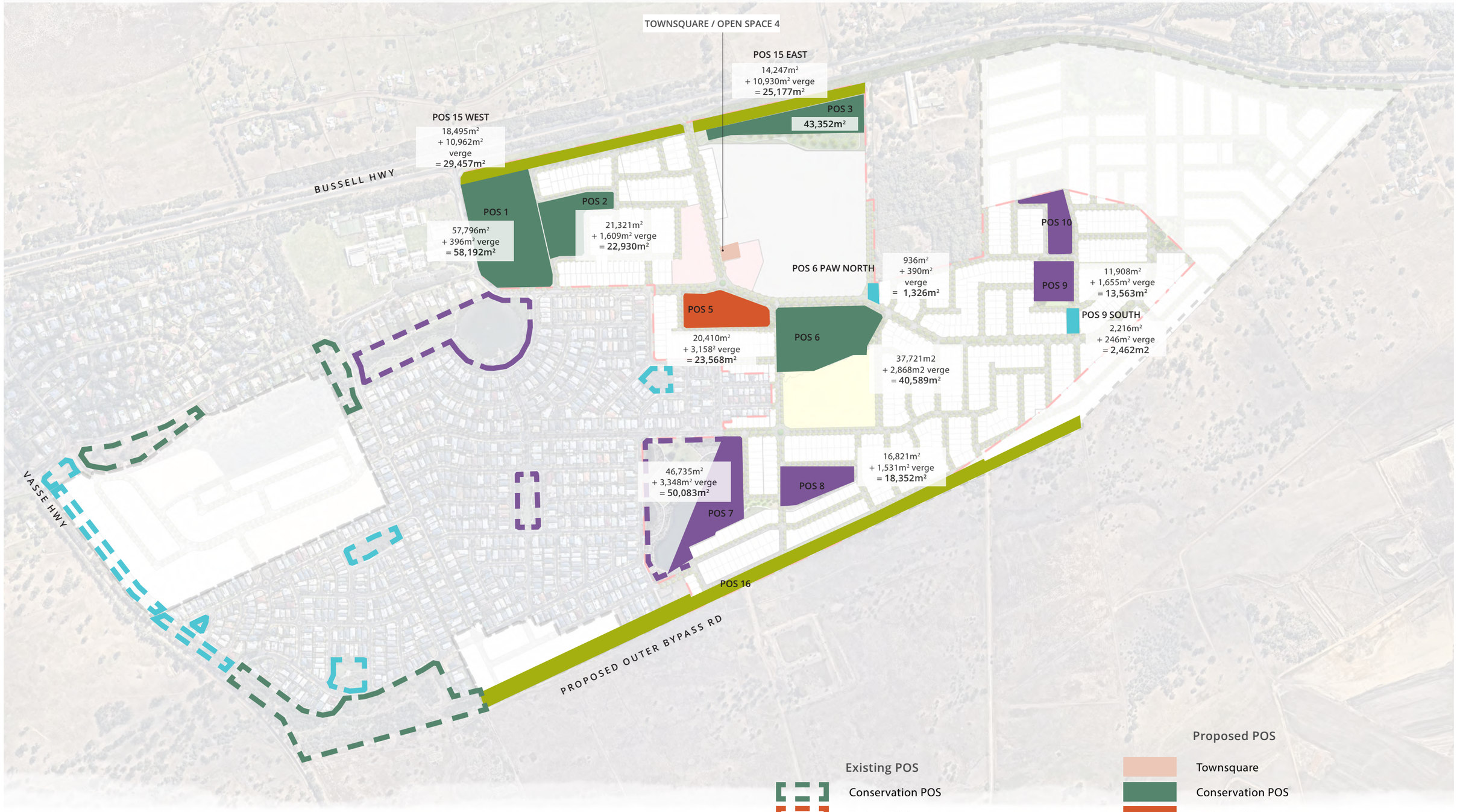
STRATEGY 2. LANDSCAPE VISION + MASTER PLAN

LD TOTAL

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POS LANDSCAPE TYPOLOGY

Embark
Busselton



NOTE:
Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

Existing POS
- Conservation POS
- District POS
- Neighborhood POS
- Local POS
- Landscape Buffer

Proposed POS
- Townsquare
- Conservation POS
- District POS
- Neighborhood POS
- Local POS
- Landscape Buffer

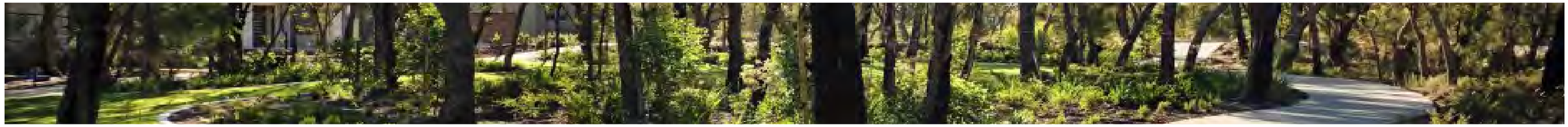
STRATEGY 2. LANDSCAPE VISION + MASTER PLAN

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POS HIERARCHY AND ASSETS

Embark
Busselton



CONSERVATION PUBLIC OPEN SPACES

KEY POINTS

- Usually 1ha to approx 7ha in size
- Predominantly revegetation and restoration areas
- Areas to provide a setting for connection to the natural environment and habitat for local fauna and ecology
- Seating nodes and shelters used strategically adjacent shared pathways and informal trails invite the user to enjoy the natural settings
- Conservation habitat areas to be enclosed

MINIMUM REQUIREMENTS

- Minimal earthworks, retention of existing trees and establishment of habitat areas
- 3m wide vehicle access gates for maintenance, service and emergency vehicles (includes fire access)
- Cement stabilised limestone track/trail surfacing.
- Benches/Seating (to be off access track and on concrete pad).
- Pedestrian access control gates (where appropriate).
- Conservation fencing.



POS 1

- External pedestrian paths
- Retention of existing trees and addition tree plantings
- Endemic native planting and understorey habitat planting
- No earthworks
- Maintenance access gates and informal trails
- Conservation fencing

POS 2

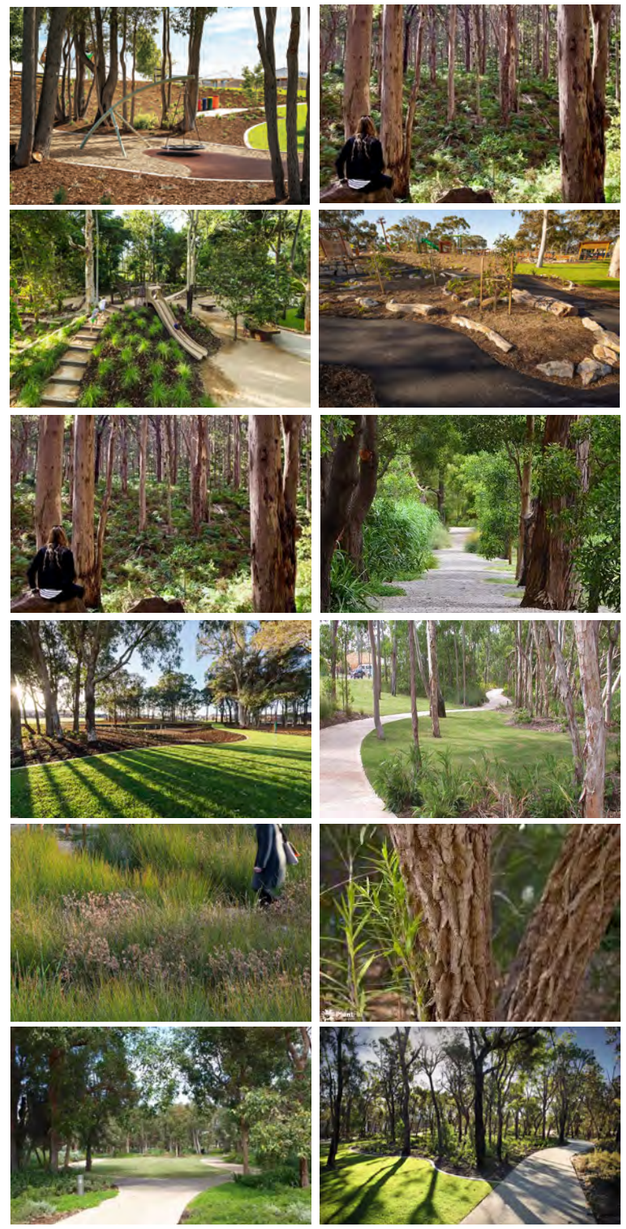
- Pedestrian footpaths and informal trails
- Endemic native planting and understorey habitat planting
- Retained vegetation & existing topography where possible
- Bench seats, lawn areas and shade structure
- Drainage infiltration basin
- Conservation fencing

POS 3

- Bench seats and small boardwalk crossing
- Pedestrian paths and informal trails
- Endemic native planting and understorey habitat planting
- Drainage basins and swales

POS 6

- Pedestrian paths and informal paths
- Small nature play area
- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Bench seats, picnic setting and shelter
- No earthworks
- Maintenance access gates and informal trails
- Conservation fencing



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POS HIERARCHY AND ASSETS

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TOWNSQUARE

KEY POINTS

- Urban Piazza/plaza town square
- A meeting space to support the immediate commercial area and surrounding community
- Potential event space
- Day/Night activities

MINIMUM REQUIREMENTS

- Clear site lines and CPTED design principles
- Places to rest and pause
- Shaded urban areas
- easy access to buildings with landscape amenity to support functional operations
- Community activated area
- Blend of Hardscape surfaces and soft landscaping, trees and lawn
- Adequate seating and shaded spaces
- Bike parking, bins, drink fountains etc to support
- Feature lighting
- Vehicle accessible for maintenance and events activation

TOWNSQUARE

- Piazza paved community areas
- Native and exotic planting, lawn
- Shade structure and seating nodes
- Drinking fountain, bike racks and bins
- Public art
- Access required for maintenance, service,and emergency vehicles
- Lighting



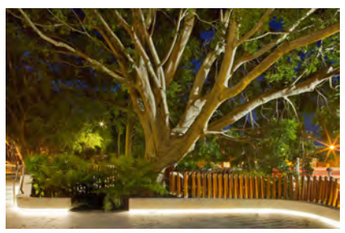
DISTRICT PUBLIC OPEN SPACES

KEY POINTS

- Active POS with sports fields
- Regional adventure playground skate park
- The park provides a large active recreational space to both Embark residents and neighboring school.
- Provides play area for all ages, BBQ facility, shade shelter and, exercise nodes
- Key views are to be emphasised and CPTED principles used to ensure sitelines
- Many native trees provided for shade for park users
- Pathways are positioned to the perimeter of the park for walkers, prams, and running, cycling and catering for all mobility levels
- Toilet facilities if required.
- Community Artwork/sculpture located at key 'entry statement' and visually creates a way finding/ signage point.

POS 5

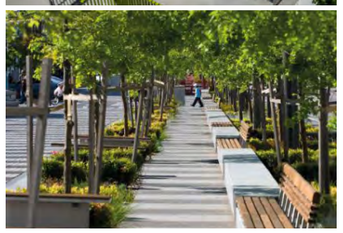
- Feature landmark artwork
- Formal park entry with signage, feature seating, bike parking
- Large kick-about lawns with sports goals
- Buffer verge planting and street trees, widened footpaths to accommodate running, bikes and pedestrians
- Shaded community meeting place with interpretive paving and artwork elements
- Enclosed basketball/multi-sports court with low tired seating areas
- Shade structure, BBQ areas, seating and picnic settings
- Adventure playground with landmark themed play tower, flying fox, pendulum swing, enclosed junior play area, bouldering and climbing features
- Nature-play area located amongst woodland area - winding discovery trails, fallen log, rope and loose parts play, interpretive and educational signage
- Teenage hangout space
- Skate, scoot and bmx park with large shade structure areas
  - Revegetated woodland areas with winding trails, seating and picnic areas



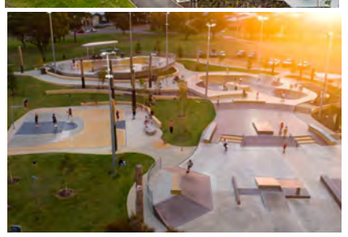










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POS HIERARCHY AND ASSETS

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Busselton



NEIGHBOURHOOD PUBLIC OPEN SPACES

KEY POINTS

- Usually 1ha to 3ha in size
- Comprised of native vegetation beds, lawn and tree zones
- Includes amenities such as shelters, play spaces, small kick-about area, paths and barbeque's
- A mix of active and passive recreation spaces
- Incorporation of basin areas within POS

POS 7

- Neighborhood POS partly constructed
- Existing waterbody - Aurelian Lake
- Shade play area, shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks (existing amenities)
- Continuation of pedestrian paths
- Additional planting to waters edge and native gardens

POS 8

- Shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks
- Shaded Play area, swings & slides
- Pedestrian paths and trails
- Turf areas
- Retained native vegetation, revegetation ares and enclosed habitat areas with conservation fencing

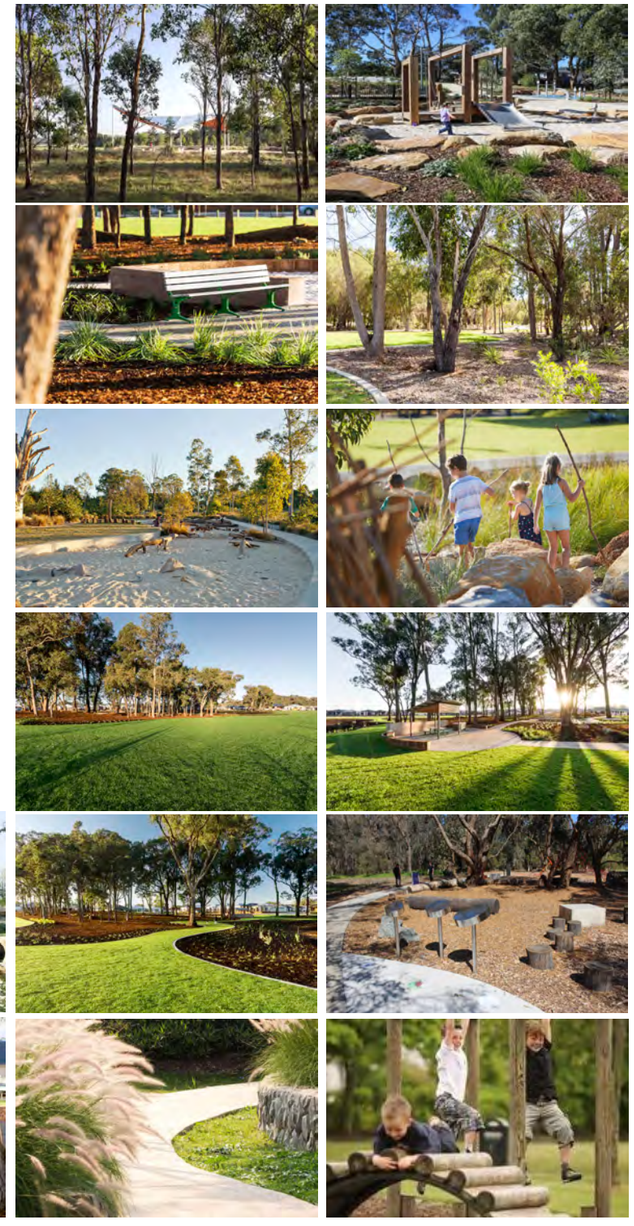
POS 9

- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Shaded play area
- Bench seats, shelters
- Turf area
- Pedestrian paths and informal trails

POS 10

- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Shaded play area
- Bench seats, shelters
- Turf area
- Pedestrian paths and informal trails







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POS HIERARCHY AND ASSETS

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LOCAL PUBLIC OPEN SPACES

KEY POINTS

- from 1,500m2 to 1,5ha - Medium sized open space
- Smaller scale local area destination to provide passive recreation or small scale play options
- Retained vegetation & existing topography where possible
- Drainage areas to be incorporated

POS 6 - PAW North

- Native planting
- Pedestrian path to Commercial/Retirement Village
- Bench seating
- Retained trees and minimal earthworks

POS 9 SOUTH

- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Small nature play and a bench seat
- Turf areas
- Pedestrian path





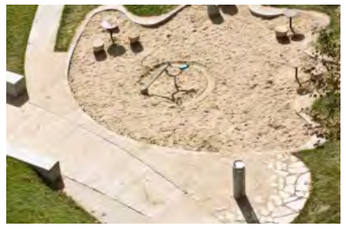




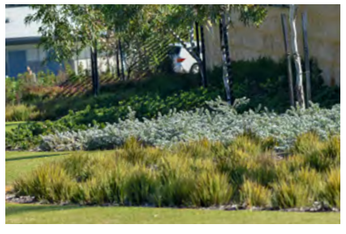










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POS HIERARCHY AND ASSETS

Embark
Busselton





LANDSCAPE BUFFER / BUND PUBLIC OPEN SPACES

KEY POINTS

- Linked green corridors for habitat, sound attenuation and revegetation areas
- Retain existing trees and provide additional habitat

MINIMUM REQUIREMENTS

- Revegetation to be undertaken in accordance with the WRPMP (western ringtail possum management plan)
- Provide maintenance access

POS 15

- Landscape Buffer
- Tree and shrubs to be retained retention
- Endemic revegetation to create habitat corridor
- Pedestrian and cycle links
- Bench seats
- Maintenance access

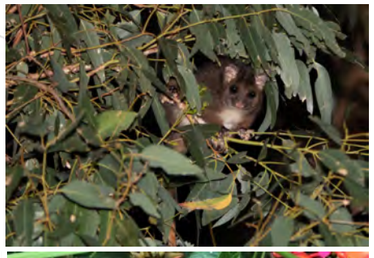
POS 16

- Landscape Buffer
- Tree and shrubs to be retained retention
- Endemic revegetation to create habitat corridor
- Pedestrian and cycle links
- Bench seats
- Maintenance access
- Linear 3m tall sound attenuation bund to be revegetated





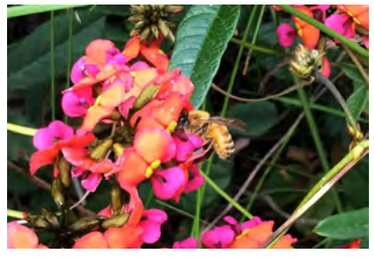














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STORMWATER AND DRAINAGE PLAN - 01

Embark
Busselton



NOTE: Diagram and base is indicative only. Refer to UWMP for detailed hydro modeling results. POS civil and landscape detail design will determine final layout of proposed stormwater storage basins and road swales.

Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

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SOFTSCAPE

Embark
Busselton

POS AREAS

Agonis flexuosa
WA Peppermint

Eucalyptus marginata
Jarrah





Corymbia calophyla
Marri

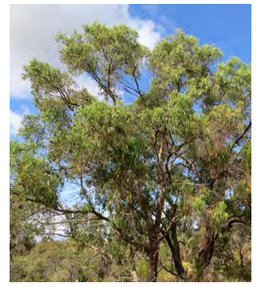
Banksia attenuata
Slender Banksia





Eucalyptus gomphocephala
Tuart

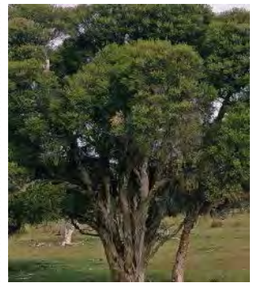
Melaleuca hueglii
Chenille Honey-myrtle





Melaleuca preissiana
Stout Paperbark

Eucalyptus rudis
Flooded Gum





TREE AND PLANTING SELECTION

Vegetation, rehab planting, swale, buffer and POS planting will be provided in a staged manner as the development stages are executed. The detail design and softscape selections, densities and sizes will be issued to City of Busselton for Review for each area prior to installation and in a timely fashion to allow securing of suitable and adequate stock and avoid significant substitutions.

Wherever possible a significantly bio-diverse planting palette of endemic species will be selected to suit the particular microclimate conditions and specific soils in each locale.

Planting selections will prioritise habitat, seasonality, robustness and suitability to the area

SHRUBS

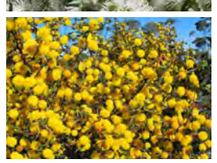
Acacia cochlearis
Coast Wattle

Melaleuca incana
Grey Honey Myrtle

Acacia pulchella
Prickly Moses



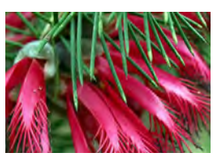




Calothamnus sanguineus
Silky leaved blood flower

Pericalymma ellipticum
Swamp teatree

Xanthorrhoea preissii
Grasstree





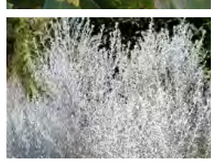


Hakea varia
Variable leaved hakea

Olearia axillaris
Coast Daisy Bush

Scaevola crassifolia
Cushion Fanflower







Patersonia occidentalis
Purple flag

Calothamnus sanguineus
Silky leaved blood flower

Gompholobium tomentosum
Hairy yellow pea







Grevillea crithmifolia
Fine-Lweaved Grevillea

Myoporum insulare
Coastal Boobialla

Conostylis candicans
Grey Cottonheads



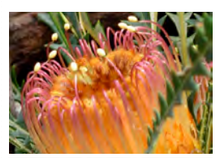




Banksia nivea
Honeypot dryandra

Anigozanthos manglesii
Red & Green Kangaroo Paw

Dampiera linearis
Common Dampiera







GROUND COVERS

Hypocalymma robustum
Swan River Myrtle

Myoporum parvifolium
Creeping boobialla

Melaleuca huegelii
Chenille Honey-Myrtle







BIOFILTERS / DRAINAGE

TREES

Eucalyptus gomphocephala
Tuart

Agonis flexuosa
WA Peppermint

Eucalyptus rudis
Flooded Gum







Melaleuca lanceolata
Rottnest Tea Tree

Melaleuca preissiana
Moonah

Melaleuca rhaphiophylla
Freshwater paperbark







SEDGES

Ficinia nodosa
Knotted Club Rush

Juncus pallidus
Pale Rush

Lepidosperma gladiatum
Coastal Sword Sedge

Patersonia occidentalis
Purple Flag









WATER TOLERANT SHRUBS

Eremophila glabra
Tar Bush

Hakea prostrata
Harsh Hakea



Hypocalymma angustifolium
White Myrtle

Kunzea micrantha
Kunzea

LD TOTAL

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STREET TREE MASTER PLAN

Embark
Busselton

TREE SELECTION

Street trees have been selected for their form, height and relationship to existing trees focusing on WA native species and deciduous trees away from waterbodies.

Tree spacing relates to the scale and use of the street and the desire to create a shaded micro-climate that encourages walking and reduces heat island effects. Generally, wider road reserves are planted with larger tree species. The design of the streetscapes has been primarily driven by the proposed boulevard 'green' spine of Embark with median swale, Western Ringtail Possum habitat and wildlife linkage, and public open space relationships.

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.



Agonis flexuosa
WA Peppermint



Corymbia calophyla
Marri



Eucalyptus marginata
Jarrah



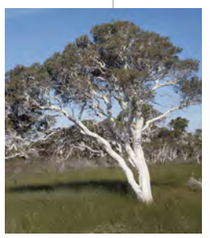
Eucalyptus gomphocephala
Tuart



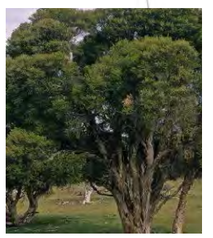
Nuytsia floribunda
WA Christmas Tree



Melaleuca cuticularis
Salt Water Paperbark



Melaleuca preissiana
Stout Paperbark



Eucalyptus rudis
Flooded Gum



Eucalyptus victrix ' Little
Dwarf Ghost Gum



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BORE AND MAINLINE STRATEGY

Embark
Busselton



STRATEGY 5. IRRIGATION STRATEGY

LD TOTAL

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OVERALL IRRIGATION SCHEDULE

Embark
Busselton

EMBARK
IRRIGATION SCHEDULE

1 October 2024

Water Licenses
GWL160990 Leederville bore (34,300 kL)
GWL157168 Yarragadee bore (168,300kL)

PUBLIC OPEN SPACE	Total area m2	POS Type	Irrigation rate (kL/ha/yr)	Irrigated Area (m²)	% Irrigated Long-term	Turf m2	Long-term (Turf) volume (kL/yr)	% Irrigated (Planting) Establishment	Planting m2	Establishment (Planting) volume (kL/yr)	Responsibility
POS 1 (only verges are irrigated)	58,129	Conservation Park		2,093	0.60%	349	235	3%	1,744	1,177	Developer
POS 2 (only verges are irrigated)	22,930	Conservation Park		4,815	15%	3,440	2,322	6%	1,376	929	Developer
POS 3	43,352	Conservation Park		15,173	5%	2,168	1,463	30%	13,006	8,779	Developer
Townsquare (Open Space 4)	2,500	Townsquare		2,625	40%	1,000	675	65%	1,625	1,097	Developer
POS 5	23,568	District POS		17,676	50%	11,784	7,954	25%	5,892	3,977	Developer
POS 6	40,589	Conservation Park		20,295	20%	8,118	5,480	30%	12,177	8,219	Developer
POS 6 PAW North	1,326	Local Park		1,193	10%	133	90	80%	1,061	716	Developer
POS 7	50,083	Neighbourhood Park		27,546	30%	15,025	10,142	25%	12,521	8,452	Developer
POS 8	18,352	Neighbourhood Park		11,011	30%	5,506	3,716	30%	5,506	3,716	Developer
POS 9	13,563	Neighbourhood Park		8,138	30%	4,069	2,747	30%	4,069	2,747	Developer
POS 9 South	2,462	Local Park	6,750.0	1,354	10%	246	166	45%	1,108	748	Developer
POS 10	19,527	Neighbourhood Park		9,764	20%	3,905	2,636	30%	5,858	3,954	Developer
POS 11	31,819	Neighbourhood Park		15,910	20%	6,364	4,296	30%	9,546	6,443	Developer
POS 12	6,256	Local Park		3,754	20%	1,251	845	40%	2,502	1,689	Developer
POS 13	8,560	Local Park		5,136	20%	1,712	1,156	40%	3,424	2,311	Developer
POS 14 West	7,176	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 14 Central	30,365	Landscape Buffer		0	0%	0	0	0%		0	Developer
POS 14 East	26,351	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 15 East	25,177	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 15 West	29,457	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 16	65,181	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 17 (only verges are irrigated)	74,454	Conservation Park		745	0%	0	0	1%	745	503	Developer
TOTAL POS m2	601,177			147,225.93			43,921.08			55,456.42	

MAIN DISTRUBTORS / COLLECTORS	Total length (linear meter)	Street Type (refer LSP)	Irrigated area (m²)		% Irrigated (Planting) Establishment		Establishment (Planting) volume (kL/yr)	Responsibility
Streetscapes - Main Boulevard (median / roundabouts)	2,700	District Distributor B	13,500		100%		9,113	Developer
TOTAL	2,700.00		13,500.00				9,112.50	

TOTAL POS + Streetscapes Irrigation for turf and planting establishment **108,490** (kL/Yr)

© LD TOTAL 2022

LD TOTAL

Head Office Perth

172 Burswood Road, Burswood, WA 6100
(08) 6436 1111

Bunbury

7 Mason Street, Bunbury, WA 6230
(08) 9725 6555

Melbourne

10 Thomas Street, Yarraville, VIC 3013
(03) 9548 3283

Gold Coast

Unit 1/5 Traders Way, Currumbin, QLD 4551
(07) 5607 0508

Sunshine Coast

Unit 1/159 Mark Road, Caloundra West, QLD 4551
(07) 5325 1508

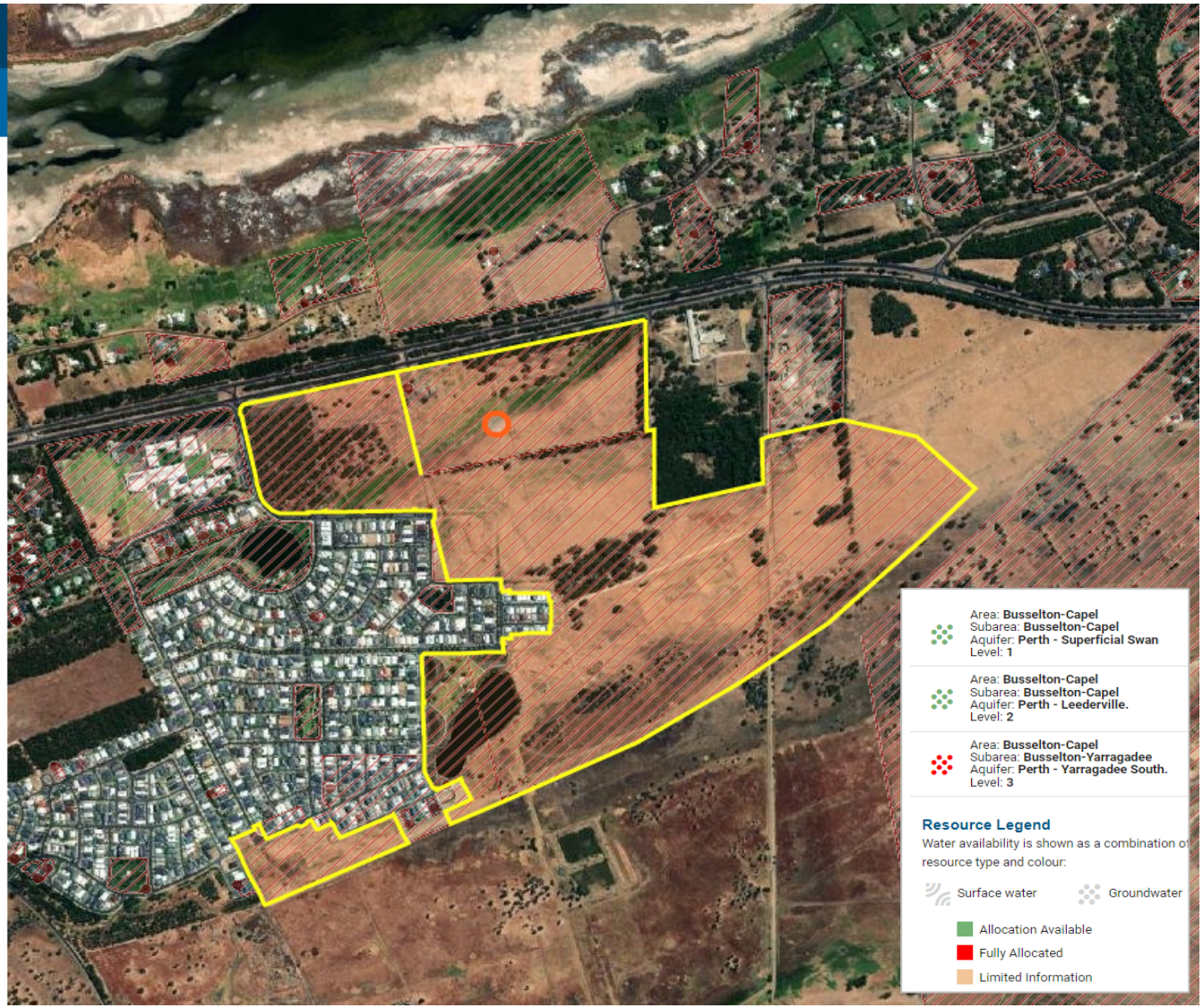
APPENDIX M
Irrigation Licencing

Date : 23/3/2023 Job No: H22018

← Licence details

Selected 1 of 1

Licence Number:	160990
Licence Type:	Groundwater Licence
Issue Date:	29/11/2022
Expiry Date:	7/8/2032
Licence Allocation:	34300 KL
Parties:	Almond Lake Pty Ltd
Postal Address:	Level 21, 90 Collins Street Melbourne VIC 3000 Australia
Groundwater Area:	Busselton-Capel
Groundwater Subarea:	Busselton-Capel
Aquifer:	Perth - Leederville.
Surface Water Area:	
Surface Water Subarea:	
Surface Water Resource:	
Licence Address:	LOT 9034 ON PLAN 416577 Volume/Folio 2969/911 Lot 9034 ; LOT 9032 ON PLAN 406716; LOT 9034 ON PLAN 416577; LOT 9033 ON PLAN 409180 Volume/Folio 2908/309 Lot 9033 ; Lot 2 on Diagram 28764 Certificate of Title Volume/Folio 1791/729
Security Interests:	No
Convictions:	No
Agreements:	No
Notations:	No
Directions:	No



hyd2o

Lot 2,30342 & 9034 Bussell Hwy Busselton LWMS

DWER Water Register Extracts

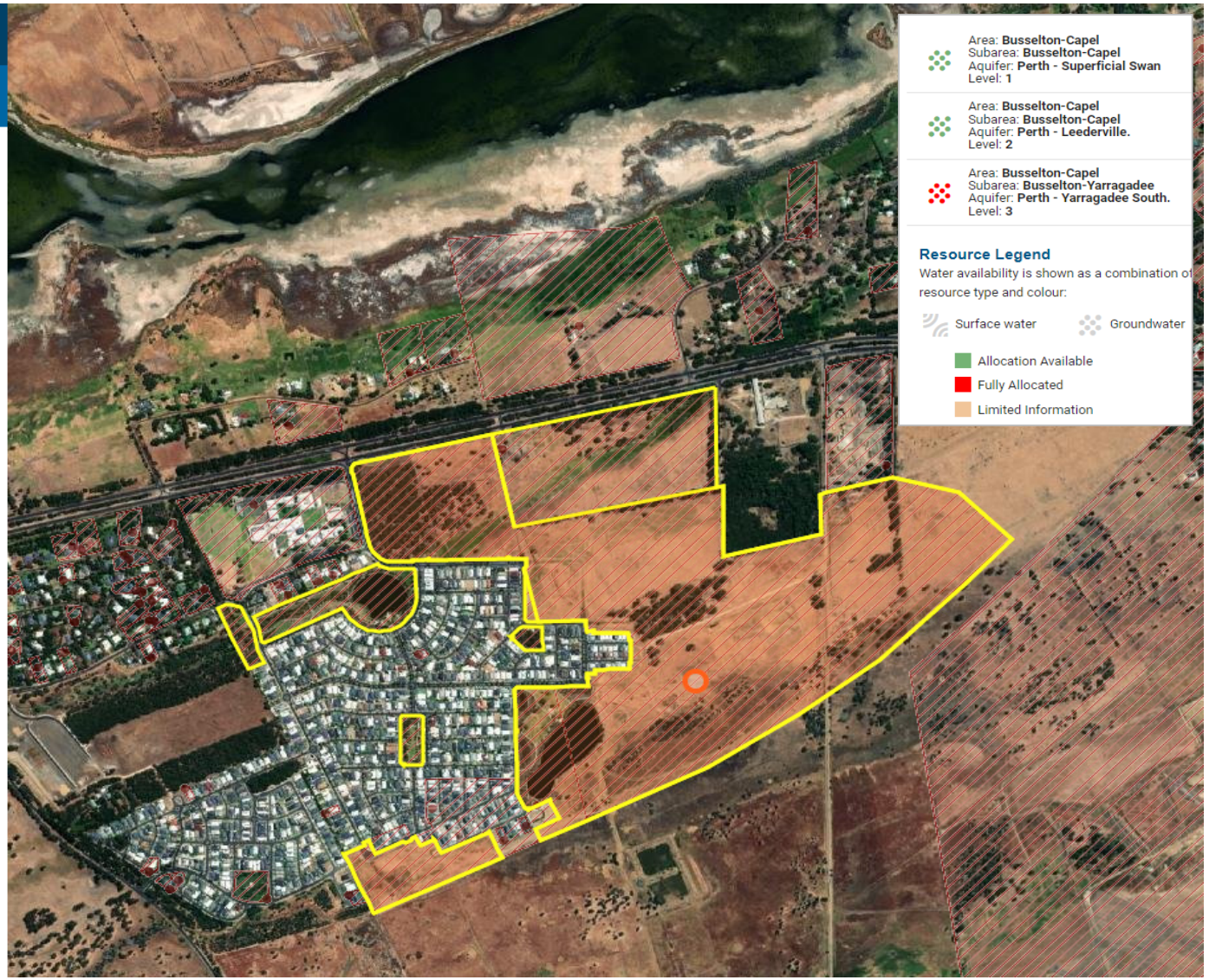
Figure L1

Date : 23/03/2023 Job No: H22018

← Licence details

Selected 1 of 2 >

Licence Number:	157168
Licence Type:	Groundwater Licence
Issue Date:	10/1/2023
Expiry Date:	7/8/2032
Licence Allocation:	168300 KL
Parties:	Almond Lake Pty Ltd
Postal Address:	Level 21, 90 Collins Street Melbourne VIC 3000 Australia
Groundwater Area:	Busselton-Capel
Groundwater Subarea:	Busselton-Yarragadee
Aquifer:	Perth - Yarragadee South.
Surface Water Area:	
Surface Water Subarea:	
Surface Water Resource:	
Licence Address:	LOT 8004 ON PLAN 62834; LOT 9033 ON PLAN 409180 Volume/Folio 2908/309 Lot 9033 ; LOT 8002 ON PLAN 59382; Lot 9032 On Plan 406716 Volume/Folio 2891/698 Lot 9032 Cable Sands Rd Yalyalup; LOT 8001 ON PLAN 59382; LOT 9034 ON PLAN 416577; LOT 9034 ON PLAN 416577 Volume/Folio 2969/911 Lot 9034 ; LOT 9034 ON PLAN 416577; LOT 8003 ON PLAN 62834
Security Interests:	No
Convictions:	No
Agreements:	No
Notations:	No
Directions:	No



hyd2o

Lot 2,30342 & 9034 Bussell Hwy Busselton LWMS

DWER Water Register Extracts

Figure L2

APPENDIX N
Aerator Brochure
and Design Infromation



Water Quality Solutions

AIR-O-LATOR CARNIVAL

AERATING FOUNTAIN KITS

Air-O-Lator's Carnival Aerating Fountain is ideal for those who need aeration and enjoy the aesthetics of a fountain display, e.g. residential feature dams, golf courses, luxury estates.

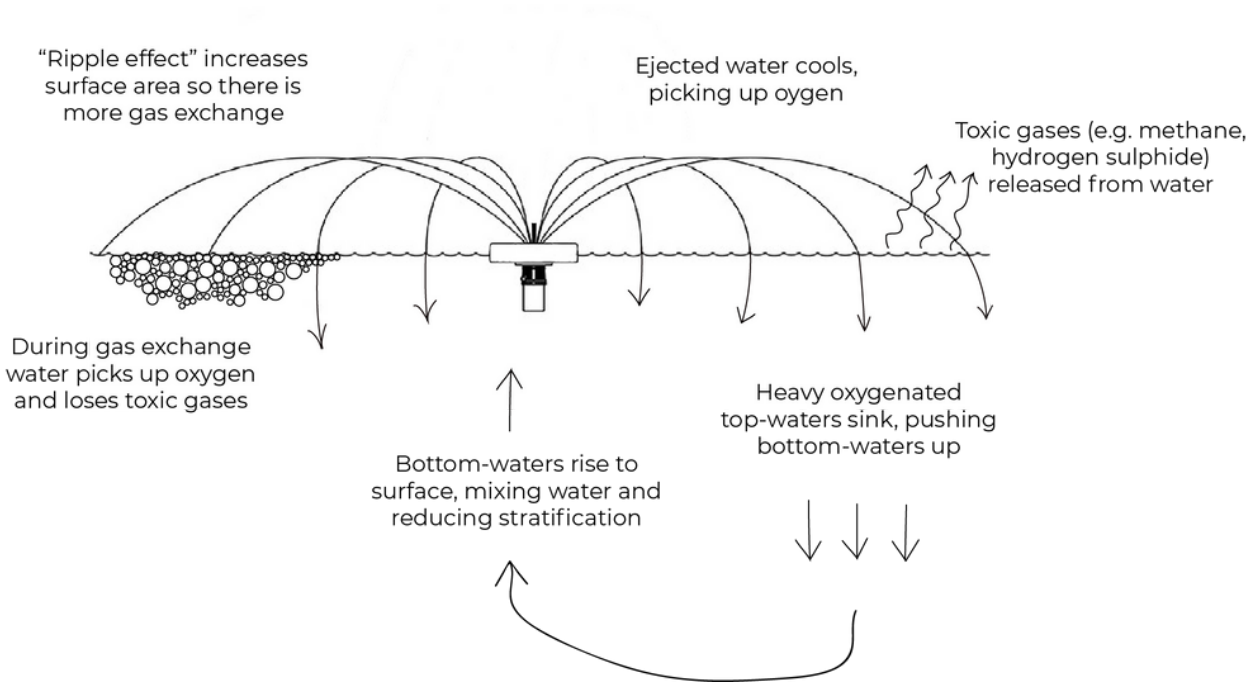
HIGHLIGHTS

- Single unit aerates up to 2.5 surface acres
- Pumps up to 5,000 litres of water per minute
- Sprays up to 2m high and 6m diameter
- Transfers up to 1.6kg O_2 per hour
- Operates up to 5m deep



AESTHETICS MEETS GENUINE AERATION.

While most manufacturers claim their fountains aerate water, very few actually do. Air-O-Lator's Carnival Aerating Fountain is one of the only fountains on the market genuinely engineered to mix and aerate your water—helping to combat algae, sludge, weeds, and dead wildlife.



CUSTOMER STORY:

ERADICATING ALGAE IN 6 WEEKS USING A CARNIVAL FOUNTAIN

Click to watch how one of our dealers used a Carnival Fountain to eradicate algae from a client's dam in just weeks



SPECS

Air-O-Lator is a USA manufacturer based in Kansas City operating for over 60 years. The company is renowned for its team of engineers who build high-quality aquatic products that are simple to use and easy to maintain.

MAINS POWER

MOTOR	AERATES†	LPM	O_2 KG/HR	VOLTS	HZ	MIN. DEPTH	SPRAY HEIGHT*	SPRAY DIAM.*
¾hp	⅓ acre	1,000	0.7	230	50	0.5M	0.4M	2M
1hp	½ acre	1,250	0.9	230	50	0.5M	0.6M	2.5M
2hp	1 acre	3,220	1.3	230	50	0.9M	1M	3M
3hp	1.5 acres	4,315	1.4	230	50	0.9M	1.6M	4.5M
5hp	2.5 acres	5,040	1.6	230	50	1.5M	1.7M	6M

SOLAR

Dam size in surface acres

MOTOR	AERATES†	LPM‡	O_2 KG/HR‡	MIN. DEPTH	SPRAY HEIGHT*	SPRAY DIAM.*	NO. SOLAR PANELS
1hp	⅓ acre	1,250	0.9	1M	0.4M	2M	2 X 270-300W
1.5hp	½ acre	2,150	1.3	1.5M	0.7M	2M	4 X 270-300W
3hp	1 acre	4,315	1.4	1.5M	1.2M	3M	8 X 270-300W

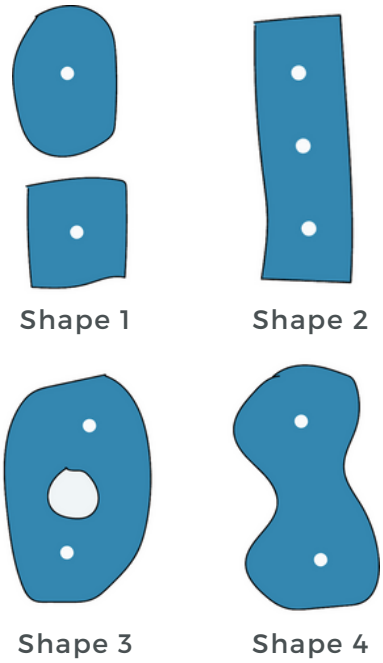
† Based on ideal dam shape and water conditions, results may differ

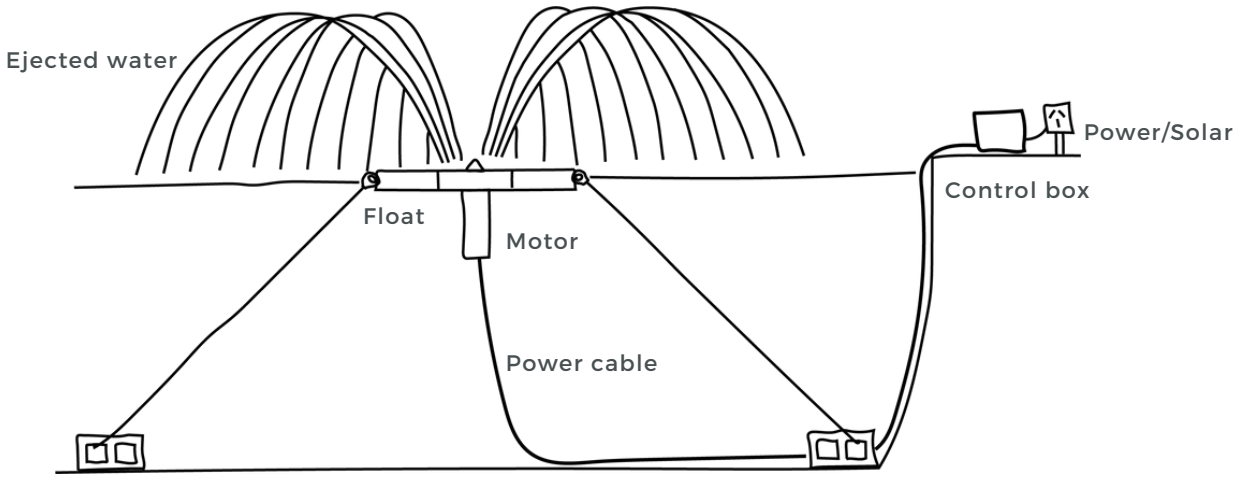
* Approximations based on conversions from US 60Hz equipment

‡ Based on maximum sunlight conditions—blue sky summer day

SIZING A MOTOR

If your dam resembles Shape 1, sizing your motor is easy— typically a 1 hp motor will aerate a ½ surface acre of dam water. If your dam resembles Shape 2, 3 or 4, you'll need to place a fountain/air-station at each of the white dots. This is because of what we call the 'zone of influence' where the circulation of oxygenated water is hindered by banks. If you don't set up enough air-stations, you may find part of your dam improves in health but not all of it.



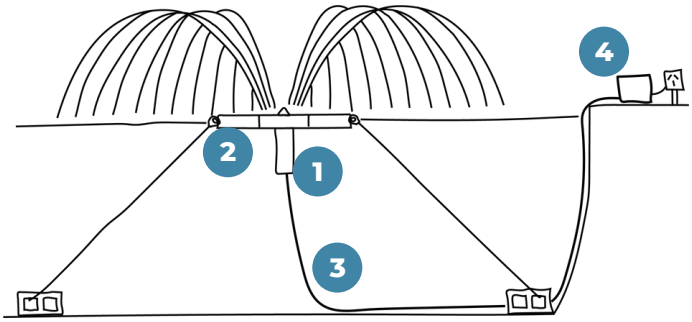


Concrete anchors (not included).
You can also anchor to the shore.

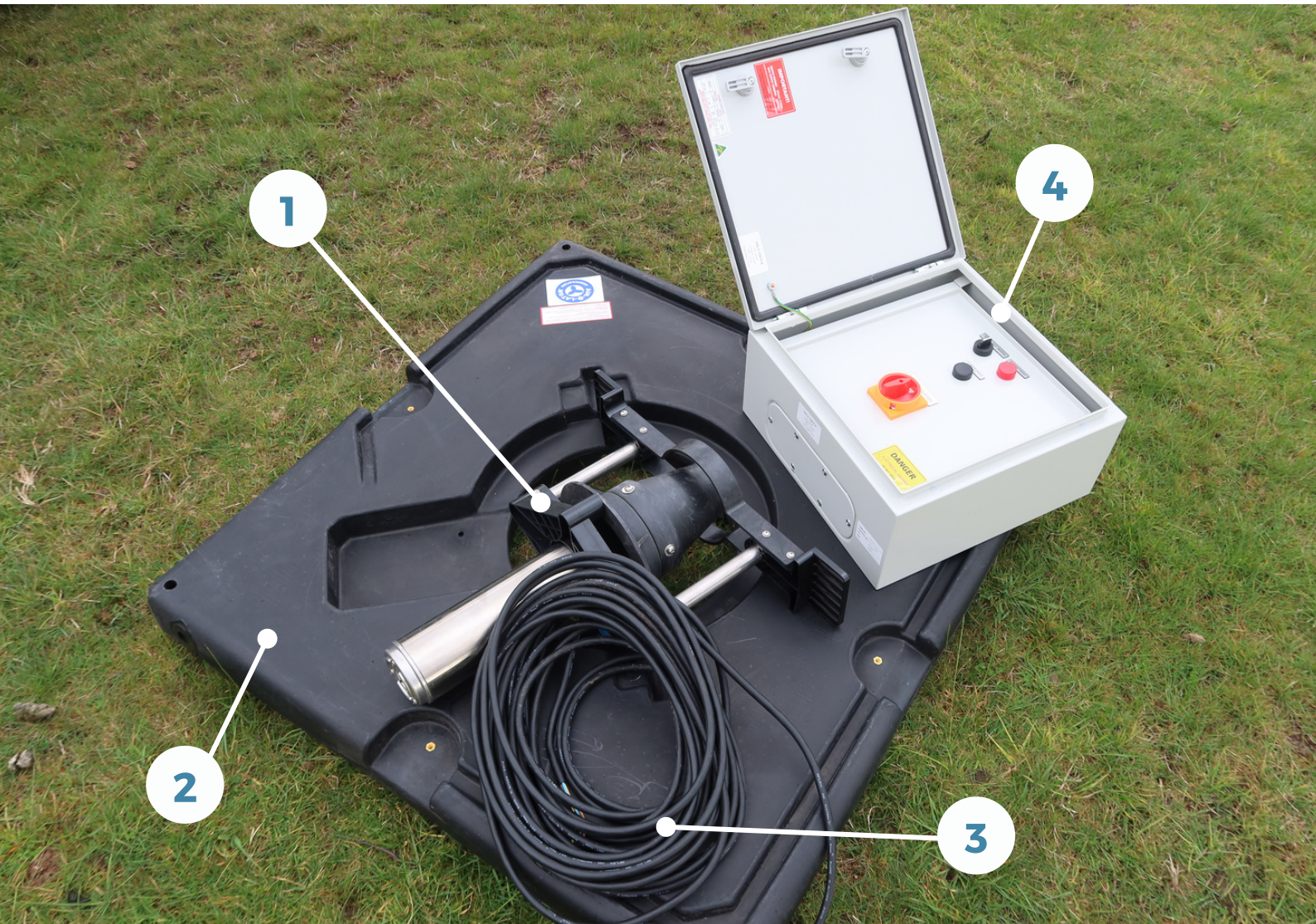
KIT 1

MAINS-POWERED

¾hp / 1hp / 2hp / 3hp / 5hp



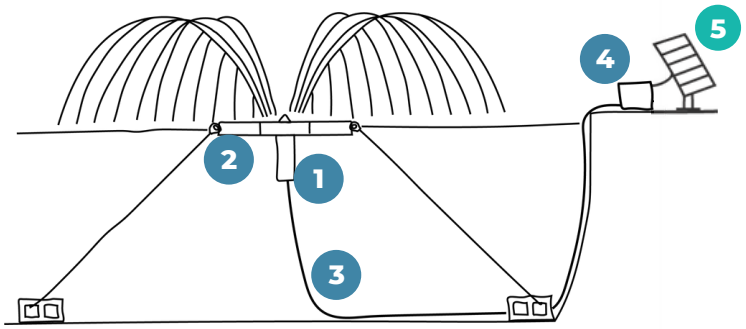
1. 1-phase / 3-phase 316 grade stainless steel motor and fountain nozzle
2. 40 inch square float
3. 40m cable (custom lengths available)
4. Lockable control box with under/over voltage & current protection and surge & overload protection, plus timer and automatic/manual selector switch



KIT 2

SOLAR

1hp / 1.5hp / 3hp



1. 304 grade stainless steel motor (1hp = DC-brushless motor; 1.5hp and 3hp = solar/mains-hybrid motor) and fountain nozzle
2. 36 inch square float
3. 30m cable (custom lengths available)
4. Solar controller complete with MPPT to maximise output in cloudy conditions
5. **OPTIONAL:** Solar panels and mount stands

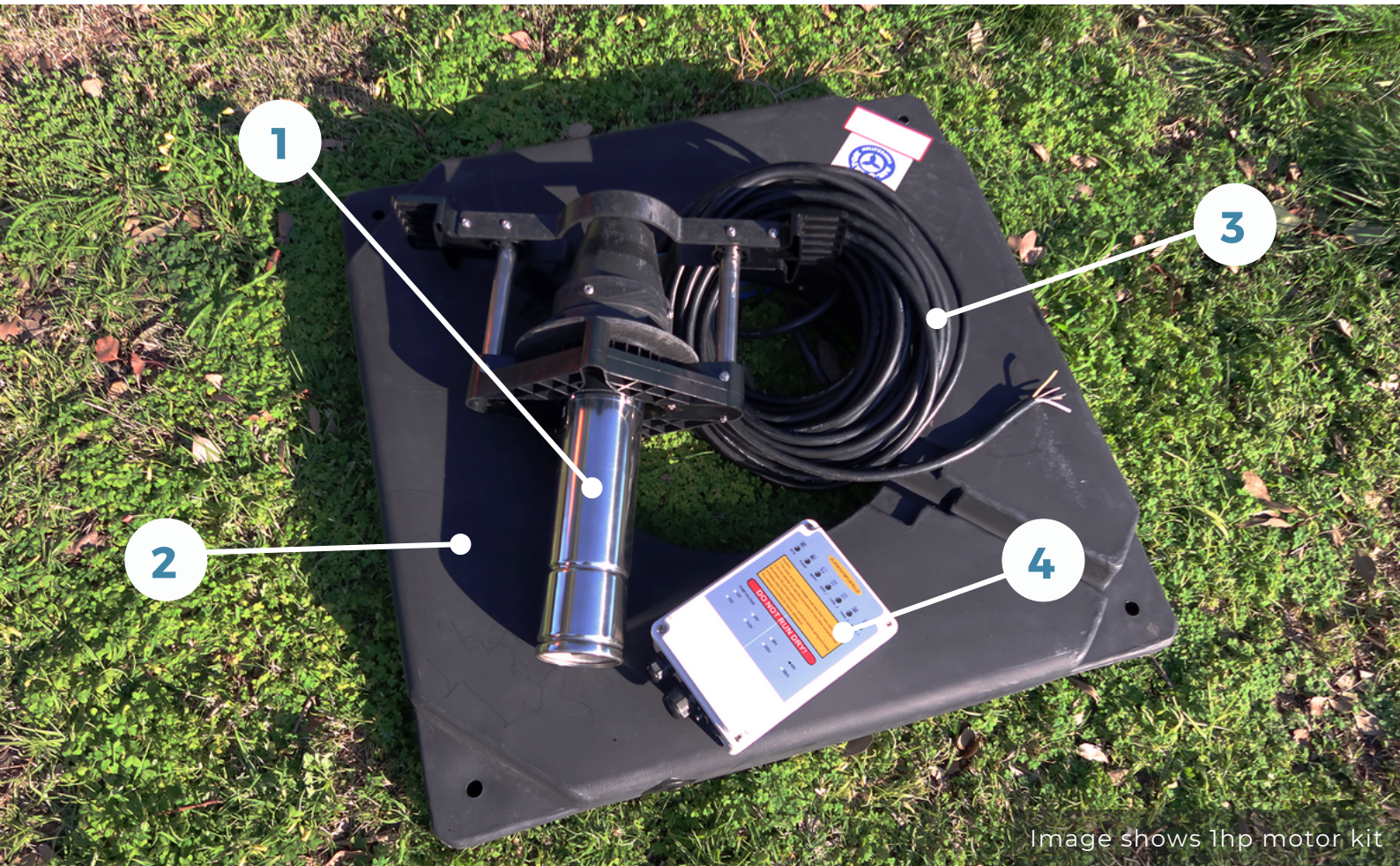


Image shows 1hp motor kit

SEE YOUR FOUNTAIN AT NIGHT, ADD A LIGHT SET.

We offer USA-manufactured light sets that attach onto the Air-O-Lator float. The lights are specifically designed to connect to the Carnival kits and come with clear/white LED bulbs.



- Uses the same power cable as pump motor so there is no additional cable in/near the water
- Available for 1-phase and 3-phase mains-powered motors
- Comes with photocell which turns lights on/off automatically so no timer is needed

Water Quality Solutions

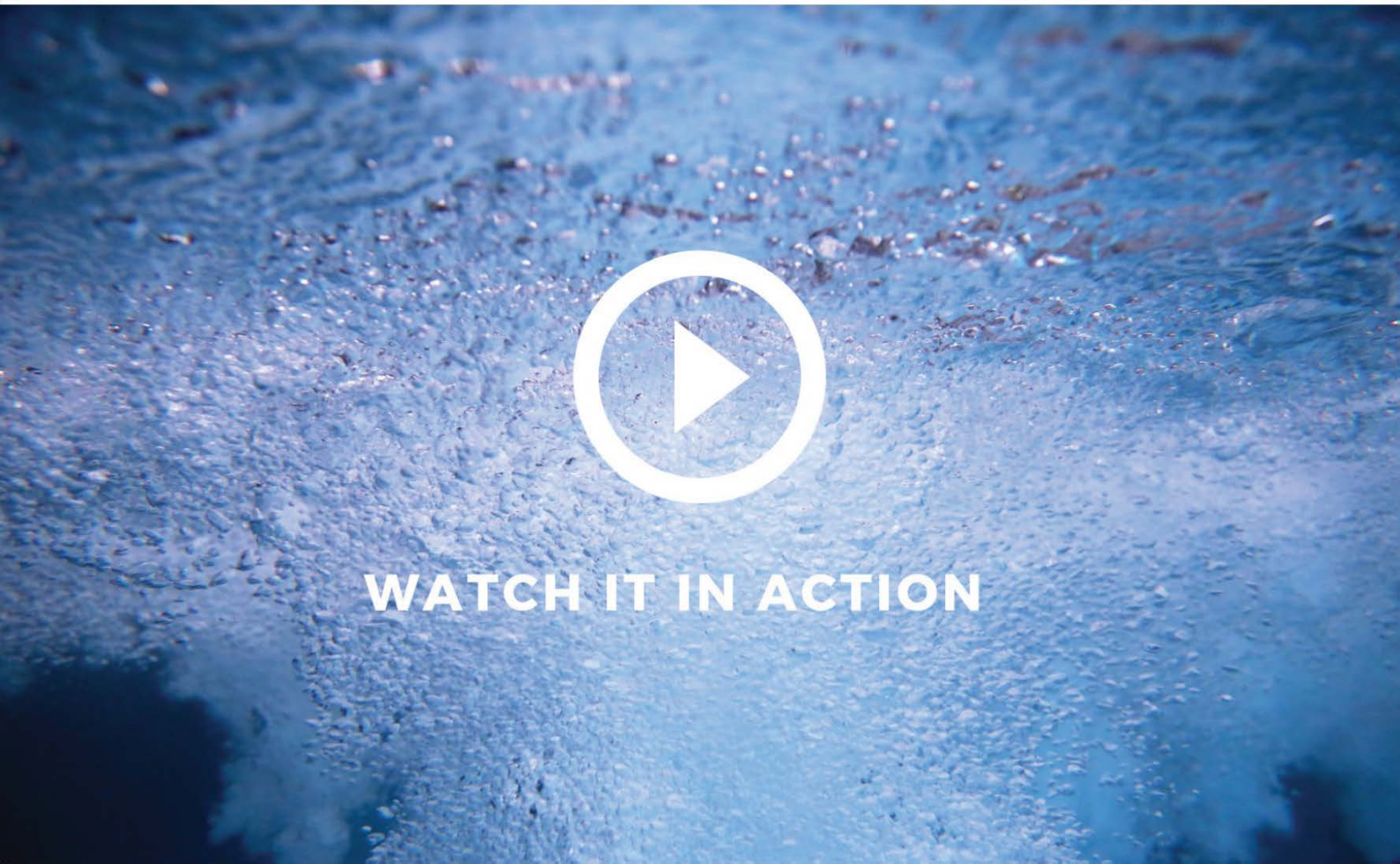
MATALA

AERATION KITS

Matala's Rocking Piston aerator is our most economical option for aerating large, deep dams.

HIGHLIGHTS

- Single compressor aerates up to 4 surface acres
- Operates from 1.5m to 12m deep
- Power up to 4 air-stations
- Ideal for swimming dams—no power in the water
- Low power consuming compared to similar sized surface aerators



CREATE A HEALTHY, "NATURAL" LOOKING DAM

Matala's Rocking Piston Aerators are sub-surface which means you can aerate your dam while maintaining a "natural" looking aesthetic (i.e. no fountain). The compressor sits on the shore and pumps air to stations placed on the floor of your dam. These air-stations release bubbles that rise up, dragging bottom-waters to the surface. Here, gas exchange occurs and oxygen enters the water.



SPECS

Matala is a Taiwanese manufacturer operating for over 20 years. The company is renowned for striking an excellent balance between quality and price.

MOTOR	AERATES*	VOLTS	POWER†	NOISE LEVEL	MIN. DEPTH	MAX. DEPTH
¼hp	¼ to 1 acre	230	200-300W	63dB	1.5m	9m
½hp	¾ to 3 acres	230	300-400W	64dB	1.5m	12m
¾hp	1 to 4 acres	230	520-650W	68dB	1.5m	12m

100% solar available (see page 12)

For a more accurate indication of surface acreage, use the chart below

		Matala Rocking Piston Aerator		
	Motor size	¼hp	½hp	¾hp
Depth	1.5-2.5m	Surface area of dam water*	¼ acre	¾ acre	1 acre
	2.5-3.5m		½ acre	1½ acres	2 acres
	3.5m+		1 acre	3 acres	4 acres

1 acre = 4,047m2

* Based on ideal dam shape and water conditions, actual results may differ

† Power usage will depend on factors influencing operating pressure, such as depth, hose length etc


COMPRESSOR


SINGLE-DISC AIR-STATION

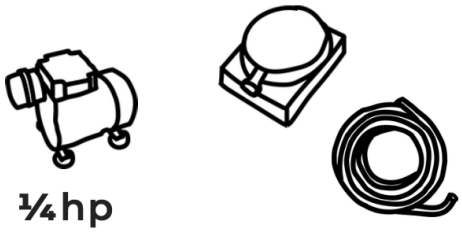

TWIN-DISC AIR-STATION


WEIGHTED HOSE (30M)

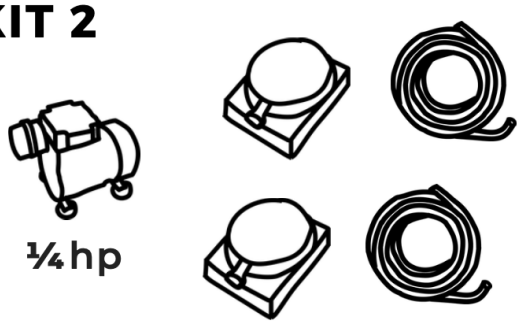
KITS

Below is an overview of our Matala Rocking Piston kits.
See next pages for a detailed list of items in each kit.

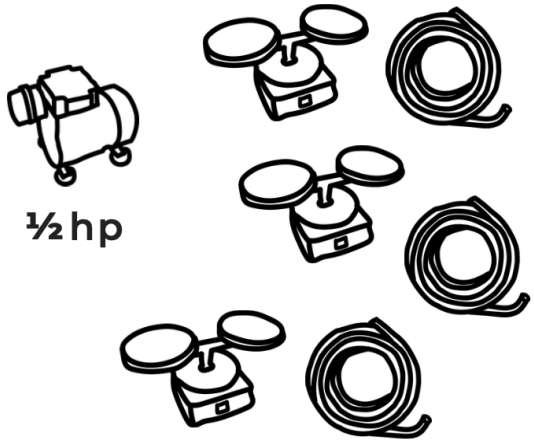
KIT 1



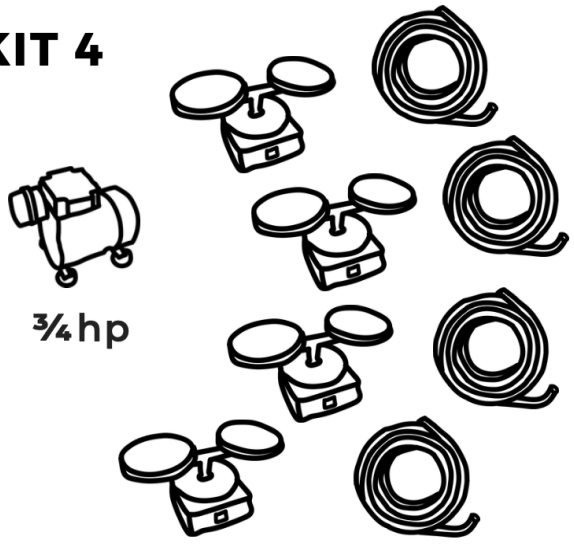
KIT 2



KIT 3

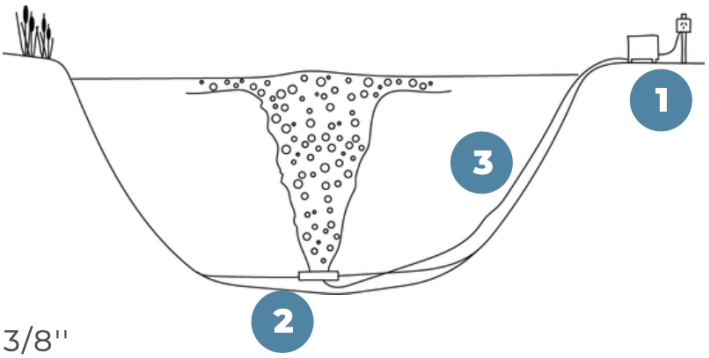


KIT 4



KIT 1

¼hp



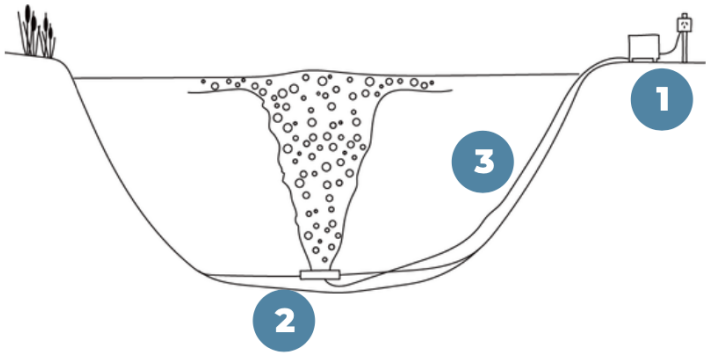
1. ¼hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 1 x single-disc Matala air-station
3. 1 x 30m roll Matala weighted air hose 3/8'' (custom lengths available)

Plus clamps and fittings



KIT 2

¼hp



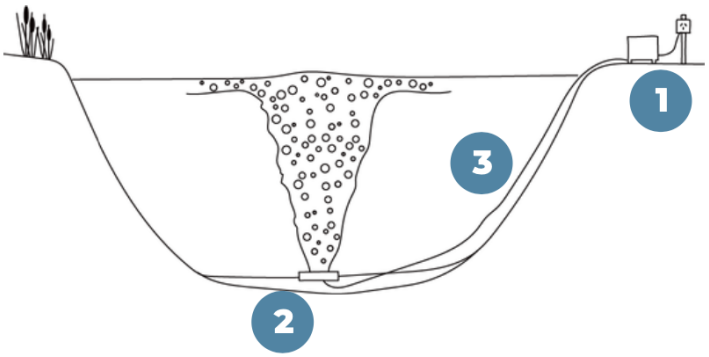
1. ¼hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 2 x single-disc Matala air-stations
3. 2 x 30m rolls Matala weighted air hose 3/8" (custom lengths available)

Plus clamps and fittings



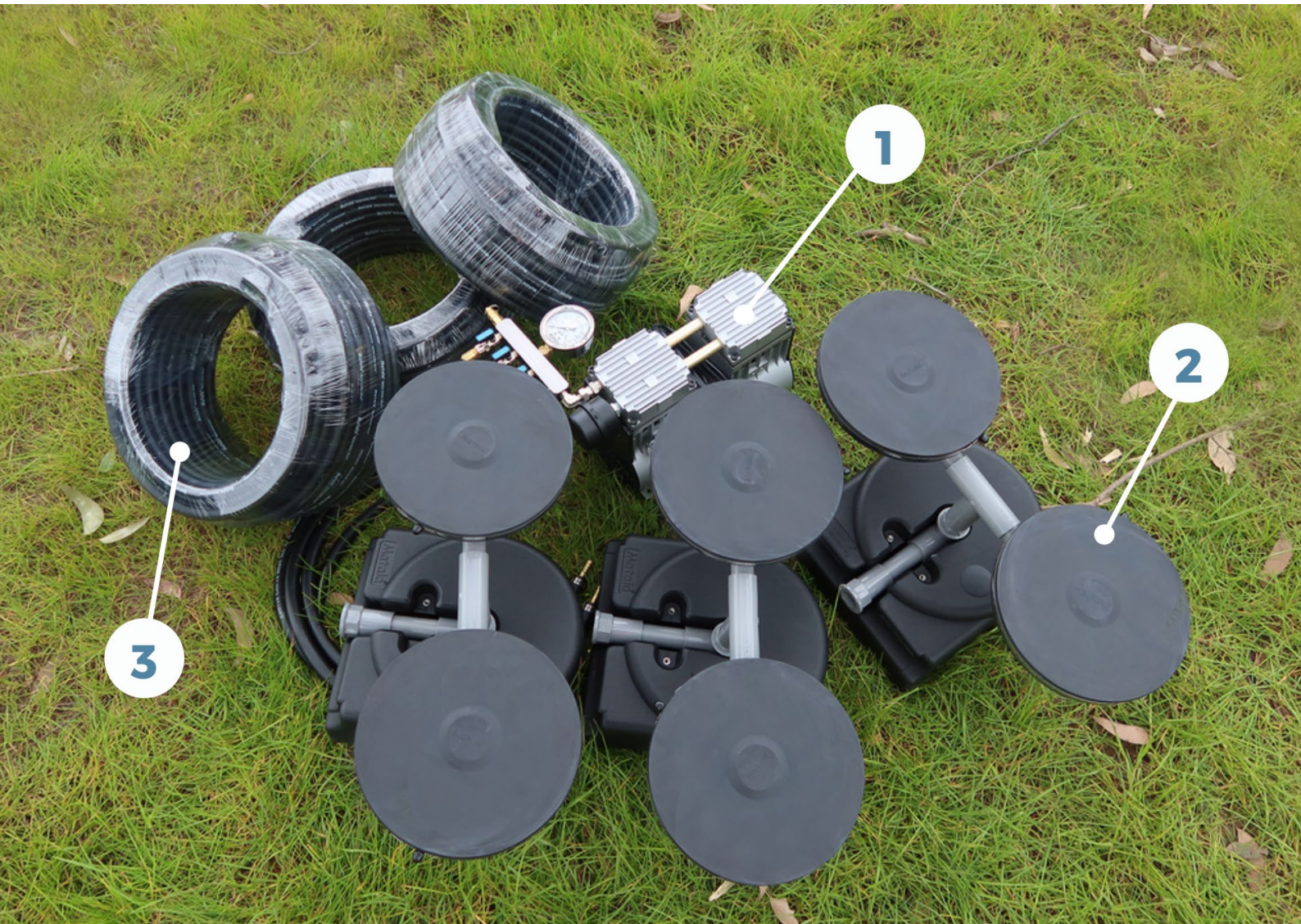
KIT 3

½ hp



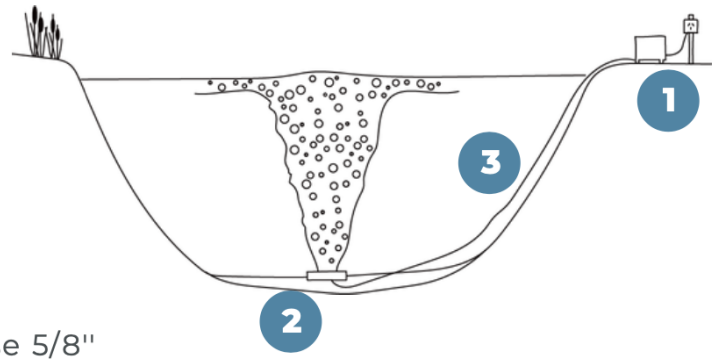
1. ½hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 3 x twin-disc Matala air-stations
3. 3 x 30m rolls Matala weighted air hose 1/2" (custom lengths available)

Plus clamps and fittings



KIT 4

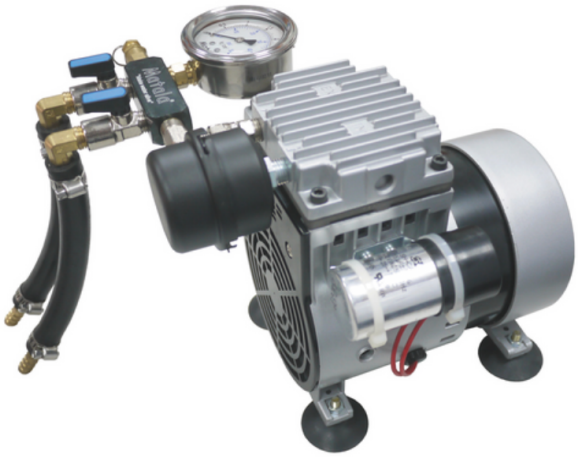
¾hp



1. ¾hp rocking piston compressor, including air filter, pressure gauge & manifold kit
2. 4 x twin-disc Matala air-stations
3. 4 x 30m rolls Matala weighted air hose 5/8" (custom lengths available)

Plus clamps and fittings





SUPERIOR PISTON DESIGN FOR HIGH PERFORMANCE

- Heavy-duty rocking piston motor
- Built from lightweight aluminium
- Oil-free, non-lube piston and cylinder
- Permanently lubricated bearings
- Cylinder hard-coated for wear resistance
- Smooth, low vibration operation

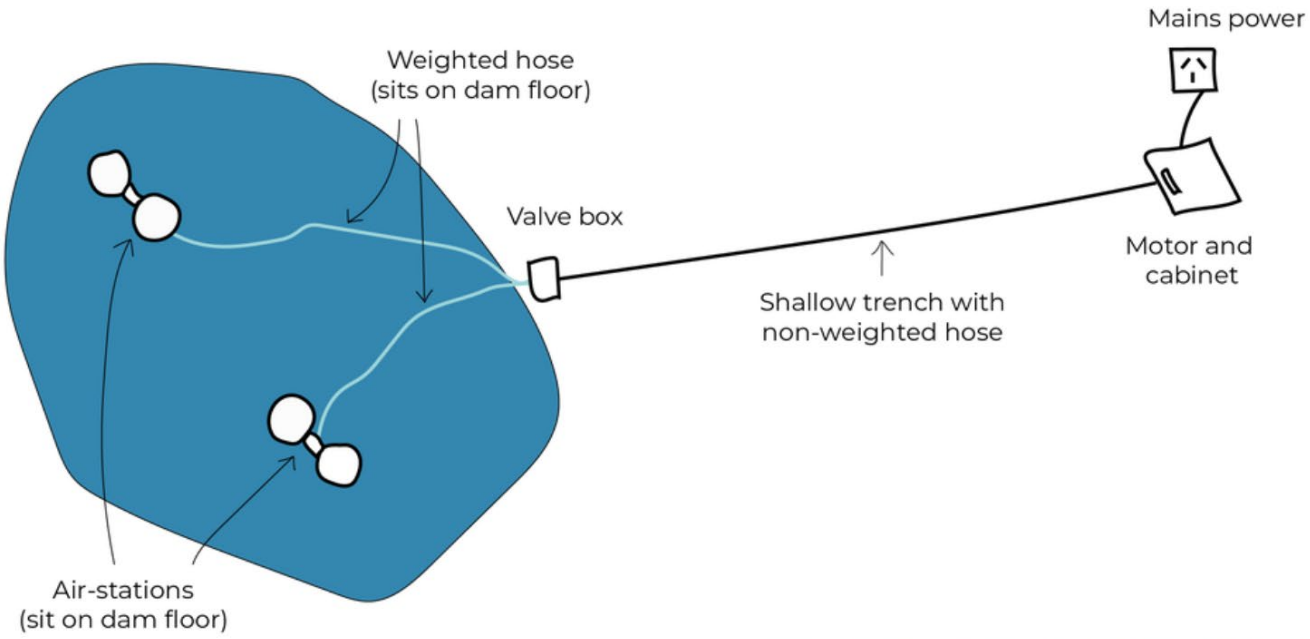
DON'T HAVE A SHED TO PROTECT YOUR GEAR? ADD A CABINET.

We offer weatherproof cabinets purpose-built to protect your compressor from extreme weather and temperatures. Our lockable powdered-coated metal cabinets have a built-in cooling fan and reinforced casing to ensure long-term protection of your gear.

CALL 1300 253 387

REMOTE SETUP (200M) AVAILABLE

Remote setup is available where you can aerate a dam up to 200m from your nearest mains power. You simply place the compressor near your mains power and run a hose through a shallow trench to your dam shore where we have a valve box which disperses the air to the various air-stations. 100% solar options are also available.



See remote setup in action





GO 100% SOLAR

Interested in going 100% solar? We offer SunTech PicoCells—USA-made solar inverters that can be used to power any Matala compressor using solar panels.

The small, multifunctional device incorporates an inverter, VFD, MPPT controller, phase initiator and voltage booster.

Designed for remote off-grid installations, the aluminium chassis is IP65-rated for harsh outdoor environments and can operate in high temperatures, humidity and corrosive environments.



To learn more, check the 'I'm interested in solar power' option when requesting an online quote.

Water Quality Solutions

BIOSTIM

BIOLOGICAL STIMULANT
100% NATURAL

WHAT IS BIOSTIM?

Biostim refers to a "biological stimulant" that comes in pellets, tablets, powder or liquid. You can think of it as a probiotic for the "good" microbes in your dam. Throw a little in each month to feed these microbes and encourage their populations to grow. These "good" guys eat the sludge on the bottom of your dam and consume nutrients like nitrogen and phosphorus. They also outcompete "bad" microbes that cause odour.





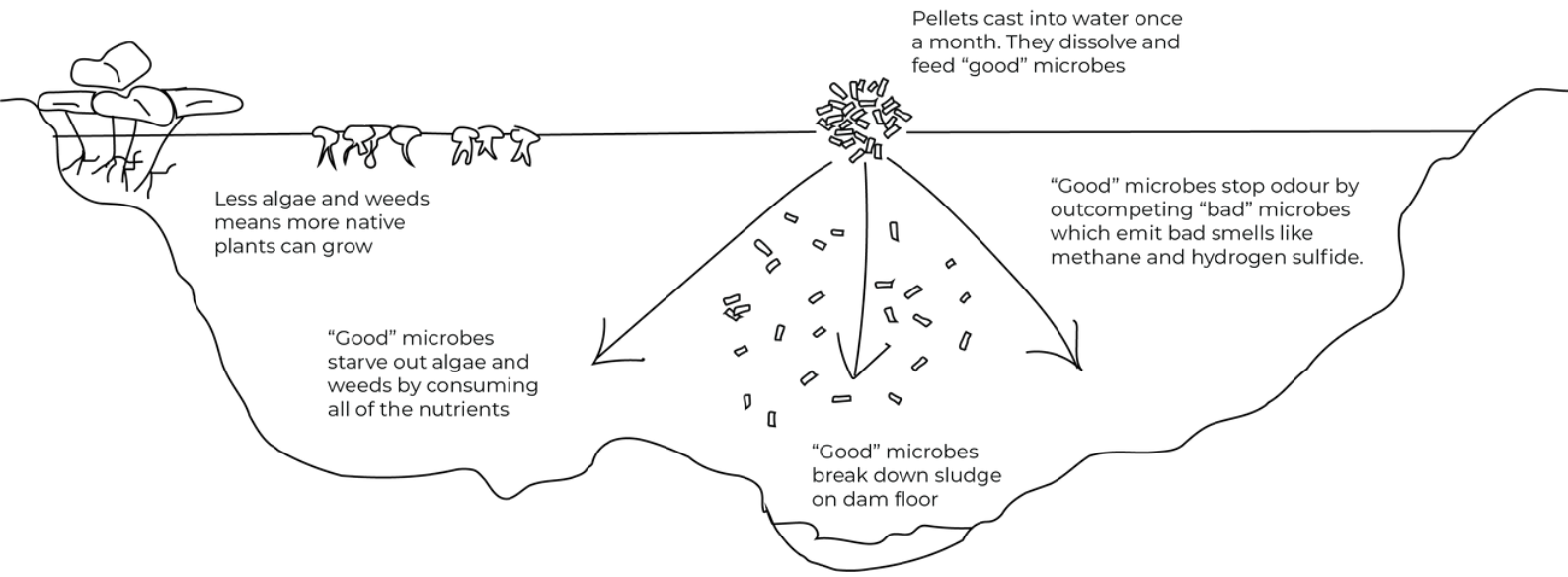


water Wa treats Tr WaterTreats
Scientific solutions for balanced water quality



WATCH: Scotty Tucker explains how Biostim works

HOW BIOSTIM WORKS



CASE STUDY: 3-MONTH RESULTS

Water Quality Solutions ran a 3-month trial with Manningham Council to test how well Biostim would work on its own—without aeration—to improve the water quality in one of their catchments. Water samples were taken in January 2021 and again 3-months later in April 2021. Here are the key results:

- **Nitrogen levels reduced by 4x** (2.6 to 0.57 mg/L)
- **Phosphorus levels reduced by 7x** (0.38 to 0.05 mg/L)
- **Suspended solids reduced by 130x** (1600 to 12 mg/L)

BIOSTIM PRODUCTS



PELLETS (10KGS / 20KGS)

Ideal for dams with a lot of sludge and dams with water moving through them (e.g. irrigation).

Buy 10kgs Buy 20kgs



DREDGING TABLETS (10KGS / 20KGS)

Second-generation pellets, ideal for sludge and moving waterbodies.

Buy 10kgs Buy 20kgs



POWDER (3KGS / 20KGS)

Ideal for water requiring a high amount of treatment (e.g. wastewater) and large waterbodies (>3 acres).

Buy 3kgs Buy 20kgs



LIQUID (5L / 20L)

Ideal for new dams (to spike the water with microbes) and dams with high amounts of suspended debris (i.e. muddy-looking water).

Buy 5L Buy 20L

WHAT CUSTOMERS SAY

"In our ponds that are too small for aerators, we used Biostim pellets on their own and have noticed a huge reduction in algae."

Andy Hart, Horticultural Curator
Department of Environment, Water and Natural Resources, SA

"We had an urgent problem—our old irrigation system had blockages from weeds. Our dam was also riddled with black sludge. Scott recommended both aeration and Biostim and within six weeks the dam became so clear I could see to the bottom of it! I was chuffed we could fix the issue without the use of chemicals."

Michael Grant, Owner
Grant's Citrus Farm, VIC

"We had a nutrient-rich stormwater lake having continuous problems with algae. We were previously treating the nutrients with a liquid solution that would just end up getting flushed away with the outgoing water. Scott recommended we switch to Biostim pellets which was exactly what we needed."

Giles Pickard, Environment Project Officer
City of Subiaco, WA



APPENDIX O

Hyd2o Irrigation Lakes Monitoring

Sasha Martens

From: Sasha Martens
Sent: Monday, 6 May 2024 10:20 PM
To: Rochelle Fredericks
Cc: Tao Bourton
Subject: Footprint Lake Water Quality Testing : March 2024
Attachments: B1490377-R00.pdf; DE03039.R0 - HYD20 - Provence.pdf; Summary Embark East Busselton Algae Analysis.pdf; Figure 1 Lake Monitoring.pdf; Northern End.jpg; Southern End.jpg

Hi Rochelle,

We have finally received all the results from laboratory testing. Apologies for the delay but the results from Queensland took a while to be received despite our continued following up.

Please find attached the laboratory reports for algae testing and a summary of the results in comparison to previous testing using the same assessment system as previous reporting. A site location map is also included for reference purposes. In summary :

a) Visually observations showed the algae in the lake was quite limited (northern area) and less prevalent than we have previously encountered in previous years sampling at this time of year. (Note the lake has regularly experienced blooms in the late summer/early autumn period irrespective of and prior to development).
b) The overall the water quality lab results at all locations supported these observations with the lake water quality considerably better than at the equivalent time last year.
c) Only at one site (northern lake site S3) was the population of Cyanobacteria including Microsystis Aeuginosa classified at an Amber alert level – all other sites reported a Green (low) level of alert.
d) Toxicity tests for all sites were also reported at the green (low) level of alert for Total Micosystins.
e) With the exception of Saxitoxin, all other biotoxins tested were below detectable limits. With respect to Saxitoxin levels note these are well below the WHO recreational water level guideline values of 30 ug/L and also below the drinking water guideline of 3 ug/L.

Note on the weekend I was passing through Busselton and called in for a visual inspection of the lake to add to this review. There was no algae visible within the lake or on its banks (both northern and southern areas). Attached are a couple of photo's taken Saturday.

Happy to respond to any queries if needed.

Regards,
Sasha

Sasha Martens
Principal Engineering Hydrologist

hyd2o hydrology

Suite 1, 387 Hay St Subiaco WA 6008
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Footprint (Iluka) Lake Monitoring
Surface Water Quality Summary

	Pop. of Cyanobacteria (Cells/mL)	Biovolume of Cyanobacteria (mm3/L)	Total Microcystins (µg/L)
Green	≥500 to <5,000	>0.04 to <0.4 mm3/L	<10 µg/L
Amber	≥5,000 to <50,000	≥0.4 to <4 mm3/L	
Red	≥50,000	≥4 mm3/L	≥10 µg/L

S1	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Cyanobacteria Microcystis Aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
01-11-21	37700	1.2633	0.6	N.D
30-11-21	8600	0.6702	<0.6	N.D
10-01-22	11040	1.9827	1	N.D
22-02-22	3010	0.5406	<0.6	N.D
04-04-22	2890	0.5190	1.8	N.D
02-05-22	137000	24.6044	<0.6	N.D
07-06-22	76000	13.6492	110	N.D
19-07-22	219000	39.3312	48	N.D
31-08-22	3110	0.3517	0.8	N.D
28-09-22	290	0.0521	2.4	N.D
17-01-23	360	0.0407	3.9	N.D
12-03-24	1230	0.2209	<0.6	*Saxitoxin (2.1 µg/L)
05-11-25	**0**	**0.0000**	<0.6	N.D
12-12-25	**0**	**0.0000**	<0.6	N.D

S2	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Cyanobacteria Microcystis Aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
01-11-21	71000	2.3792	<0.6	N.D
30-11-21	16000	1.0296	<0.6	N.D
10-01-22	5180	0.9303	1.0	N.D
22-02-22	7680	1.3793	<0.6	N.D
04-04-22	2740	0.4921	<0.6	N.D
02-05-22	26600	4.7772	<0.6	N.D
07-06-22	50200000	9010.5600	5000	N.D
19-07-22	36000	6.4654	7.8	N.D
31-08-22	7490	0.8471	1.2	N.D
28-09-22	2180	0.3915	<0.6	N.D
17-01-23	80	0.0091	2.9	N.D
12-03-24	2640	0.4741	<0.6	*Saxitoxin (1.8 µg/L)
05-11-25	**0**	**0.0000**	<0.6	ND
12-12-25	**0**	**0.0000**	<0.6	N.D

S2A	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Cyanobacteria Microcystis Aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
01-11-21	52000	1.7425	0.9	N.D
30-11-21	18300	0.9873	<0.6	N.D
10-01-22	N/A	N/A	0.7	N.D
22-02-22	9180	1.6487	<0.6	N.D
04-04-22	14990	2.6921	0.9	N.D
02-05-22	25500	4.5797	<0.6	N.D
07-06-22	240000	43.1027	N/A	N/A
19-07-22	63400	11.3863	10.0	N.D
31-08-22	1030	0.1165	3.0	N.D
28-09-22	2560	0.4598	8.4	N.D
17-01-23	1450	0.1640	2.7	N.D
12-03-24	3650	0.6555	1.1	*Saxitoxin (2.0 µg/L)
05-11-25	**0**	**0.0000**	<0.6	ND
12-12-25	**0**	**0.0000**	<0.6	N.D

S3	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Cyanobacteria Microcystis Aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
01-11-21	136230	4.6480	1.0	N.D
30-11-21	11890	0.7271	<0.6	N.D
10-01-22	7040	1.2643	0.6	N.D
22-02-22	126000	22.6289	<0.6	N.D
04-04-22	7600	1.3649	1.1	N.D
02-05-22	264000	47.4129	<0.6	N.D
07-06-22	104100	18.6778	29.0	N.D
19-07-22	38400	6.8964	4.3	N.D
31-08-22	187500	21.2058	420.0	N.D
28-09-22	1070	0.1922	3.2	N.D
17-01-23	730	0.0826	8.3	N.D
12-03-24	18890	3.3925	1.1	*Saxitoxin (2.2 µg/L)
05-11-25	**0**	**0.0000**	<0.6	ND
12-12-25	**0**	**0.0000**	<0.6	N.D

*no established guideline value for recreational water

H22018
Footprint (Iluka) Lake Monitoring
Surface Water Quality Summary

	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Microcystis aeruginosa (mm3/L)	Total Microcystins (µg/L)
Green	≥500 to <5,000	>0.04 to <0.4 mm3/L	<10 µg/L
Amber	≥5,000 to <50,000	≥0.4 to <4 mm3/L	
Red	≥50,000	≥4 mm3/L	≥10 µg/L

Almond Parkway Lake (APL)	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Microcystis aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
19/07/2022	6750	1.2123	8.4	N.D
31/08/2022	460	0.0520	0.6	N.D
28/09/2022	260	0.0467	1.3	N.D
17/01/2023	470	0.0532	<0.6	N.D
12/03/2024	110	0.0198	<0.6	*Saxitoxin (0.9 µg/L)
*no established guideline value for recreational water				

Northern Swale (NS)	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Microcystis aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
19/07/2022	130	0.0234	<0.6	N.D
31/08/2022	160	0.0181	0.5	N.D
28/09/2022	206800	37.1400	<0.6	N.D
17/01/2023	Dry			
12/03/2024	Dry			

12/03/2024	1230	0.2209		
Southern Swale (SS)	Pop. of Cyanobacteria Microcystis Aeruginosa (Cells/mL)	Biovolume of Microcystis aeruginosa (mm3/L)	Total Microcystins (µg/L)	Other biotoxins
19/07/2022	30	0.0054	<0.6	N.D
31/08/2022	0	0.0000	<0.6	N.D
28/09/2022	0	0.0000	<0.6	N.D
17/01/2023	Dry			
12/03/2024	Dry			

Date: 31/04/2024 Job No. H24013



Monitoring Location & Status

- Green Level
- Amber Level
- Red Level

0 20 40 60 80 Meters

hyd2o

Footprint (Iluka) Lake Hydrological Monitoring

March Monitoring Results 2024

Figure 1





Symbio LABORATORIES

CERTIFICATE OF ANALYSIS

Certificate Number	B1490377 [R00]	**Page**	1/2
Client	hyd2o Hydrology	**Registering Laboratory**	Brisbane
Contact	Andre Righetti	**Contact**	Customer Service Team
Address	Suite 1, 387 Hay Street Subiaco WA 6008	**Address**	52 Brandl Street, Eight Mile Plains, QLD 4113
		Email	admin@symbiolabs.com.au
Telephone	---	**Telephone**	1300 703 166
Order Number	---	**Date Samples Received**	14/03/2024 11:02
Project ID	Water H22018	**Date Analysis Commenced**	14/03/2024 11:02
Sampler	Customer	**Issue Date**	19/03/2024
Client Job Reference	---	**Receipt Temperature (°C)**	10
No. of Samples Registered	5 | Sampler: Customer	**Storage Temperature (°C)**	4
Priority	Normal	**Quote Number**	---

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ABN: 82 079 645 015

NATA

Accreditation No: 2455
Accredited for compliance with ISO/IEC 17025 - Testing

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Definitions

| <: Less Than | >: Greater Than | RP: Result Pending | MPN: Most Probable Number | CFU: Colony Forming Units | ---: Not Received/Not Requested | NA: Not Applicable | ND: Not Detected | LOR: Limit of Reporting | [NT]: Not Tested |

| ~: Estimated | ^ Subcontracted Analysis | TBA: To Be Advised | + Client Specified Limit | ** Potential Holding Time Concern | * Test not covered by NATA scope of accreditation | # Result derived from a calculation and includes results equal to or greater than the LOR |

Authorised By

Name	Position	Accreditation Category
Glen Rangott	Environmental Laboratory Manager, Brisbane	Environmental Chemistry

Sample Information - *Client/Sampler Supplied*

Sample ID	B1490377/1	B1490377/2	B1490377/3	B1490377/4	B1490377/5
Sample Description	S1	S2	S2A	S3	APL
Sample Date/Time	2024-03-12 11:29	2024-03-12 11:41	2024-03-12 11:35	2024-03-12 12:37	2024-03-12 02:47

Client	hyd2o Hydrology	**Project ID**	Water H22018
Certificate Number	B1490377 [R00]	**Sampler**	Customer
Page	2/2	**Order Number**	---

Analytical Results

Compound/Analyte	LOR	Limit Range+	Units	S1	S2	S2A	S3	APL
Client Sample Description				S1	S2	S2A	S3	APL
Client Sampling date/time				12/03/2024 11:29	12/03/2024 11:41	12/03/2024 11:35	12/03/2024 12:37	12/03/2024 02:47
				B1490377/1	B1490377/2	B1490377/3	B1490377/4	B1490377/5
				Results	Results	Results	Results	Results
Biotoxins in Water by LC/MS								
ENV139 Biotoxins in Water by LC/MS								
Anatoxin-a	0.1	---	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Cylindrospermopsin	0.1	---	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1
Deoxycylindrospemopsin	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Microcystin-LR	0.2	---	µg/L	<0.2	<0.2	1.1	1.1	<0.2
Microcystin-RR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Microcystin-YR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Neosaxitoxin	1	---	µg/L	<1.0	<1.0	<1.0	<1.0	<1.0
Nodularin	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2	<0.2
Saxitoxin	0.5	---	µg/L	2.1	1.8	2.0	2.2	0.9
Microcystin-Total	0.6	---	µg/L	<0.6	<0.6	1.1	1.1	<0.6

Analysis Location

All in-house analysis was completed by Symbio Laboratories - Brisbane.

Report Comments

Total microcystins expressed as microcystin-LR toxicity equivalents (TE) calculation is based on toxicity equivalency factors (TEFs) proposed by Wolf and Frank (2002).

Symbio LABORATORIES

CERTIFICATE OF ANALYSIS

Certificate Number	B2011938 [R00]	**Page**	1/2
Client	hyd2o Hydrology	**Registering Laboratory**	Brisbane
Contact	Georgia Ross	**Contact**	Customer Service Team
Address	Suite 1, 387 Hay Street Subiaco WA 6008	**Address**	52 Brandl Street, Eight Mile Plains, QLD 4113
		Email	admin@symbiolabs.com.au
Telephone	---	**Telephone**	1300 703 166
Order Number	---	**Date Samples Received**	11/11/2025 14:41
Project ID	Water H25077	**Date Analysis Commenced**	11/11/2025 15:41
Sampler	Customer	**Issue Date**	19/11/2025
Client Job Reference	---	**Receipt Temperature (°C)**	6
No. of Samples Registered	4 | Sampler: Customer	**Storage Temperature (°C)**	4
Priority	Normal	**Quote Number**	---

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ABN: 82 079 645 015

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Accreditation No: 2455
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| ~: Estimated | ^ Subcontracted Analysis | TBA: To Be Advised | + Client Specified Limit | ** Potential Holding Time Concern | * Test not covered by NATA scope of accreditation | # Result derived from a calculation and includes results equal to or greater than the LOR |

Authorised By

Name	Position	Accreditation Category
Yeleen Chui	Residue Laboratory Manager, Brisbane	Environmental and Food Chemistry

Sample Information - *Client/Sampler Supplied*

Sample ID	B2011938/1	B2011938/2	B2011938/3	B2011938/4
Sample Description	S1	S2	S2A	S3
Sample Date/Time	2025-11-05 13:30	2025-11-05 13:55	2025-11-05 13:50	2025-11-05 12:50

Client	hyd2o Hydrology	**Project ID**	Water H25077
Certificate Number	B2011938 [R00]	**Sampler**	Customer
Page	2/2	**Order Number**	---

Analytical Results

Compound/Analyte	LOR	Limit Range+	Units	S1	S2	S2A	S3
Client Sample Description				S1	S2	S2A	S3
Client Sampling date/time				05/11/2025 13:30	05/11/2025 13:55	05/11/2025 13:50	05/11/2025 12:50
				B2011938/1	B2011938/2	B2011938/3	B2011938/4
				Results	Results	Results	Results
ENV139 Biotoxins in Water by LC/MS							
ENV139 Biotoxins in Water by LC/MS							
Anatoxin-a	0.1	---	µg/L	<0.1	<0.1	<0.1	<0.1
Cylindrospermopsin	0.1	---	µg/L	<0.1	<0.1	<0.1	<0.1
Deoxycylindrospemopsin	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Microcystin-LR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Microcystin-RR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Microcystin-YR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Neosaxitoxin	1	---	µg/L	<1.0	<1.0	<1.0	<1.0
Nodularin	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Saxitoxin	0.5	---	µg/L	<0.5	<0.5	<0.5	<0.5
Microcystin-Total	0.6	---	µg/L	<0.6	<0.6	<0.6	<0.6

Analysis Location

All in-house analysis was completed by Symbio Laboratories - Brisbane.

Report Comments

Total microcystins expressed as microcystin-LR toxicity equivalents (TE) calculation is based on toxicity equivalency factors (TEFs) proposed by Wolf and Frank (2002).

Symbio LABORATORIES

CERTIFICATE OF ANALYSIS

Certificate Number	B2038672 [R00]	**Page**	1/2
Client	hyd2o Hydrology	**Registering Laboratory**	Brisbane
Contact	Georgia Ross	**Contact**	Customer Service Team
Address	Suite 1, 387 Hay Street Subiaco WA 6008	**Address**	52 Brandl Street, Eight Mile Plains, QLD 4113
		Email	admin@symbiolabs.com.au
Telephone	---	**Telephone**	1300 703 166
Order Number	---	**Date Samples Received**	05/12/2025 12:01
Project ID	Water H25077 Footprint lake Monitoring	**Date Analysis Commenced**	05/12/2025 13:01
Sampler	Customer	**Issue Date**	10/12/2025
Client Job Reference	---	**Receipt Temperature (°C)**	5
No. of Samples Registered	4 | Sampler: Customer	**Storage Temperature (°C)**	4
Priority	Normal	**Quote Number**	---

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Definitions

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| ~: Estimated | ^ Subcontracted Analysis | TBA: To Be Advised | + Client Specified Limit | ** Potential Holding Time Concern | * Test not covered by NATA scope of accreditation | # Result derived from a calculation and includes results equal to or greater than the LOR |

Authorised By

Name	Position	Accreditation Category
Yeleen Chui	Residue Laboratory Manager, Brisbane	Environmental and Food Chemistry

Sample Information - *Client/Sampler Supplied*

Sample ID	B2038672/1	B2038672/2	B2038672/3	B2038672/4
Sample Description	S1	S2	S2A	S3
Sample Date/Time	2025-12-02 13:40	2025-12-02 14:00	2025-12-02 13:50	2025-12-02 13:15

Client	hyd2o Hydrology	**Project ID**	Water H25077 Footprint lake Monitoring
Certificate Number	B2038672 [R00]	**Sampler**	Customer
Page	2/2	**Order Number**	---

Analytical Results

				S1	S2	S2A	S3
			Client Sample Description				
			Client Sampling date/time	02/12/2025 13:40	02/12/2025 14:00	02/12/2025 13:50	02/12/2025 13:15
Compound/Analyte	**LOR**	**Limit Range+**	**Units**	**B2038672/1**	**B2038672/2**	**B2038672/3**	**B2038672/4**
				Results	**Results**	**Results**	**Results**
ENV139 Biotoxins in Water by LC/MS							
ENV139 Biotoxins in Water by LC/MS							
Anatoxin-a	0.1	---	µg/L	<0.1	<0.1	<0.1	<0.1
Cylindrospermopsin	0.1	---	µg/L	<0.1	<0.1	<0.1	<0.1
Deoxycylindrospemopsin	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Microcystin-LR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Microcystin-RR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Microcystin-YR	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Neosaxitoxin	1	---	µg/L	<1.0	<1.0	<1.0	<1.0
Nodularin	0.2	---	µg/L	<0.2	<0.2	<0.2	<0.2
Saxitoxin	0.5	---	µg/L	<0.5	<0.5	<0.5	<0.5
Microcystin-Total	0.6	---	µg/L	<0.6	<0.6	<0.6	<0.6

Analysis Location

All in-house analysis was completed by Symbio Laboratories - Brisbane.

Report Comments

Total microcystins expressed as microcystin-LR toxicity equivalents (TE) calculation is based on toxicity equivalency factors (TEFs) proposed by Wolf and Frank (2002).

dalcon environmental

NATA WORLD RECOGNISED ACCREDITATION

CLIENT DETAILS

Contact	Andre Ferraz Righetti
Client	Hyd2o
Address	Unit 1, 387 Hay St, Subiaco WA 6008
Telephone	(08) 9382 8683
Facsimile	410383203
Email	andre.righetti@hyd2o.com.au
Project	H22018 Provence
Samples	5
Date Received	13/03/2024

LABORATORY DETAILS

Principal	Stuart Helleren
Laboratory	Dalcon Environmental
Address	C/- Dept. of Primary Industries & Regional Development Building 38, Dalcon Environmental 3 Baron-Hay Ct South Perth WA 6151
Telephone	+61 (0)8 9368 3616
Email	stuart.helleren@dalconenvironmental.com.au
Dalcon Environmental Reference	DE03039
Report Number	DE03039.R0
Date Reported	19/03/2024

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA accredited laboratory 20077.

These results apply only to the sample(s) as received and tested.
This report may only be reproduced in full.

SIGNATORY



Dr Stuart Helleren
Principal/Senior Scientist

Analytical Report
Report DE03039.R0

CLIENT DETAILS

Contact	Andre Ferraz Righetti
Client	Hyd2o
Address	Unit 1, 387 Hay St, Subiaco WA 6008
Telephone	(08) 9382 8683
Facsimile	410383203
Email	andre.righetti@hyd2o.com.au
Project	H22018 Provence
Samples	5
Date Received	13/03/2024

LABORATORY DETAILS

Principal	Stuart Helleren
Laboratory	Dalcon Environmental
Address	C/- Dept. of Primary Industries & Regional Development Building 38, Dalcon Environmental 3 Baron-Hay Ct South Perth WA 6151
Telephone	+61 (0)8 9368 3616
Email	stuart.helleren@dalconenvironmental.com.au
Dalcon Environmental Reference	DE03039
Report Number	DE03039.R0
Date Reported	19/03/2024

LABORATORY COMMENTS

Sample received unpreserved and unchilled. Sample integrity intact.
Sample preserved with Lugol's Iodine by Dalcon Environmental upon receipt (unpreserved sample retained and refrigerated until analysis complete).

Suffix (PT) = potential toxin producer
Suffix (O) = potential producer of odour-causing compounds
Suffix (s) = spiral trichome/filament
Suffix (c) = colony
Suffix (t) = trichome/filament
Suffix (unknown) = unidentifiable to genus level

Where (PT) or (O) is indicated next to a genus, it should be noted that not all (and, in most cases, only a few) species within that genus are responsible for producing these compounds.

OTHER COMMENTS

Purchase Order: NA

Sample Description:
DE03039.1 - **DE03039.5**: Sample clear and colourless.

Sample Notes:

SAMPLE DETAILS

DE Sample Number	DE03039.1	DE03039.2
Sample Type	Freshwater	Freshwater
Client Sample Desc.	S1	S2
Sample Date	12/03/2024	12/03/2024
Test Method: DE-AM-01		
Analysis Date	15/03/2024	15/03/2024
Chamber Type	SRC	SRC
Chamber Volume	1ml	1ml
Concentration Factor	NA	NA
Units (Density)	cells ml^{-1}	cells ml^{-1}
Units (Biovolume)	$mm^3 L^{-1}$	$mm^3 L^{-1}$
LOR	10	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**20**		**0.35**	**40**		**1.05**
Amphora spp						
Epithemia spp				10		0.26
Fragilaria spp (O)						
Gomphonema spp				30		0.79
Mastogloia spp						
Navicula spp	20		0.35			
Rhopalodia spp						
Chlorodendrophyceae						
Tetraselmis spp						
Chlorophyceae						
Chlamydomonas spp (O)						
Cosmarium spp (O)						
Desmodesmus spp						
Elakatothrix spp						
Monoraphidium spp						
Oocystis spp (O)						
Cryptophyceae	**10**		**0.18**	**20**		**0.52**
Cryptomonas spp (O)	10		0.18	20		0.52
Cyanobacteria	**2440**	**0.2748**	**43.11**	**3140**	**0.5140**	**82.41**
Cyanocatena imperfecta						
Cyanogranis spp						
Dactylococcopsis spp						
Dolichospermum circinale (O) (PT)	80	0.0090	1.41	290	0.0328	7.61
Dolichospermum spp (O) (PT)				210	0.0070	5.51
Glaucospira laxissima						
Komvophoron sp						
Microcystis aeruginosa (O) (PT)	1230	0.2209	21.73	2640	0.4741	69.29
Microcystis flos-aquae (O) (PT)	350	0.0117	6.18			
Planktolyngbya limnetica						
Pseudanabaena spp (O) (PT)						
Trichodesmium spp	780	0.0331	13.78			
Dinophyceae	**3040**		**53.71**	**530**		**13.91**
Ceratium hirundinella (O)	3040		53.71	530		13.91
Euglenophyceae	**40**		**0.71**	**10**		**0.26**
Euglena spp (O)						
Trachelomonas spp	40		0.71	10		0.26
Prasinophyceae	**110**		**1.94**	**70**		**1.84**
Prasinophytes (unknown)	110		1.94	70		1.84
TOTAL (All Taxa)	**5660**		**100**	**3810**		**100**

SAMPLE DETAILS

DE Sample Number	DE03039.3	DE03039.4
Sample Type	Freshwater	Freshwater
Client Sample Desc.	S2A	S3
Sample Date	12/03/2024	12/03/2024
Test Method: DE-AM-01		
Analysis Date	15/03/2024	15/03/2024
Chamber Type	SRC	SRC
Chamber Volume	1ml	1ml
Concentration Factor	NA	NA
Units (Density)	cells ml^{-1}	cells ml^{-1}
Units (Biovolume)	mm^3 L^{-1}	mm^3 L^{-1}
LOR	10	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**30**		**0.38**	**230**		**1.05**
Amphora spp	10		0.13	10		0.05
Epithemia spp						
Fragilaria spp (O)				80		0.37
Gomphonema spp						
Mastogloia spp						
Navicula spp	20		0.26	140		0.64
Rhopalodia spp						
Chlorodendrophyceae						
Tetraselmis spp						
Chlorophyceae				**20**		**0.09**
Chlamydomonas spp (O)						
Cosmarium spp (O)						
Desmodesmus spp						
Elakatothrix spp						
Monoraphidium spp						
Oocystis spp (O)				20		0.09
Cryptophyceae	**10**		**0.13**	**40**		**0.18**
Cryptomonas spp (O)	10		0.13	40		0.18
Cyanobacteria	**6250**	**0.8334**	**79.82**	**21310**	**3.5206**	**97.39**
Cyanocatena imperfecta						
Cyanogranis spp						
Dactylococcopsis spp						
Dolichospermum circinale (O) (PT)	1140	0.1289	14.56	590	0.0667	2.70
Dolichospermum spp (O) (PT)	1140	0.0382	14.56			
Glaucospira laxissima						
Komvophoron sp						
Microcystis aeruginosa (O) (PT)	3650	0.6555	46.62	18890	3.3925	86.33
Microcystis flos-aquae (O) (PT)	320	0.0107	4.09	1830	0.0613	8.36
Planktolyngbya limnetica						
Pseudanabaena spp (O) (PT)						
Trichodesmium spp						
Dinophyceae	**1380**		**17.62**	**240**		**1.10**
Ceratium hirundinella (O)	1380		17.62	240		1.10
Euglenophyceae	**10**		**0.13**	**20**		**0.09**
Euglena spp (O)						
Trachelomonas spp	10		0.13	20		0.09
Prasinophyceae	**150**		**1.92**	**20**		**0.09**
Prasinophytes (unknown)	150		1.92	20		0.09
TOTAL (All Taxa)	**7830**		**100**	**21880**		**100**

SAMPLE DETAILS

DE Sample Number	DE03039.4
Sample Type	Freshwater
Client Sample Desc.	APL
Sample Date	12/03/2024

Test Method: DE-AM-01

Analysis Date	15/03/2024
Chamber Type	SRC
Chamber Volume	1ml
Concentration Factor	NA
Units (Density)	cells ml^{-1}
Units (Biovolume)	mm^3 L^{-1}
LOR	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**100**		**0.00**			
Amphora spp	40		0.00			
Epithemia spp						
Fragilaria spp (O)						
Gomphonema spp						
Mastogloia spp	30		0.00			
Navicula spp	20		0.00			
Rhopalodia spp	10		0.00			
Chlorodendrophyceae	**250**		**0.00**			
Tetraselmis spp	250		0.00			
Chlorophyceae	**2290**		**0.03**			
Chlamydomonas spp (O)	110		0.00			
Cosmarium spp (O)	10		0.00			
Desmodesmus spp	20		0.00			
Elakatothrix spp	40		0.00			
Monoraphidium spp	1900		0.02			
Oocystis spp (O)	210		0.00			
Cryptophyceae	**700**		**0.01**			
Cryptomonas spp (O)	700		0.01			
Cyanobacteria	**8056870**	**4.5069**	**99.93**			
Cyanocatena imperfecta	7824000	4.0966	97.04			
Cyanogranis spp	114000	0.0597	1.41			
Dactylococcopsis spp	1500	0.0247	0.02			
Dolichospermum circinale (O) (PT)	140	0.0158	0.00			
Dolichospermum spp (O) (PT)	30	0.0010	0.00			
Glaucospira laxissima	1300	0.0102	0.02			
Komvophoron sp	130	0.0041	0.00			
Microcystis aeruginosa (O) (PT)	110	0.0198	0.00			
Microcystis flos-aquae (O) (PT)						
Planktolyngbya limnetica	115500	0.2721	1.43			
Pseudanabaena spp (O) (PT)	160	0.0028	0.00			
Trichodesmium spp						
Dinophyceae						
Ceratium hirundinella (O)						
Euglenophyceae	**20**		**0.00**			
Euglena spp (O)	20		0.00			
Trachelomonas spp						
Prasinophyceae	**2200**		**0.03**			
Prasinophytes (unknown)	2200		0.03			
TOTAL (All Taxa)	**8062430**		**100**			

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NATA WORLD RECOGNISED ACCREDITATION

CLIENT DETAILS

Contact	Andre Ferraz Righetti
Client	Hyd2o
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Facsimile	410383203
Email	andre.righetti@hyd2o.com.au
Project	H25077 Footprint Monitoring
Samples	4
Date Received	6/11/2025

LABORATORY DETAILS

Principal	Stuart Helleren
Laboratory	Dalcon Environmental
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Dalcon Environmental Reference	DE03630
Report Number	DE03630.R0
Date Reported	11/11/2025

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA accredited laboratory 20077.

These results apply only to the sample(s) as received and tested.
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SIGNATORY



Dr Stuart Helleren
Principal/Senior Scientist

Analytical Report
Report DE03630.R0

CLIENT DETAILS

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Client	Hyd2o
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Telephone	(08) 9382 8683
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Email	andre.righetti@hyd2o.com.au
Project	H25077 Footprint Monitoring
Samples	4
Date Received	6/11/2025

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Email	stuart.helleren@dalconenvironmental.com.au
Dalcon Environmental Reference	DE03630
Report Number	DE03630.R0
Date Reported	11/11/2025

LABORATORY COMMENTS

Sample received unpreserved and unchilled. Sample integrity intact.
Sample preserved with Lugol's Iodine by Dalcon Environmental upon receipt (unpreserved sample retained and refrigerated until analysis complete).

Suffix (PT) = potential toxin producer
Suffix (O) = potential producer of odour-causing compounds
Suffix (s) = spiral trichome/filament
Suffix (c) = colony
Suffix (t) = trichome/filament
Suffix (unknown) = unidentifiable to genus level

Where (PT) or (O) is indicated next to a genus, it should be noted that not all (and, in most cases, only a few) species within that genus are responsible for producing these compounds.

OTHER COMMENTS

Purchase Order: NA

Sample Description:
DE03630.1 - **DE03630.5**: Sample clear and colourless.

Sample Notes:

Analytical Report
Report DE03630.R0

SAMPLE DETAILS

DE Sample Number	DE03630.1	DE03630.2
Sample Type	Freshwater	Freshwater
Client Sample Desc.	S1	S2
Sample Date	5/11/2025	5/11/2025
Test Method: DE-AM-01		
Analysis Date	11/11/2025	11/11/2025
Chamber Type	SRC	SRC
Chamber Volume	1ml	1ml
Concentration Factor	NA	NA
Units (Density)	cells ml^{-1}	cells ml^{-1}
Units (Biovolume)	mm^3 L^{-1}	mm^3 L^{-1}
LOR	10	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**370**		**32.74**	**110**		**8.66**
Achnanthidium minutissima						
Amphora spp						
Cyclotella spp (O)	20		1.77			
Fragilaria spp (O)	340		30.09	60		4.72
Navicula spp						
Synedra spp (O)	10		0.88	50		3.94
Chrysophyceae	**60**		**5.31**	**110**		**8.66**
Ochromonas spp	60		5.31	110		8.66
Cryptophyceae	**30**		**2.65**	**40**		**3.15**
Cryptomonas spp (O)	30		2.65	40		3.15
Dinophyceae	**640**		**56.64**	**1010**		**79.53**
Ceratium hirundinella (O)	640		56.64	1010		79.53
Euglenophyceae	**30**		**2.65**			
Trachellomonas spp	30		2.65			
TOTAL (All Taxa)	**1130**		**100**	**1270**		**100**

Analytical Report
Report DE03630.R0

SAMPLE DETAILS

DE Sample Number	DE03630.3	DE03630.4
Sample Type	Freshwater	Freshwater
Client Sample Desc.	S2A	S3
Sample Date	5/11/2025	5/11/2025
Test Method: DE-AM-01		
Analysis Date	10/11/2025	10/11/2025
Chamber Type	SRC	SRC
Chamber Volume	1ml	1ml
Concentration Factor	NA	NA
Units (Density)	cells ml^{-1}	cells ml^{-1}
Units (Biovolume)	mm^3 L^{-1}	mm^3 L^{-1}
LOR	10	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**990**		**56.57**	**210**		**8.82**
Achnanthidium minutissima	600		34.29			
Amphora spp	10		0.57			
Cyclotella spp (O)				10		0.42
Fragilaria spp (O)	240		13.71	170		7.14
Navicula spp	30		1.71			
Synedra spp (O)	110		6.29	30		1.26
Chrysophyceae	**50**		**2.86**	**30**		**1.26**
Ochromonas spp	50		2.86	30		1.26
Cryptophyceae	**20**		**1.14**			
Cryptomonas spp (O)	20		1.14			
Dinophyceae	**690**		**39.43**	**2140**		**89.92**
Ceratium hirundinella (O)	690		39.43	2140		89.92
Euglenophyceae						
Trachellomonas spp						
TOTAL (All Taxa)	**1750**		**100**	**2380**		**100**

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NATA WORLD RECOGNISED ACCREDITATION

CLIENT DETAILS

Contact	Andre Ferraz Righetti
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Project	H25077 Footprint Monitoring
Samples	4
Date Received	2/12/2025

LABORATORY DETAILS

Principal	Stuart Helleren
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Dalcon Environmental Reference	DE03666
Report Number	DE03666.R0
Date Reported	15/12/2025

COMMENTS

Accredited for compliance with ISO/IEC 17025 - Testing.
NATA accredited laboratory 20077.

These results apply only to the sample(s) as received and tested.
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SIGNATORY



Dr Stuart Helleren
Principal/Senior Scientist

Analytical Report
Report DE03666.R0

CLIENT DETAILS

Contact	Andre Ferraz Righetti
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Project	H25077 Footprint Monitoring
Samples	4
Date Received	2/12/2025

LABORATORY DETAILS

Principal	Stuart Helleren
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Email	stuart.helleren@dalconenvironmental.com.au
Dalcon Environmental Reference	DE03666
Report Number	DE03666.R0
Date Reported	15/12/2025

LABORATORY COMMENTS

Sample received unpreserved and unchilled. Sample integrity intact.
Sample preserved with Lugol's Iodine by Dalcon Environmental upon receipt (unpreserved sample retained and refrigerated until analysis complete).

Suffix (PT) = potential toxin producer
Suffix (O) = potential producer of odour-causing compounds
Suffix (s) = spiral trichome/filament
Suffix (c) = colony
Suffix (t) = trichome/filament
Suffix (unknown) = unidentifiable to genus level

Where (PT) or (O) is indicated next to a genus, it should be noted that not all (and, in most cases, only a few) species within that genus are responsible for producing these compounds.

OTHER COMMENTS

Purchase Order: NA

Sample Description:
DE03666.1 - **DE03666.4**: Sample clear and colourless.

Sample Notes:
DE03666.2: Sample contained large amounts of fractured *Ceratium hirundinella* cells.

Analytical Report
Report DE03666.R0

SAMPLE DETAILS

DE Sample Number	DE03666.1	DE03666.2
Sample Type	Freshwater	Freshwater
Client Sample Desc.	S1	S2
Sample Date	2/12/2025	2/12/2025
Test Method: DE-AM-01		
Analysis Date	12/12/2025	12/12/2025
Chamber Type	SRC	SRC
Chamber Volume	1ml	1ml
Concentration Factor	NA	NA
Units (Density)	cells ml^{-1}	cells ml^{-1}
Units (Biovolume)	$mm^3 L^{-1}$	$mm^3 L^{-1}$
LOR	10	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**20**		**0.51**	**40**		**66.67**
Amphora spp	10		0.26			
Cyclotella spp (O)	10		0.26			
Fragilaria spp (O)				40		66.67
Navicula spp						
Synedra spp (O)						
Chlorophyceae						
Oocystis spp						
Chrysophyceae	**240**		**6.15**			
Ochromonas spp	240		6.15			
Cryptophyceae	**10**		**0.26**			
Cryptomonas spp (O)	10		0.26			
Dinophyceae	**3630**		**93.08**	**10**		**16.67**
Ceratium hirundinella (O)	3630		93.08	10		16.67
Peridinium spp (O)						
Euglenophyceae				**10**		**16.67**
Trachelomonas spp				10		16.67
TOTAL (All Taxa)	**3900**		**100**	**60**		**100**

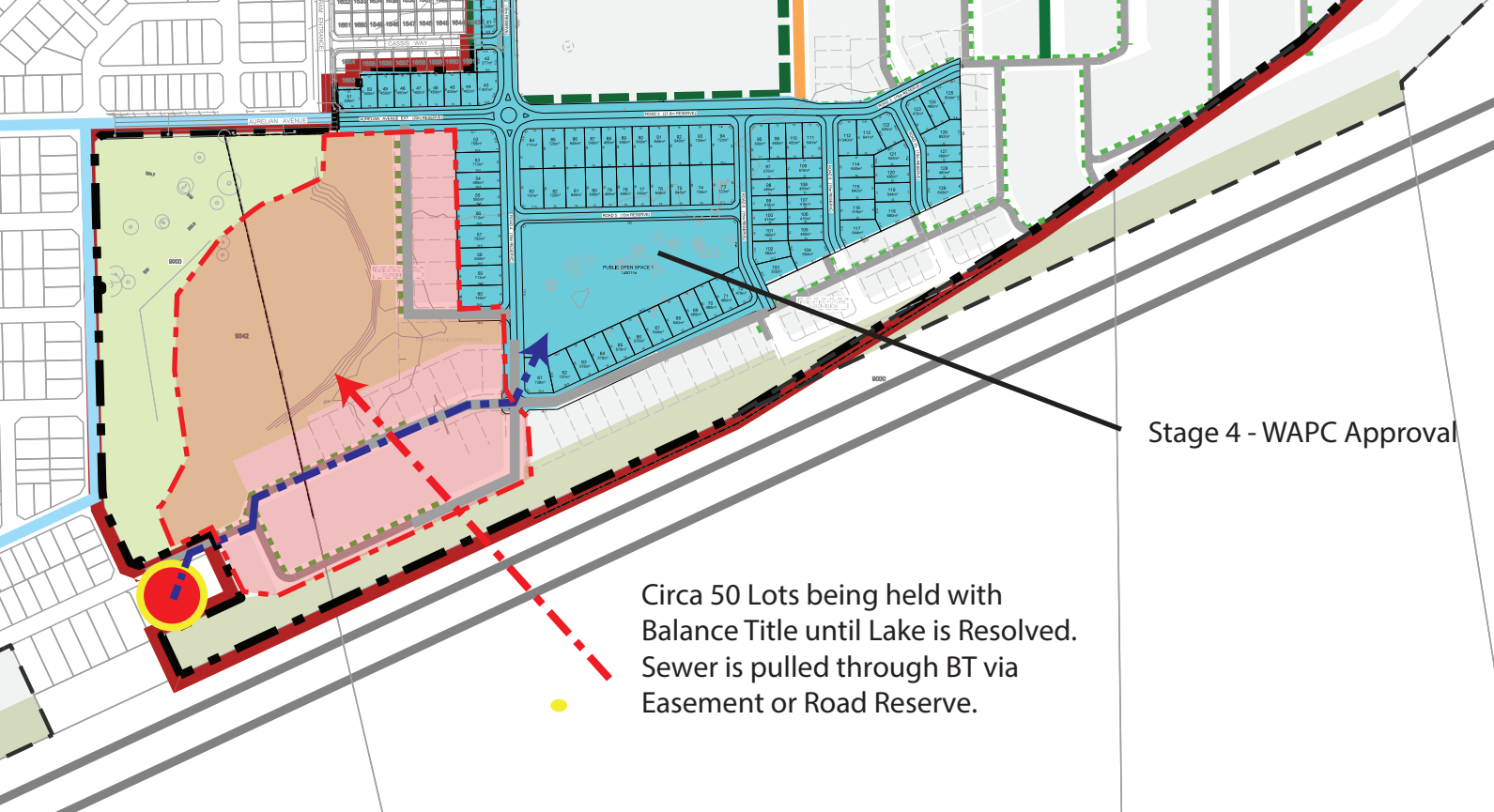
Analytical Report
Report DE03666.R0

SAMPLE DETAILS

DE Sample Number	DE03666.3	DE03666.4
Sample Type	Freshwater	Freshwater
Client Sample Desc.	S2A	S3
Sample Date	2/12/2025	2/12/2025
Test Method: DE-AM-01		
Analysis Date	12/12/2025	12/12/2025
Chamber Type	SRC	SRC
Chamber Volume	1ml	1ml
Concentration Factor	NA	NA
Units (Density)	cells ml^{-1}	cells ml^{-1}
Units (Biovolume)	mm^3 L^{-1}	mm^3 L^{-1}
LOR	10	10

Analytical Results

Taxon	Abund.	BV	%	Abund.	BV	%
Bacillariophyceae	**180**		**54.55**	**230**		**14.38**
Amphora spp				20		1.25
Cyclotella spp (O)						
Fragilaria spp (O)	160		48.48	200		12.50
Navicula spp	10		3.03			
Synedra spp (O)	10		3.03	10		0.63
Chlorophyceae	**10**		**3.03**			
Oocystis spp	10		3.03			
Chrysophyceae	**30**		**9.09**	**50**		**3.13**
Ochromonas spp	30		9.09	50		3.13
Cryptophyceae						
Cryptomonas spp (O)						
Dinophyceae	**110**		**33.33**	**1320**		**82.50**
Ceratium hirundinella (O)	110		33.33	1300		81.25
Peridinium spp (O)				20		1.25
Euglenophyceae						
Trachelomonas spp						
TOTAL (All Taxa)	**330**		**100**	**1600**		**100**


Stage 4 - WAPC Approval
Circa 50 Lots being held with
Balance Title until Lake is Resolved.
Sewer is pulled through BT via
Easement or Road Reserve.

APPENDIX P

Catchment Land Use Breakdown
& CURRV Runoff Rate Calculator

APPENDIX O

Embark Estate Landuse Breakdown

Catchment	Lots - Soakwells(ha)	Lots - Lot Connections (ha)	Roads (ha)	Landscape/POS (ha)	Retirement Village (ha)	Commercial (ha)	School (ha)	Rural (ha)	Grand Total (ha)
A	3.92	8.52	7.19	7.32	14.67	2.81	0.00	0.00	44.43
B	8.70	0.00	5.24	2.52	0.00	0.00	0.00	0.00	16.46
C1	2.78	0.00	1.05	0.23	0.00	0.00	0.00	0.00	4.07
C2	0.93	0.00	0.52	0.76	0.00	0.00	0.00	0.00	2.21
C3	1.32	0.00	0.78	1.87	0.00	0.00	0.00	0.00	3.98
E1	9.54	0.00	3.39	4.09	0.00	0.00	0.00	0.00	17.02
E2	1.19	0.00	0.57	0.54	0.00	0.00	0.00	0.00	2.30
E3	2.68	0.00	0.86	0.51	0.00	0.00	0.00	0.00	4.05
E4	1.42	0.00	1.22	0.59	0.00	0.00	0.00	0.00	3.24
EF	0.00	0.00	0.02	6.60	0.00	0.00	0.00	0.00	6.62
F	2.19	1.68	1.70	3.22	0.00	0.00	0.00	0.00	8.79
G	4.68	2.85	4.07	4.08	0.00	0.00	4.51	0.00	20.19
H	7.45	0.00	4.25	9.21	0.00	0.00	0.00	10.80	31.70
I	1.51	0.00	0.93	0.72	0.00	0.00	0.00	0.00	3.16
J	3.15	0.00	1.36	0.51	0.00	0.00	0.00	0.00	5.02
K	5.16	0.00	1.93	1.67	0.00	0.00	0.00	0.00	8.77
L	9.84	0.00	3.82	1.74	0.00	0.00	0.00	0.00	15.40
M	19.32	0.00	10.53	7.55	0.00	0.00	0.00	0.00	37.41
Grand Total (ha)	85.80	13.05	49.44	53.74	14.67	2.82	4.51	10.80	234.82

CURRV

Calculator for Urban Runoff Rates & Volumes

25-02-26

Project: **Lot 2, 9032 & 9034 Bussell Highway, Busselton LWMS**

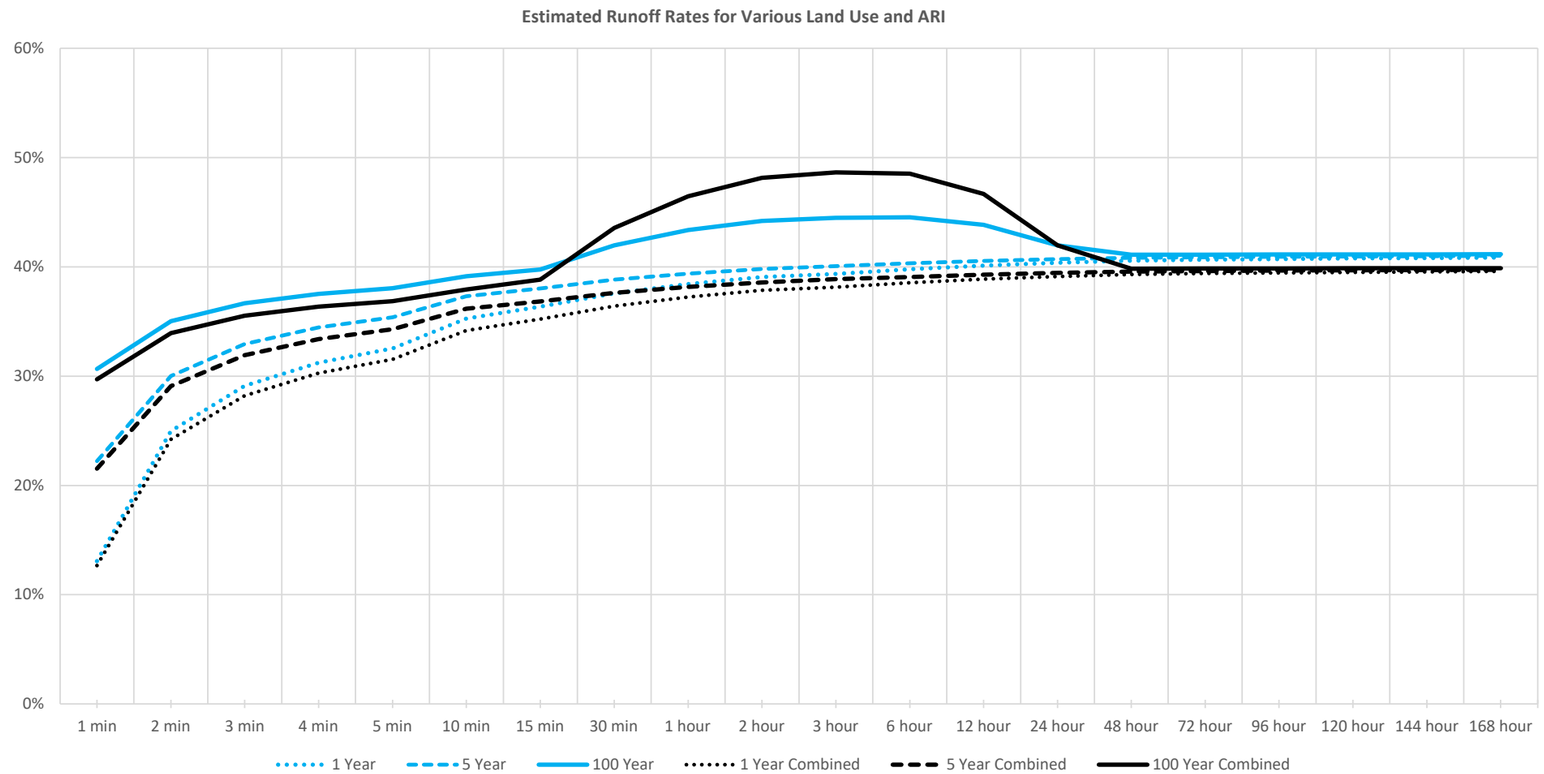
	Land Use Description	Area (ha)	Use in Calc	Imperv Initial Loss mm	Perv Initial Loss mm	Perv Continue Loss mm/hr	On Site Soak (mm)	AR&R Empty (days)	EIA/TIA System Connect Ratio	Roof %	Ext Imp %	Ext Perv %	Comment
1	Residential	85.80	Yes	1.5	30.0	4.0	0.0	1.00	50%	63	20	17	15mm soakwells on site
2	Residential - Modelled Lot Connections	13.05	Yes	1.5	30.0	4.0	0.0	1.00	80%	63	20	17	Lot connections
3	Roads	49.44	Yes	1.5	30.0	4.0	0.0	1.00	100%	0	75	25	
4	Commercial	2.82	Yes	1.5	30.0	4.0	0.0	1.00	95%	60	30	10	First 15mm to be managed on site
5	POS/Landscape	53.74	Yes	1.5	30.0	4.0	0.0	1.00	40%	0	0	100	
6	Retirement Village	14.67	Yes	1.5	30.0	4.0	0.0	1.00	80%	45	30	25	First 15mm to be managed on site
7	Rural Residential	10.80	Yes	1.5	30.0	4.0	0.0	1.00	30%	20	10	70	First 15mm to be managed on site
8	Primary School	4.51	Yes	1.5	30.0	4.0	0.0	1.00	40%	25	25	0	First 15mm to be managed on site
9								1.00					
10								1.00					

EIA : Effective Impervious Area, TIA : Total Impervious Area

Land Use Graph Selector: **1**

(11 - combined total)

Residential



Rainfall IFD Data

Annual Exceedence Probability

	Duration	63.2% 1.00	50% 1.44	20% 4.48	10% 10	5% 20	2% 50	1% 100
1	1 min	2.2	2.4	3.2	3.8	4.4	5.1	5.7
2	2 min	3.8	4.2	5.4	6.3	7.3	8.6	9.6
3	3 min	5.0	5.6	7.3	8.5	9.8	11.5	12.9
4	4 min	6.1	6.7	8.8	10.4	11.9	14.0	15.7
5	5 min	7.0	7.7	10.2	11.9	13.7	16.1	18.0
6	10 min	10.0	11.2	14.9	17.5	20.1	23.6	26.4
7	15 min	12.1	13.5	17.9	21.0	24.2	28.4	31.8
8	30 min	15.9	17.7	23.4	27.5	31.6	37.2	41.7
9	1 hour	20.3	22.4	29.5	34.6	39.9	47.1	53.0
10	2 hour	25.6	28.2	37.0	43.3	49.9	59.1	66.6
11	3 hour	29.2	32.2	42.2	49.5	57.0	67.5	76.1
12	6 hour	36.5	40.3	52.9	62.1	71.5	84.7	95.5
13	12 hour	45.3	50.1	65.8	77.0	88.5	105.0	118.0
14	24 hour	55.3	61.1	79.7	92.9	106.0	125.0	141.0
15	48 hour	66.5	73.0	93.6	108.0	122.0	143.0	159.0
16	72 hour	74.0	80.8	102.0	116.0	130.0	151.0	167.0
17	96 hour	80.2	87.2	109.0	123.0	136.0	156.0	172.0
18	120 hour	85.9	93.2	115.0	129.0	142.0	161.0	176.0
19	144 hour	91.5	99.1	121.0	135.0	148.0	166.0	179.0
20	168 hour	97.0	105.0	128.0	142.0	154.0	171.0	183.0

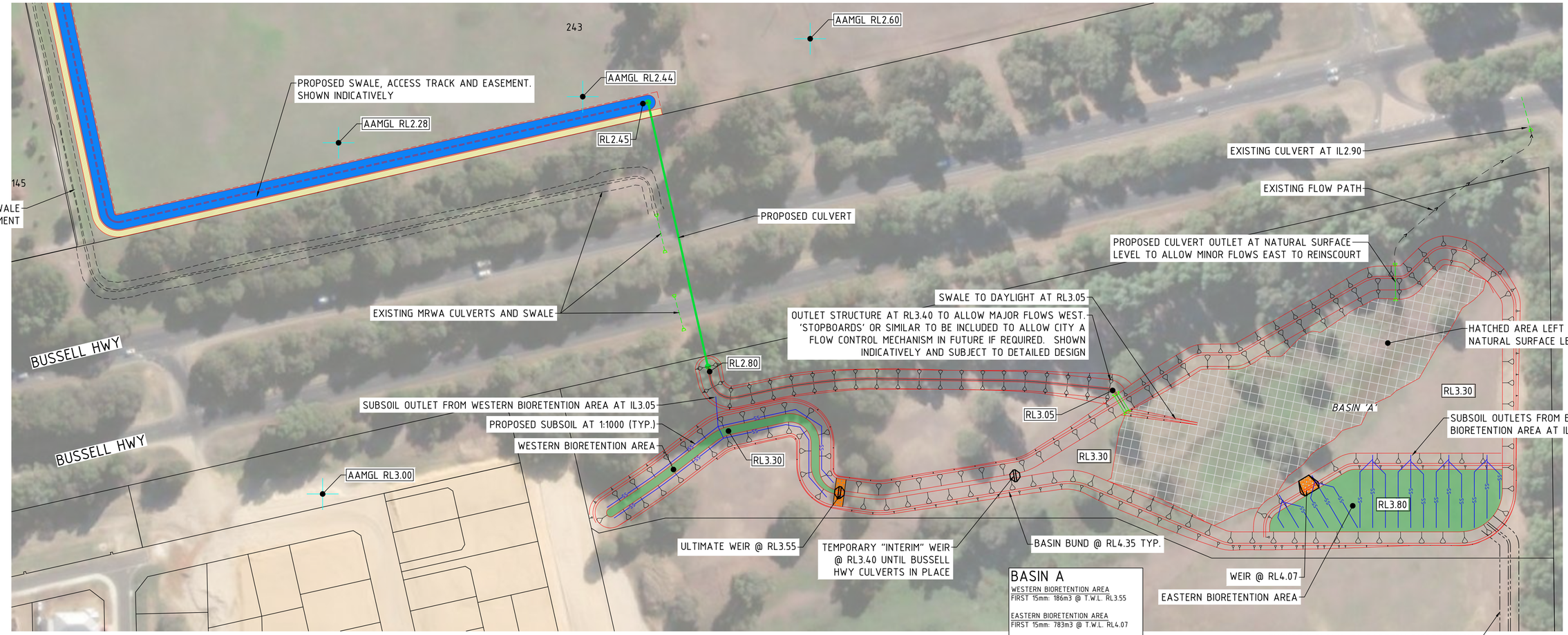
Estimated Runoff Rates

Annual Exceedence Probability

	63.2%	50%	20%	10%	5%	2%	1%
Maximum of All Events	1.00	1.44	4.48	10	20	50	100
Residential	**41%**	41%	**41%**	**42%**	43%	44%	**45%**
Residential - Modelled Lot Connections	**65%**	65%	**66%**	**67%**	68%	70%	**71%**
Roads	**74%**	74%	**74%**	**77%**	80%	83%	**85%**
Commercial	**84%**	84%	**84%**	**85%**	86%	87%	**88%**
POS/Landscape	**0%**	0%	**0%**	**6%**	11%	15%	**18%**
Retirement Village	**59%**	59%	**59%**	**61%**	64%	66%	**68%**
Rural Residential	**9%**	9%	**9%**	**12%**	14%	17%	**18%**
Primary School	**20%**	20%	**20%**	**20%**	20%	20%	**20%**
0	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
0	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
combined total	**40%**	40%	**40%**	**42%**	45%	47%	**49%**

Event Selector	**9**	**1 hour**					
Residential	**38%**	39%	**39%**	**40%**	41%	43%	**43%**
Residential - Modelled Lot Connections	**61%**	62%	**63%**	**64%**	66%	68%	**69%**
Roads	**69%**	70%	**71%**	**72%**	76%	80%	**82%**
Commercial	**79%**	80%	**81%**	**82%**	84%	85%	**86%**
POS/Landscape	**0%**	0%	**0%**	**1%**	6%	11%	**14%**
Retirement Village	**56%**	56%	**57%**	**58%**	61%	64%	**65%**
Rural Residential	**8%**	8%	**9%**	**9%**	12%	15%	**16%**
Primary School	**19%**	19%	**19%**	**19%**	19%	19%	**19%**
0	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
0	**0%**	0%	**0%**	**0%**	0%	0%	**0%**
combined total	**37%**	38%	**38%**	**39%**	42%	45%	**46%**

APPENDIX Q
Basin Design Concepts



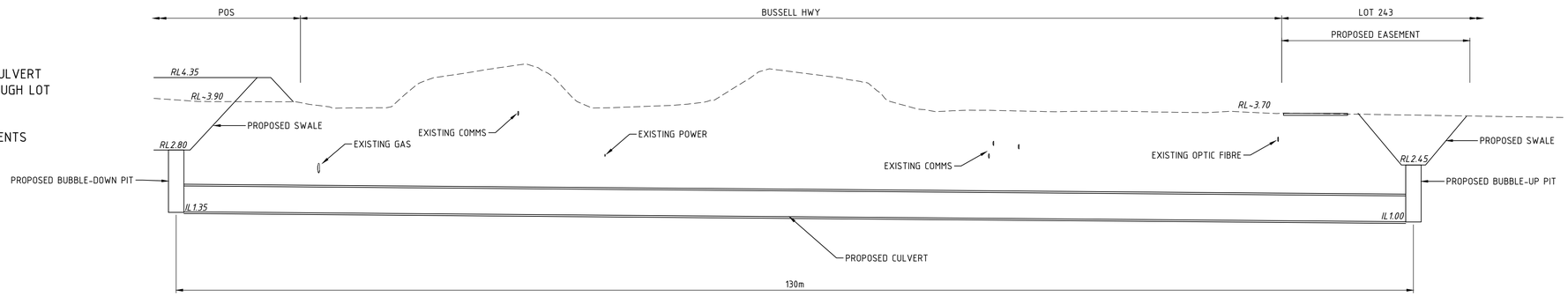
BASIN A
WESTERN BIORETENTION AREA
FIRST 15mm: 186m3 @ T.W.L. RL3.55

EASTERN BIORETENTION AREA
FIRST 15mm: 783m3 @ T.W.L. RL4.07

OVERALL
20%AEP: 4,935m3 @ T.W.L. RL3.72
1%AEP: 10,954m3 @ T.W.L. RL4.03
(ANY STORAGE BELOW RL3.40 IGNORED)

PLAN
SCALE 1:1000

KEY POINTS
- PROPOSED CULVERT WILL TYPICALLY SEE "CLEAN" FLOWS FROM SUBSOIL DISCHARGE
- ONLY IN STORM EVENTS ABOVE FIRST 15mm WILL STORMWATER FLOW THROUGH THIS CULVERT
- DEVELOPER TO MAINTAIN CULVERT & OUTLET SWALE THROUGH LOT 243 & TRACK THROUGH LOT 243 FOR DURATION OF DEVELOPMENT + 2 YEARS
- LEVEL OF EXISTING SUBSOIL OUTLETS FROM EXISTING DEVELOPED AREAS WHICH WILL DISCHARGE TO BASIN IS LIMITING FACTOR FOR BASIN/SWALE INVERT LEVELS AND PREVENTS THEM BEING RAISED



PROPOSED CULVERT SECTION
NOT TO SCALE

JDS232179.0_SK012 REVISION D
EMBARK - BASIN A - CONCEPT ARRANGEMENT WITH DUAL OUTLETS TO EAST AND WEST WITH NEW BUSSELL HWY CULVERT
CONCEPT ONLY - SUBJECT TO DETAILED DESIGN
0 10 20 40 60m
SCALE 1:1000 @ ORIGINAL SHEET SIZE A1

PRELIMINARY

Plotted By: RFowler Plot Date: 24/02/26 - 10:37 Cad File: I:\JDS232179\JDS232179.0\02 CIVIL\Drawings\Sketches\JDS232179.0_SK012.dwg



0 25 50 100 150m

SCALE 1:2500 @ ORIGINAL SHEET SIZE A1

PRELIMINARY

REV	DATE	DRAWN	CHECKED	APPROVED

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NOTE
This drawing shall be preliminary only until it is Issued for Construction.

JDSi

CLIENT:

PROJECT:
EMBARK, BUSSELTON

DRAWING TITLE:
PRELIMINARY BASIN SIZING

DRAWN	WAPC No.	
R. FOWLER		
DESIGNED	SCALE @ A1	
-	1:2500	
PROJECT MANAGER	DATUM	CO-ORDS
R. FOWLER	AHD	BCG94
JDSi PROJECT No.	DRAWING No.	REVISION
232179	SK007	A

APPENDIX R
Stormwater Modelling Outputs

Ensemble Statistics Utility

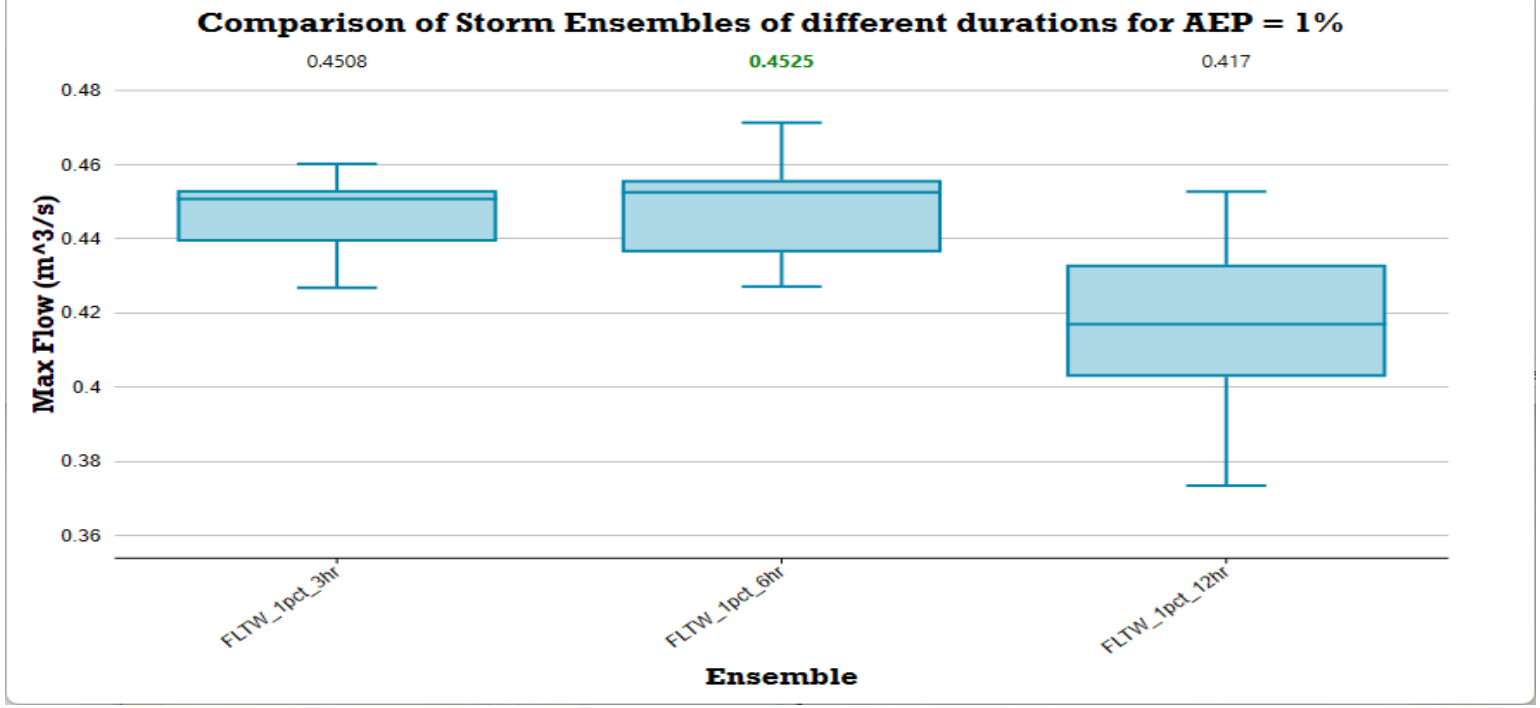
Object: BussellCulvert Result Type: Max Flow (m^3/s)

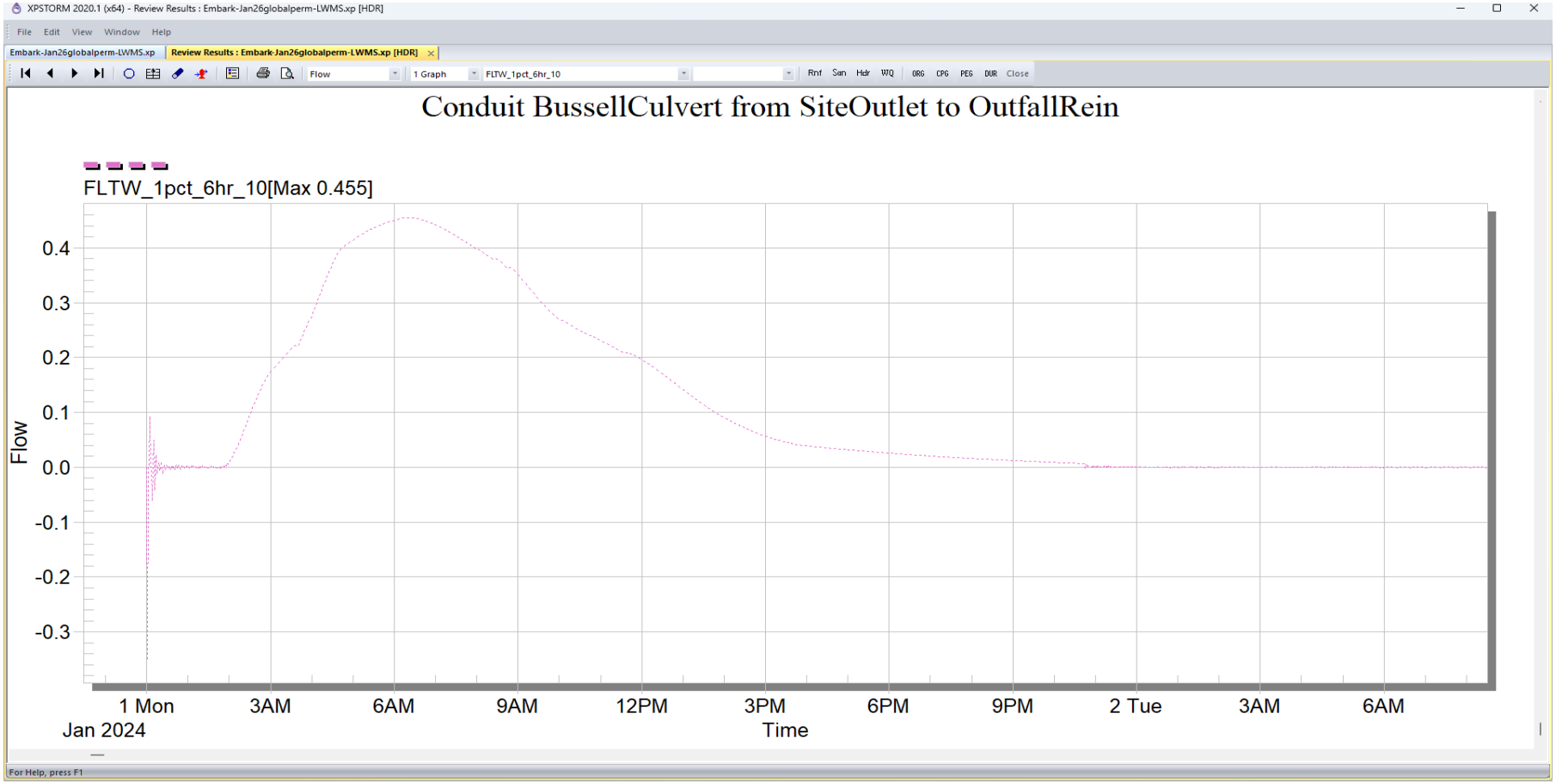
Object type: Link

	Ensemble Name	AEP	Mean	Mean Storm	Median	Median Storm	Min	Min Storm	Max	Max Storm
1	FLTW_1pct_3hr	1%	0.44656	FLTW_1pct_3hr_1	0.45076	FLTW_1pct_3hr_7	0.42675	FLTW_1pct_3hr_5	0.46019	FLTW_1pct_3hr_10
2	FLTW_1pct_6hr	1%	0.44803	FLTW_1pct_6hr_1	0.45251	FLTW_1pct_6hr_10	0.42713	FLTW_1pct_6hr_3	0.47127	FLTW_1pct_6hr_6
3	FLTW_1pct_12hr	1%	0.41548	FLTW_1pct_12hr_5	0.41698	FLTW_1pct_12hr_5	0.37336	FLTW_1pct_12hr_8	0.45269	FLTW_1pct_12hr_10

Box and Whisker Plot

Selected AEP: 1% Show Inner Points Show Outliers Show Mean Marks Show Mean Line Display: Median



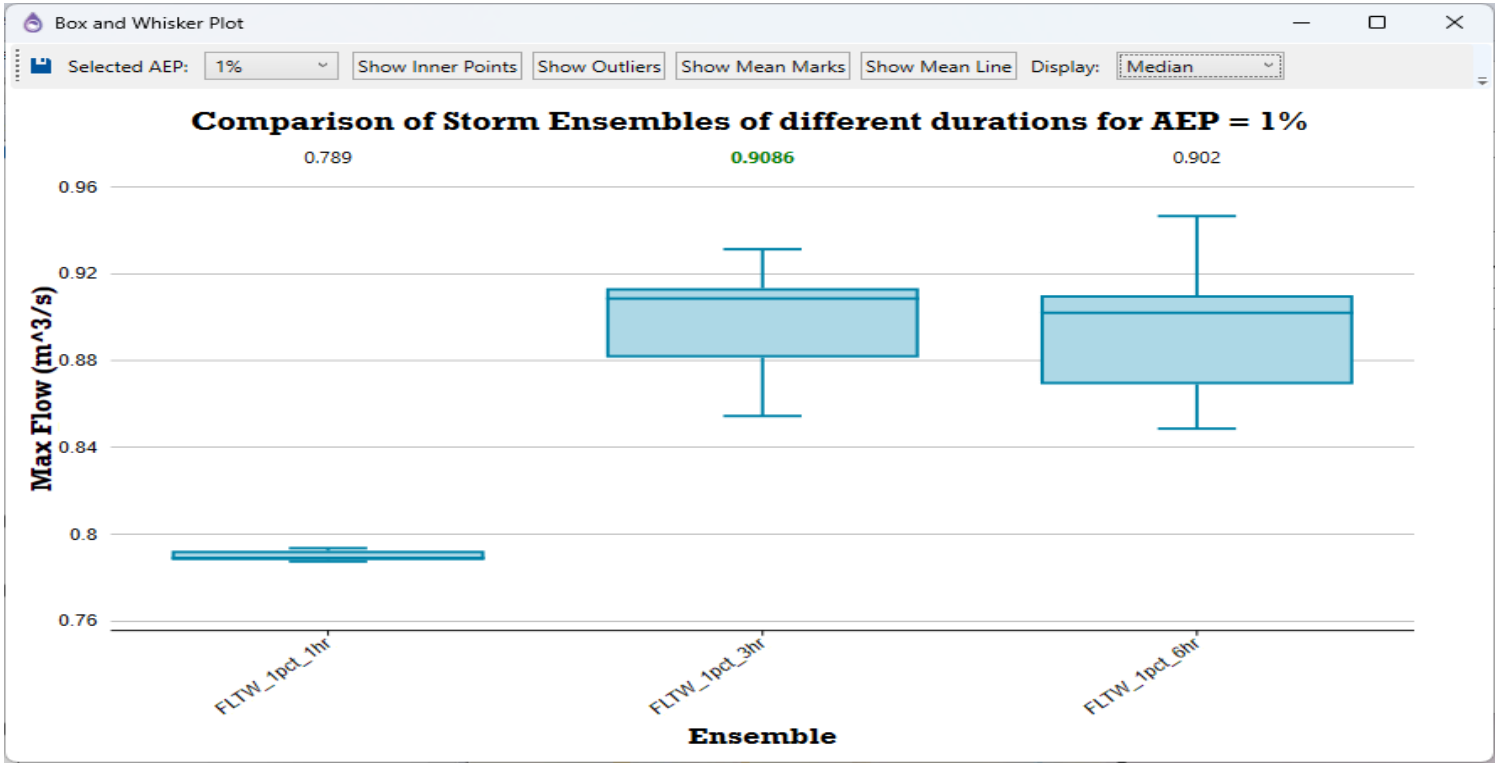

XPSTORM 2020.1 (x64) - Review Results : Embark-Jan26globalperm-LWMS.xp [HDR]
File Edit View Window Help
Embark-Jan26globalperm-LWMS.xp
Review Results : Embark-Jan26globalperm-LWMS.xp [HDR]
Flow
1 Graph
FLTW_1pct_6hr_10
Conduit BussellCulvert from SiteOutlet to OutfallRein
FLTW_1pct_6hr_10[Max 0.455]
Flow
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
1 Mon
Jan 2024
3AM
6AM
9AM
12PM
3PM
6PM
9PM
2 Tue
3AM
6AM
Time
For Help, press F1

Ensemble Statistics Utility

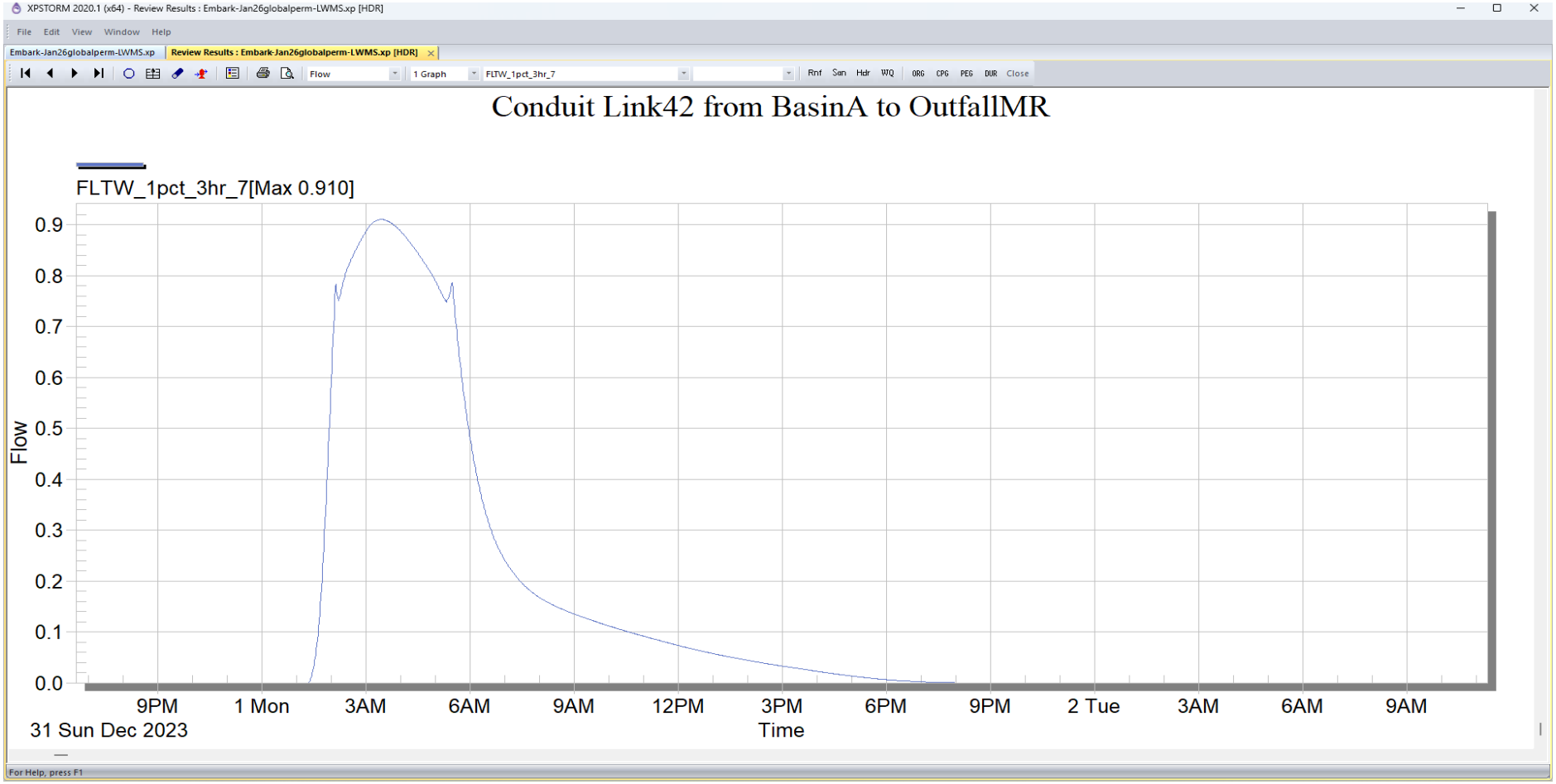
Object: Link42 Result Type: Max Flow (m^3/s)

Object type: Link

	Ensemble Name	AEP	Mean	Mean Storm	Median	Median Storm	Min	Min Storm	Max	Max Storm
1	FLTW_1pct_1hr	1%	0.78999	FLTW_1pct_1hr_5	0.78900	FLTW_1pct_1hr_3	0.78745	FLTW_1pct_1hr_8	0.79347	FLTW_1pct_1hr_9
2	FLTW_1pct_3hr	1%	0.89930	FLTW_1pct_3hr_1	0.90857	FLTW_1pct_3hr_7	0.85438	FLTW_1pct_3hr_5	0.93128	FLTW_1pct_3hr_10
3	FLTW_1pct_6hr	1%	0.89445	FLTW_1pct_6hr_1	0.90198	FLTW_1pct_6hr_10	0.84859	FLTW_1pct_6hr_3	0.94664	FLTW_1pct_6hr_6



Date : 21/01/2026 Job No: H22018



APPENDIX S
UNDO Nutrient Input Modelling

Government of **Western Australia**
Department of **Water and Environmental Regulation**

Project: EMBARK LWMS PRE DEV MODEL

Date: 04-Apr-25

Version: Version 1.2.0.19289

Subregion name: EMBARK PRE DEV

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	0	0.00	0.00	0.00
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	100	235.00	16473.50	3102.00
Public open space	0	0.00	0.00	0.00
Road reserve	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
235.00	100

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
17702.55	3137.25

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
1758.57	27.85

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	100	235.00
No livestock	0	0.00
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
235.00	100

Nitrogen input (kg)	Phosphorus input (kg)
16473.50	3102.00

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Soil and drainage information

Type of drainage	**Infiltration**	**Does it contain imported fill?**	**No**
Soil type	**Spearwood Dune**	**Does subregion contain onsite sewage diposal system?**	**No**
Depth to groundwater (m)	**2**		
Groundwater slope (%)	**0.5**		
Soil PRI	**11.0**		

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices

Treatment	Name	Size (m²)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Load removed					**0.00**	**0.00**
Net export					**1758.57**	**27.85**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
EMBARK PRE DEV	235.00	27.85	1758.57

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
1758.57	**27.85**	**0.00**	**0.00**	**1758.57**	**27.85**

Project: EMBARK POST DEV

Date: 04-Apr-25

Version: Version 1.2.0.19289

Subregion name: Catchment A

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	62	26.23	616.13	180.50
Industrial, commercial & schools	7	2.96	42.34	8.59
Rural living	0	0.00	0.00	0.00
Public open space	15	6.35	64.72	1.27
Road reserve	16	6.77	0.00	0.00

Total area (ha)	Total percent (%)
42.30	18

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
944.43	196.70

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
97.15	3.07

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	26.23	616.13	180.50
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
26.226	62

Nitrogen input (kg)	Phosphorus input (kg)
616.13	180.50

Commercial, Industry and Schools

Landuse	Percent (%)	Area (ha)
Light industrial	100	2.96
Heavy industrial	0	0.00
Commercial / Offices	0	0.00
Schools	0	0.00
Public buildings	0	0.00

Total area (ha)	Total percent (%)
2.96	7

Nitrogen input (kg)	Phosphorus input (kg)
42.34	8.59

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	90	5.71
Sport	0	0.00
Recreation	10	0.63
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
6.35	15

Nitrogen input (kg)	Phosphorus input (kg)
64.72	1.27

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	6.77
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
6.768	16

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: **Catchment B**

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	53	8.72	204.83	60.01
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	15	2.47	162.86	4.94
Road reserve	32	5.26	0.00	0.00

Total area (ha)	Total percent (%)
16.45	**7**

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
453.71	**67.41**

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
46.67	**1.05**

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	8.72	204.83	60.01
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
8.7185	**53**

Nitrogen input (kg)	Phosphorus input (kg)
204.83	**60.01**

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	100	2.47
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
2.47	**15**

Nitrogen input (kg)	Phosphorus input (kg)
162.86	**4.94**

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	5.26
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
5.264	32

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment C

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	49	4.61	108.21	31.70
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	28	2.63	10.53	0.00
Road reserve	23	2.16	0.00	0.00

Total area (ha)	Total percent (%)
9.40	4

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
167.90	33.11

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
17.34	0.52

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	4.61	108.21	31.70
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
4.606	49

Nitrogen input (kg)	Phosphorus input (kg)
108.21	31.70

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	100	2.63
Sport	0	0.00
Recreation	0	0.00
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
2.63	28

Nitrogen input (kg)	Phosphorus input (kg)
10.53	0.00

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	2.16
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
2.162	23

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment F

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	52	7.33	172.25	50.46
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	29	4.09	269.87	8.18
Road reserve	19	2.68	0.00	0.00

Total area (ha)	Total percent (%)
14.10	6

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
515.87	60.76

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
53.12	0.95

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	7.33	172.25	50.46
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
7.332	52

Nitrogen input (kg)	Phosphorus input (kg)
172.25	50.46

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	100	4.09
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
4.09	29

Nitrogen input (kg)	Phosphorus input (kg)
269.87	8.18

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	2.68
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
2.679	19

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment G

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	31	5.83	136.92	40.11
Industrial, commercial & schools	26	4.89	493.69	98.25
Rural living	0	0.00	0.00	0.00
Public open space	22	4.14	16.54	0.00
Road reserve	21	3.95	0.00	0.00

Total area (ha)	Total percent (%)
18.80	8

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
745.47	141.18

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
76.68	2.20

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	5.83	136.92	40.11
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
5.828	31

Nitrogen input (kg)	Phosphorus input (kg)
136.92	40.11

Commercial, Industry and Schools

Landuse	Percent (%)	Area (ha)
Light industrial	0	0.00
Heavy industrial	0	0.00
Commercial / Offices	0	0.00
Schools	100	4.89
Public buildings	0	0.00

Total area (ha)	Total percent (%)
4.89	26

Nitrogen input (kg)	Phosphorus input (kg)
493.69	98.25

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	100	4.14
Sport	0	0.00
Recreation	0	0.00
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
4.14	22

Nitrogen input (kg)	Phosphorus input (kg)
16.54	0.00

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	3.95
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.948	21

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment H

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	24	7.33	172.25	50.46
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	34	10.39	728.13	137.11
Public open space	29	8.86	35.44	0.00
Road reserve	13	3.97	0.00	0.00

Total area (ha)	Total percent (%)
30.55	13

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
1095.60	192.15

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
112.70	3.00

Residential

Size (m²)	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
<400	100	7.33	172.25	50.46
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
7.332	24

Nitrogen input (kg)	Phosphorus input (kg)
172.25	50.46

Rural living

Landuse	Percent (%)	Area (ha)
Unrestricted	100	10.39
No livestock	0	0.00
No clearing apart from the housing pad	0	0.00

Total area (ha)	Total percent (%)
10.39	34

Nitrogen input (kg)	Phosphorus input (kg)
728.13	137.11

Note: Commercial horticultre is not permitted in the rural living zone, due to spray drift buffers.

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	100	8.86
Sport	0	0.00
Recreation	0	0.00
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
8.86	29

Nitrogen input (kg)	Phosphorus input (kg)
35.44	0.00

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	3.97
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.9715	13

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment I

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	48	1.13	26.50	7.76
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	23	0.54	35.67	1.08
Road reserve	29	0.68	0.00	0.00

Total area (ha)	Total percent (%)
2.35	1

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
74.46	9.20

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
4.83	0.43

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	1.13	26.50	7.76
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
1.128	48

Nitrogen input (kg)	Phosphorus input (kg)
26.50	7.76

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	100	0.54
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.54	23

Nitrogen input (kg)	Phosphorus input (kg)
35.67	1.08

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	0.68
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
0.6815	29

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage	**Piped drainage**
Soil type	**Spearwood Dune**
Depth to groundwater (m)	**3**
Groundwater slope (%)	**0.5**
Soil PRI	**11.0**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment J

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	63	2.96	69.56	20.38
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	10	0.47	31.02	0.94
Road reserve	27	1.27	0.00	0.00

Total area (ha)	Total percent (%)
4.70	2

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
125.16	22.02

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
8.10	1.03

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	2.96	69.56	20.38
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
2.961	63

Nitrogen input (kg)	Phosphorus input (kg)
69.56	20.38

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	100	0.47
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
0.47	10

Nitrogen input (kg)	Phosphorus input (kg)
31.02	0.94

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	1.27
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
1.269	27

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage: **Piped drainage**

Soil type: **Spearwood Dune**

Depth to groundwater (m): **3**

Groundwater slope (%): **0.5**

Soil PRI: **11.0**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment K

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	59	5.55	130.29	38.17
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	19	1.79	117.88	3.57
Road reserve	22	2.07	0.00	0.00

Total area (ha)	Total percent (%)
9.40	4

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
297.33	43.15

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
19.18	2.02

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	5.55	130.29	38.17
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
5.546	59

Nitrogen input (kg)	Phosphorus input (kg)
130.29	38.17

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	100	1.79
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
1.79	19

Nitrogen input (kg)	Phosphorus input (kg)
117.88	3.57

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	2.07
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
2.068	22

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage: **Piped drainage**

Soil type: **Spearwood Dune**

Depth to groundwater (m): **3**

Groundwater slope (%): **0.5**

Soil PRI: **11.0**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment L

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	63	10.36	243.47	71.33
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	13	2.14	141.14	4.28
Road reserve	24	3.95	0.00	0.00

Total area (ha)	Total percent (%)
16.45	7

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
470.65	78.07

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
30.26	3.66

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	10.36	243.47	71.33
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
10.3635	63

Nitrogen input (kg)	Phosphorus input (kg)
243.47	71.33

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	100	2.14
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
2.14	13

Nitrogen input (kg)	Phosphorus input (kg)
141.14	4.28

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	3.95
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
3.948	24

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage: **Piped drainage**

Soil type: **Spearwood Dune**

Depth to groundwater (m): **2.5**

Groundwater slope (%): **0.5**

Soil PRI: **11.0**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment M

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	52	19.55	459.34	134.57
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	20	7.52	281.85	8.12
Road reserve	28	10.53	0.00	0.00

Total area (ha)	Total percent (%)
37.60	16

Nitrogen input (kg/yr)	Phosphorus input (kg/yr)
937.84	148.33

Nitrogen export (kg/yr)	Phosphorus (kg/yr)
60.30	6.99

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	19.55	459.34	134.57
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
19.552	52

Nitrogen input (kg)	Phosphorus input (kg)
459.34	134.57

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	0	0.00
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	46	3.46
Sport	0	0.00
Recreation	54	4.06
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	0	0.00

Total area (ha)	Total percent (%)
7.52	20

Nitrogen input (kg)	Phosphorus input (kg)
281.85	8.12

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	10.53
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
10.528	28

Nitrogen input (kg)	Phosphorus input (kg)
0.00	0.00

Soil and drainage information

Type of drainage: **Piped drainage**

Soil type: **Spearwood Dune**

Depth to groundwater (m): **2**

Groundwater slope (%): **0.5**

Soil PRI: **11.0**

Does it contain imported fill? **No**

Does subregion contain onsite sewage diposal system? **No**

Note: Please attach the results of soil tests to this report when submitting.

Subregion name: Catchment E

Landuse	Percent (%)	Area (ha)	Input load Nitrogen (kg)	Input load Phosphorus (kg)
Residential	45	14.81	347.82	101.90
Industrial, commercial & schools	0	0.00	0.00	0.00
Rural living	0	0.00	0.00	0.00
Public open space	37	12.17	296.29	9.36
Road reserve	18	5.92	0.00	0.00

Total area (ha)	Total percent (%)
32.90	14

Nitrogen input	Phosphorus input
816.18	116.19

Nitrogen export	Phosphorus
83.95	1.81

Residential

Input load

Size (m²)	Percent (%)	Area (ha)	Nitrogen (kg)	Phosphorus (kg)
<400	100	14.81	347.82	101.90
400-500 m²	0	0.00	0.00	0.00
501-600 m²	0	0.00	0.00	0.00
601-730 m²	0	0.00	0.00	0.00
>730 m²	0	0.00	0.00	0.00
Multiple dwellings	0	0.00	0.00	0.00

Total area (ha)	Total percent (%)
14.805	**45**

Nitrogen input (kg)	Phosphorus input (kg)
347.82	**101.90**

Public Open Space (POS)

Landuse	Percent (%)	Area (ha)
Native gardens	61	7.43
Non-native gardens	0	0.00
Not fertilised	0	0.00
Nature	0	0.00
Sport	0	0.00
Recreation	11	1.34
Golf course	0	0.00
Bowling green	0	0.00
Impervious	0	0.00
Water body	28	3.41

Total area (ha)	Total percent (%)
12.17	**37**

Nitrogen input (kg)	Phosphorus input (kg)
296.29	**9.36**

Road reserve

Landuse	Percent (%)	Area (ha)
Roads	100	5.92
Road reserve - impervious	0	0.00
Road reserve - native garden	0	0.00
Road reserve - non-native garden	0	0.00
Road reserve - turf	0	0.00
Road reserve - not fertilised	0	0.00

Total area (ha)	Total percent (%)
5.922	**18**

Nitrogen input (kg)	Phosphorus input (kg)
0.00	**0.00**

Soil and drainage information

Type of drainage	**Subsoil drainage**	**Does it contain imported fill?**	**Yes**
Soil type	**Spearwood Dune**	Type of fill imported	**White sands (Bassendean)**
Depth to groundwater (m)	**2**	Fill depth (m)	**1**
Groundwater slope (%)	**0.5**	Approximate PRI of imported fill	**5**
Soil PRI	**8.0**	**Does subregion contain onsite sewage diposal system?**	**No**

Note: Please attach the results of soil tests to this report when submitting.

Summary: Nutrient stripping devices

Treatment	Name	Size (m²)	Treated area (ha)	Treating	N removed (kg/yr)	P removed (kg/yr)
Biofilter	Catch A 15mm	3800.00	42.30	Sandy soils – Runoff and subsoil drains	44.13	1.19
Detention / infiltration basin	Catch A 1%	21200.00	42.30	Sandy soils – Runoff and subsoil drains	4.19	0.10
Biofilter	Catch B 15 mm	1500.00	16.45	Sandy soils – Runoff and subsoil drains	21.21	0.41
Detention / infiltration basin	Catch B 1%	7800.00	16.45	Sandy soils – Runoff and subsoil drains	1.96	0.03
Biofilter	Catch C 15 mm	1000.00	9.40	Sandy soils – Runoff and subsoil drains	7.90	0.20
Detention / infiltration basin	Catch C 1%	1400.00	9.40	Sandy soils – Runoff and subsoil drains	0.45	0.01

Biofilter	Catch F 15 mm	1700.00	14.10	Sandy soils – Runoff and subsoil drains	24.30	0.38
Detention / infiltration basin	Catch F 1% AEP	12000.00	14.10	Sandy soils – Runoff and subsoil drains	2.92	0.04
Biofilter	Catch G 15mm	1600.00	18.80	Sandy soils – Runoff and subsoil drains	34.80	0.85
Detention / infiltration basin	Catch G 1%	7600.00	18.80	Sandy soils – Runoff and subsoil drains	2.97	0.06
Biofilter	Catch H 15mm	1900.00	30.55	Sandy soils – Runoff and subsoil drains	50.62	1.12
Detention / infiltration basin	Catch H 1%	5400.00	30.55	Sandy soils – Runoff and subsoil drains	3.15	0.05
Biofilter	Catch I 15mm	300.00	2.35	Sandy soils – Runoff only (infiltration on lots)	0.88	0.10
Detention / infiltration basin	Catch I 1%	1000.00	2.35	Sandy soils – Runoff only (infiltration on lots)	0.15	0.01
Biofilter	Catch J 15mm	400.00	4.70	Sandy soils – Runoff only (infiltration on lots)	1.42	0.22
Detention / infiltration basin	Catch J 1%	1600.00	4.70	Sandy soils – Runoff only (infiltration on lots)	0.22	0.02
Biofilter	Catch K 15mm	500.00	9.40	Sandy soils – Runoff only (infiltration on lots)	3.24	0.41
Detention / infiltration basin	Catch K 1%	2800.00	9.40	Sandy soils – Runoff only (infiltration on lots)	0.51	0.03
Biofilter	Catch L 15mm	1000.00	16.45	Sandy soils – Runoff only (infiltration on lots)	5.17	0.75
Detention / infiltration basin	Catch L 1%	5300.00	16.45	Sandy soils – Runoff only (infiltration on lots)	0.83	0.06
Biofilter	Catch M 15mm	2300.00	37.60	Sandy soils – Runoff only (infiltration on lots)	10.31	1.44
Detention / infiltration basin	Catch M 1%	10500.00	37.60	Sandy soils – Runoff only (infiltration on lots)	1.56	0.11
Biofilter	Catch E 15mm	4500.00	32.90	Sandy soils – Runoff and subsoil drains	38.54	0.73
Load removed					**261.42**	**8.32**
Net export					**348.85**	**18.41**

Summary: Nutrient load exports

Region	Area (ha)	P export (kg/yr)	N export (kg/yr)
Catchment A	42.30	3.07	97.15
Catchment B	16.45	1.05	46.67
Catchment C	9.40	0.52	17.34
Catchment F	14.10	0.95	53.12
Catchment G	18.80	2.20	76.68
Catchment H	30.55	3.00	112.70
Catchment I	2.35	0.43	4.83
Catchment J	4.70	1.03	8.10
Catchment K	9.40	2.02	19.18
Catchment L	16.45	3.66	30.26
Catchment M	37.60	6.99	60.30
Catchment E	32.90	1.81	83.95

PRE-TREATMENT LOAD (kg/yr)		LOAD REMOVED (kg/yr)		NET LOAD EXPORT (kg/yr)	
NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS	NITROGEN	PHOSPHORUS
610.27	**26.72**	**261.42**	**8.32**	**348.85**	**18.41**

Treatment diagram



APPENDIX T

Subsoil Guidelines &
DRAINMOD Modelling of Subsoil

Western Australia
IPWEA
INSTITUTE OF PUBLIC WORKS ENGINEERING AUSTRALASIA

Specification
Separation distances for groundwater controlled urban development

Prepared by the
Land development in groundwater constrained landscapes Steering Group

Version 2: February 2016

While every care has been exercised to present accurate data throughout the content of this specification, no responsibility is implied or accepted for claims arising from the use of the information contained herein.

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Deemed to comply criteria

Drainage infrastructure should be designed in accordance with Module 8 of this guideline. In addition, the separation distances in Table 3 apply.

Table 3: Separation criteria for drainage infrastructure

Type of drainage infrastructure	Specification
Underground infiltration systems	0mm from the 50% AEP phreatic surface
Surface infiltration systems (vegetated)	300mm from the 50% AEP phreatic surface
Surface infiltration systems (duel function turf)	Default to Recreation POS standards

Performance measures

Underground infiltration systems – 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).

Surface infiltration systems – None.

4.5 Private spaces

In areas where groundwater is shallow, land that is waterlogged during winter can become muddy and/or inaccessible depending on the amount and type of traffic (pedestrian, vehicular). Development in these landscapes should consider the amenity requirements of the specific urban form proposed.

Deemed to comply criteria

The separation distances in Table 4 apply in the design of private spaces.

Table 4: Separation criteria for private spaces

Type of drainage infrastructure	Specification
Residential lots > 800 m2	No criteria. It is expected that design of lots will include site specific consideration of appropriate levels of amenity.
Residential lots 400 m2 to 800 m2	300mm of coarse sand applied to anticipated garden areas in the rear of lots above the 50% AEP phreatic surface
Residential lots <400 m2	150mm of coarse sand applied to anticipated garden areas in the rear of lots above the 50% AEP phreatic surface

Engineering and Works Services Standards and Specifications

Section 6

Property Development
Technical Requirements and Guidelines
Earthworks, Drainage and Parking

These Standards and Specifications have been adopted by the City, and are required to be applied in the City of Busselton for all property development, earthworks, drainage and parking works designed by Consultants and carried out by Contractors, Developers and the City Staff. These Standards and Specifications will be maintained by the Director, Engineering and Works Services.

Revision No	Date	Section Amended	Prepared	Reviewed
A	December 2009	All	Community Infrastructure	Infrastructure Development
B	June 2013	All	Engineering and Works Services	Development Control

Subsoil drainage will be required to protect property from high ground water levels. Ground water shall be controlled to levels not higher than:

- Top of lowest sub-grade for roads or access ways; and
- 1200mm from top of fill level on urban and industrial lots.

Subsoil drainage shall be designed to address soil percolation, direction of soil water flow, back flooding from stormwater systems, silting and clogging of the filter material and maintenance using high pressure water or cleaning rods. In some circumstances stormwater and subsoil drainage may be combined where it can be shown that surching of soil will not occur. Filter material may be crushed stone (20mm all in) and/or geo-fabric filter.

Reflux valves where required to prevent backflow from an outlet which is flooded shall be of an approved type. Varying water levels occur at outlets - such as tidal outlets may require such a system. Ease of operation, removal and maintenance are basic criteria to be addressed in selection of the type of valve.

Plans submitted shall show how the land can be drained and connected to the district drainage (comprehensive scheme).

A drainage plan is to be submitted showing all details including existing surface and proposed pipe invert levels, development site contours and levels, stormwater soakage and surface disposal areas, soak/detention pits, manholes, gullies, connection point/s, silt trap/s, subsoil drainage, basins and open drains - all with brief specifications.

The plan is to be approved and a bond may be required to ensure compliance, and is to be paid prior to the issue of a Building Licence.

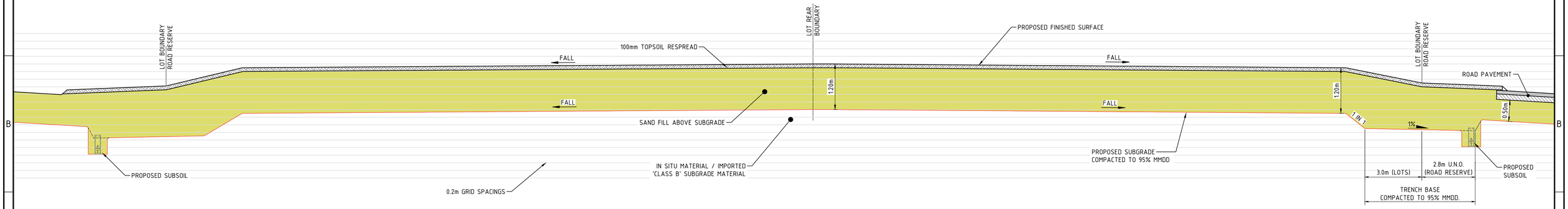
Site drainage may be provided by the installation of a stormwater roof and paved surface pick-up system and directed to the kerb *via* paved surface flow for smaller Lots up to 2000 m^2 and/or to the underground street system by drainage pipe.

Paved Surface Flow - where site conditions are difficult to excavate and/or no drainage system is available; discharge *via* a paved surface (such as kerbed driveways or paths) to the street is allowable. This applies only to small developments.

For service areas involving fuels and oils, food handling, drainage is to be especially trapped or treated prior to entry into the stormwater system approved for the development. Fuels and oils are to be run through a triple interceptor trap prior to discharge.

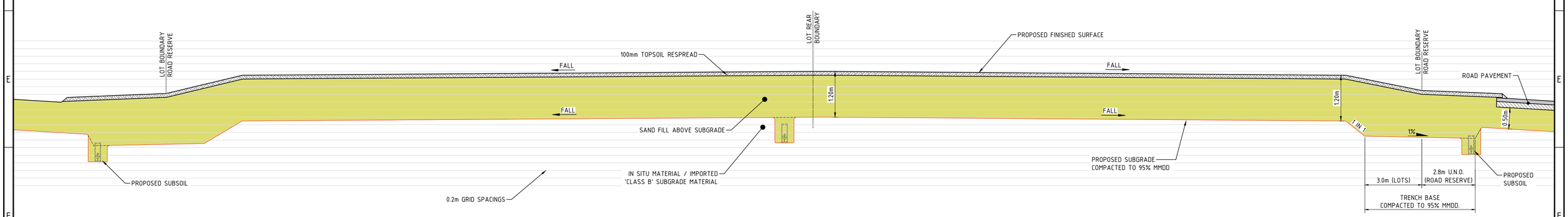
Where discharge to a wetland or public open space/reserve occurs, specific approval may be required by the Department of Environment (DOE) or the Department of Environment and Conservation (DEC) or the City and/or Landgate. A nutrient stripping basin and/or a swaled/grassed disposal pond may be required to be constructed within the development.

A drainage contribution will be required for developments in the Busselton Central Business District (CBD), East Busselton and Dunsborough, to assist with construction of major drainage upgrades in these catchments. The fee schedule for these contributions is available from the City on request.



TYPICAL SECTION WITHOUT REAR SUBSOIL

SCALE HORIZ 1:100
VERT 1:50



TYPICAL SECTION WITH REAR SUBSOIL

SCALE HORIZ 1:100
VERT 1:50

0 1 2 4 6m
SCALE 1:100 @ ORIGINAL SHEET SIZE A1

0 0.5 1 2 3m
SCALE 1:50 @ ORIGINAL SHEET SIZE A1

BEFORE YOU DIG www.byda.com.au

REV	DATE	DRAWN	CHECKED	APPROVED	
A	18.06.25	AP			ISSUED FOR INFORMATION

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NOTE
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CLIENT: embark BUSSELTON

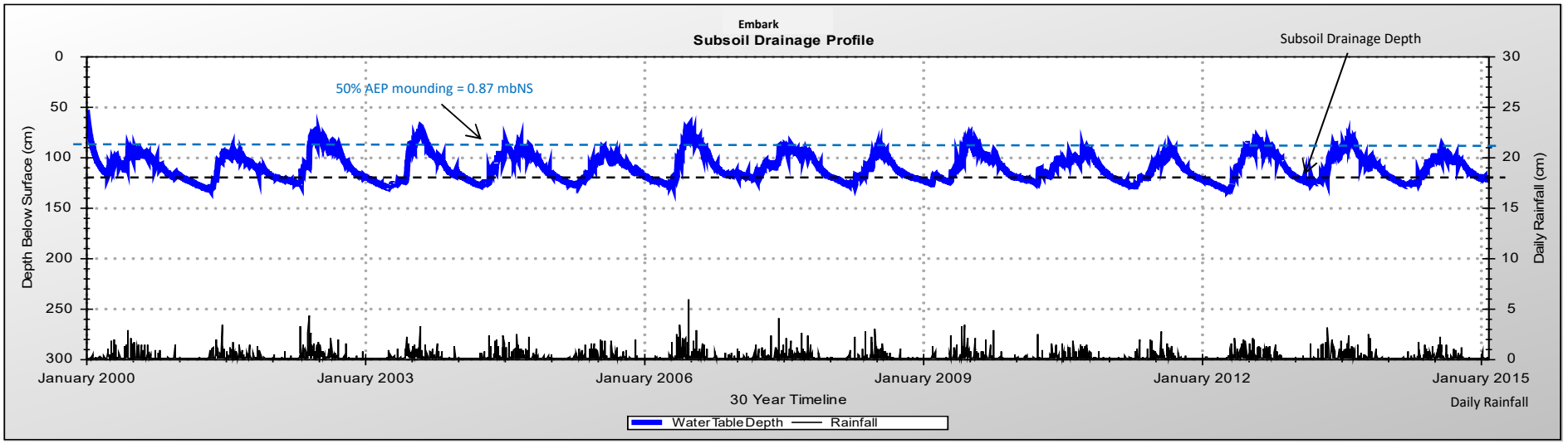
PROJECT: EMBARK, BUSSELTON

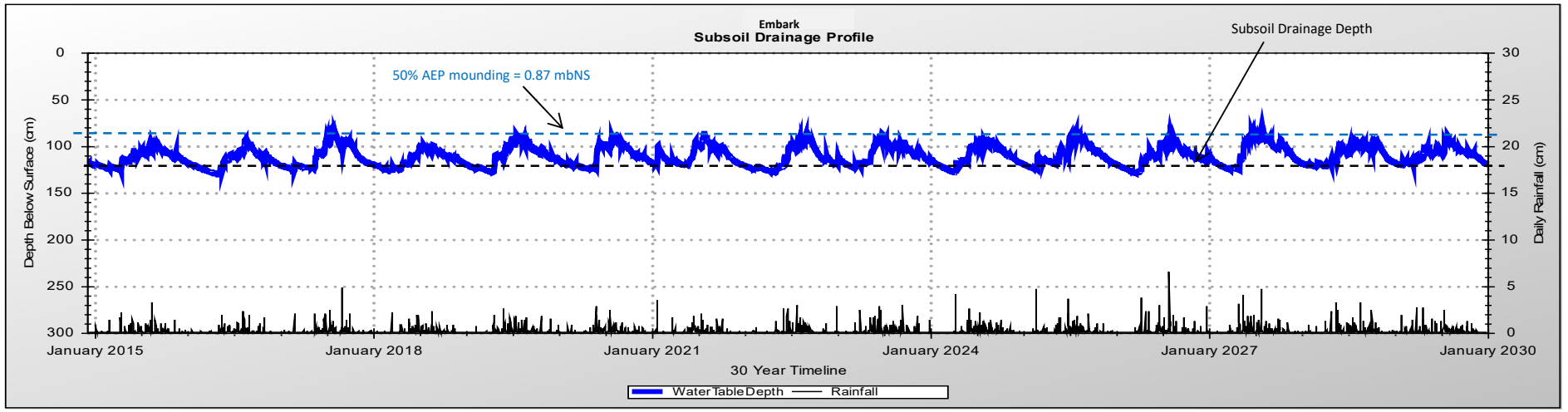
DRAWING TITLE: TYPICAL LOT SAND TRENCH AND SUBSOIL SECTIONS

DRAWN: A. PANZICH	WAPC No.: 200524
DESIGNED: A. PANZICH	SCALE @ A1: 1:100 1:50
PROJECT MANAGER: R. FOWLER	DATUM: AHD / CO-ORDS: BCG94
JDSI PROJECT No.: JDS232179.0	DRAWING No.: SK010 / REVISION: A

Plotted By: APanzich Plot Date: 18/06/25 - 10:32 Cad File: I:\JDS232179\JDS232179.0\02 CIVIL\Drawings\Sketches\JDS232179.0_SK010.dwg

Date :03/04/2025 Job No H22018





KEY ASSUMPTIONS
Subsoil Spacing : 80 m
Soakwells
Assumed Recharge : 80% (Uniform Distribution)
Post Dev Area for ET : 17%
Soil Hydraulic Conductivity : 5 m/day
Depth of Subsoil below Natural Surface: 1.2 m
Rainfall : Median Future Rainfall Scenario via DWER

hyd$_2$o

Lots 2, 9033 & 9034 Bussell Highway Hydrological Investigation

Subsoil Drainage Performance : 30 Year Daily Model

Appendix S

Appendix I

Noise Management Plan

Appendix J

Landscape Strategy

HERRING STORER ACOUSTICS

YOLK PROPERTY GROUP

EMBARK – EAST BUSSELTON ESTATE
PROPOSED
LOCAL STRUCTURE PLAN

BUSSELL HIGHWAY, YALYALUP

ROAD TRAFFIC (SPP 5.4)
NOISE MANAGEMENT PLAN

DECEMBER 2022

OUR REFERENCE: 30433-3-22198

Rochdale Holdings Pty Ltd A.B.N. 85 009 049 067 trading as:
HERRING STORER ACOUSTICS
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DOCUMENT CONTROL PAGE

SPP 5.4 NOISE MANAGEMENT PLAN
EMBARK – EAST BUSSELTON ESTATE

Job No: 22198

Document Reference: 30433-3-22198

FOR

YOLK PROPERTY GROUP

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Author:	Paul Daly	**Checked By:**	Tim Reynolds
Date of Issue:	14 December 2022		

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1	3	Yolk Property Group Attn: Sheldon Day Email: sheldon@yolkpropertygroup.com.au		✓

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A	LSP Concept Plan
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C	Quiet House Design Noise Contour Plot
D	“Quiet House” Design – General Information
E	MRWA Traffic Data

EXECUTIVE SUMMARY

Herring Storer Acoustics were commissioned by Yolk Property Group to carry out an acoustical assessment of noise received at the Local Structure Plan (LSP) stage of the Embark residential development located on Bussell Highway, Yalyalup.

Under the Western Australian Planning Commission (WAPC) Planning Policy 5.4 "Road and Rail Noise" (SPP 5.4), the appropriate criteria for assessment for this development are:

EXTERNAL

$L_{Aeq(Day)}$ of 55 dB(A);
$L_{Aeq(Night)}$ of 50 dB(A).

INTERNAL

$L_{Aeq(Day)}$ of 40 dB(A) in living and work areas; and
$L_{Aeq(Night)}$ of 35 dB(A) in bedrooms.

Additional to the above, noise received at an outdoor living area should also be reduced as far as practicable, with an aim of achieving an L_{Aeq} of 50 dB(A) during the night period.

To ensure compliance with SPP 5.4, the following noise attenuation measures have been provided:

- 3.0m bund at the boundary of the development, facing the Bussell Highway and the Outer Bypass.
- Noise bund, Quiet House Design Package A and Notification on Titles for façade Lots facing / backing on to Bussell Highway.

Any future lots exceeding the 55 dB(A) day target criteria would require Notification on Titles.

Information on the deemed to satisfy constructions for the various "Quiet House Design" packages are contained in Appendix D.

With regards to aircraft noise, as all parts of the Embark residential LSP are not within the stipulate criteria, there are no acoustic requirements for future residential development.

Notes:

1 The summary of the Quiet House Design Packages attached in Appendix C and D, are "Deemed to Satisfy" constructions. Alternative constructions would be acceptable, provided they are supported by an acoustic report prepared by a suitably qualified acoustic consultant.

2 Quiet House Design requirements are likely to lessen for residential premises set back from the highway, as the façade residences will barrier those behind.

1. INTRODUCTION

Herring Storer Acoustics were commissioned by Yolk Property Group to carry out an acoustical assessment of noise received at the Local Structure Plan (LSP) stage of the Embark residential development located on Bussell Highway, Yalyalup.

As part of the study, the following was carried out:

- Determine by noise modelling the noise that would be received at proposed residences within this development from vehicles travelling on the Bussell Highway and the proposed outer bypass in the future.
- Assess the predicted noise levels for compliance with the appropriate criteria.
- Provide detailed information as to noise control requirements such as quiet house design, noise walls and future notification on titles.

Additionally, consideration of aircraft noise from the future Busselton Margaret River Regional Airport on future residences within the estate has been made.

For information, the Concept Structure Plan is attached in Appendix A.

2. CRITERIA

2.1 ROAD TRAFFIC NOISE

The Western Australian Planning Commission (WAPC) released on 6th September 2019 State Planning Policy 5.4 *"Road and Rail Noise".* The requirements of State Planning Policy 5.4 are outlined below.

POLICY APPLICATION (Section 4)

When and where it applies (Section 4.1)

SPP 5.4 applies to the preparation and assessment of planning instruments, including region and local planning schemes; planning strategies, structure plans; subdivision and development proposals in Western Australia, where there is proposed:

*a) noise-sensitive land-use within the policy's trigger distance of a transport corridor as specified in **Table 1**;*

*b) New or major upgrades of roads as specified in **Table 1** and maps **(Schedule 1,2 and 3);** or*

*c) New railways or major upgrades of railways as specified in maps (**Schedule 1, 2 and 3);** or any other works that increase capacity for rail vehicle storage or movement and will result in an increased level of noise.*

Policy trigger distances (Section 4.1.2)

***Table 1** identifies the State's transport corridors and the trigger distances to which the policy applies.*

*The designation of land within the trigger distances outlined in **Table 1** should not be interpreted to imply that land is affected by noise and/or that areas outside the trigger distances are un-affected by noise.*

*Where any part of the lot is within the specified trigger distance, an assessment against the policy is required to determine the likely level of transport noise and management/ mitigation required. An initial screening assessment (**guidelines: Table 2: noise exposure forecast**) will determine if the lot is affected and to what extent."*

TABLE 1: TRANSPORT CORRIDOR CLASSIFICATION AND TRIGGER DISTANCES

Transport corridor classification	***Trigger distance***	***Distance measured from***
Roads		
Strategic freight and major traffic routes *Roads as defined by Perth and Peel Planning Frameworks and/or roads with either 500 or more Class 7 to 12 Austroads vehicles per day, and/or 50,000 per day traffic volume*	*300 metres*	*Road carriageway edge*
Other significant freight/traffic routes *These are generally any State administered road and/or local government road identified as being a future State administered road (red road) and other roads that meet the criteria of either >=23,000 daily traffic count (averaged equivalent to 25,000 vehicles passenger car units under region schemes)*	*200 metres*	*Road carriageway edge*
Passenger railways		
	100 metres	*Centreline of the closest track*
Freight railways		
	200 metres	*Centreline of the closest track*

Proponents are advised to consult with the decision making authority as site specific conditions (significant differences in ground levels, extreme noise levels) may influence the noise mitigation measures required, that may extend beyond the trigger distance.

POLICY MEASURES (Section 6)

The policy applies a performance-based approach to the management and mitigation of transport noise. The policy measures and resultant noise mitigation will be influenced by the function of the transport corridor and the type and intensity of the land-use proposed. Where there is risk of future land-use conflict in close proximity to strategic freight routes, a precautionary approach should be applied. Planning should also consider other broader planning policies. This is to ensure a balanced approach takes into consideration reasonable and practical considerations.

Noise Targets (Section 6.1)

***Table 2** sets out noise targets that are to be achieved by proposals under which the policy applies. Where exceeded, an assessment is required to determine the likely level of transport noise and management/mitigation required.*

In the application of the noise targets the objective is to achieve:

- *indoor noise levels as specified in **Table 2** in noise sensitive areas (for example, bedrooms and living rooms of houses, and school classrooms); and*

- *a reasonable degree of acoustic amenity for outdoor living areas on each residential lot. For non-residential noise-sensitive developments, for example schools and child care centres the design of outdoor areas should take into consideration the noise target.*

It is recognised that in some instances, it may not be reasonable and/or practicable to meet the outdoor noise targets. Where transport noise is above the noise targets, measures are expected to be implemented that balance reasonable and practicable considerations with the need to achieve acceptable noise protection outcomes.

TABLE 2: NOISE TARGETS

Proposals	***New/Upgrade***	***Noise Targets***		
		Outdoor		***Indoor***
		Day (L_{Aeq}(Day) dB) (6 am-10 pm)	***Night (L_{Aeq}(Night) dB) (10 pm-6 am)***	***(L_{Aeq} dB)***
Noise-sensitive land-use and/or development	*New noise sensitive land use and/or development within the trigger distance of an existing/proposed transport corridor*	*55*	*50*	*L_{Aeq} (Day) 40(Living and work areas)* *L_{Aeq} (Night) 35 (bedrooms)*
Roads	*New*	*55*	*50*	*N/A*
	Upgrade	*60*	*55*	*N/A*
Railways	*New*	*55*	*50*	*N/A*
	Upgrade	*60*	*55*	*N/A*

Notes:

- *The noise target is to be measured at one metre from the most exposed, habitable façade of the proposed building, which has the greatest exposure to the noise-source. A habitable room has the same meaning as defined in State Planning Policy 3.1 Residential Design Codes.*

- *For all noise-sensitive land-use and/or development, indoor noise targets for other room usages may be reasonably drawn from Table 1 of Australian Standard/New Zealand Standard AS/NZS 2107:2016 Acoustics – Recommended design sound levels and reverberation times for building interiors (as amended) for each relevant time period.*

- *The 5dB difference in the criteria between new and upgrade infrastructure proposals acknowledges the challenges in achieving noise level reduction where existing infrastructure is surrounded by existing noise-sensitive development.*

- *Outdoor targets are to be met at all outdoor areas as far as is reasonable and practical to do so using the various noise mitigation measures outlined in the guidelines. For example, it is likely unreasonable for a transport infrastructure provider to achieve the outdoor targets at more than 1 or 2 floors of an adjacent development with direct line of sight to the traffic.*

Noise Exposure Forecast (Section 6.2)

*When it is determined that SPP 5.4 applies to a planning proposal as outlined in Section 4, proponents and/or decision makers are required to undertake a preliminary assessment using **Table 2**: noise exposure forecast in the guidelines. This will provide an estimate of the potential noise impacts on noise-sensitive land-use and/ or development within the trigger distance of a specified transport corridor. The outcomes of the initial assessment will determine whether:*

- *no further measures is required;*
- *noise-sensitive land-use and/or development is acceptable subject to deemed-to- comply mitigation measures; or*
- *noise-sensitive land-use and/or development is not recommended. Any noise-sensitive land-use and/ or development is subject to mitigation measures outlined in a noise management plan."*

2.2 AIRCRAFT CRITERIA

AS2021: Acoustics – Aircraft Noise Intrusion-Building Siting and Construction, provides guidelines for determines the type of building construction necessary to provide a given noise reduction, given that external windows and doors are closed.

Additionally, guidance has been sort from *the Busselton – Margaret River Regional Airport Noise Management Plan 2015 (and Draft 2016).*

2.2.1 Building Site Acceptability

AS2021:2015 lists the building types compared to the acceptable ANEF contour in Table 2.1 of AS2021:2015. The applicable building types are reproduced in Table 1 below.

TABLE 1 – ANEF ACCEPTABILITY FOR SITING AND CONSTRUCTION

Building Type	ANEF zone of Site		
	Acceptable	Conditionally Acceptable	Unacceptable
House, home unit, flat, caravan park	Less than 20 ANEF	20 to 25 ANEF	Greater than 25 ANEF

AS2021:2015 *"Acoustics – Aircraft Noise Intrusion-Building Siting and Construction"* provides guidelines for determining the type of building construction necessary to provide a given noise reduction, given that external windows and doors are closed.

Indoor design sound levels for determination of aircraft noise reductions are given as follows:

Sleeping areas	-	50 dB(A)
Other habitable spaces	-	55 dB(A)

For commercial buildings:

Private offices	-	55 dB(A)
Open offices	-	65 dB(A)
Shops, showrooms etc.	-	75 dB(A)
Industrial	-	75 dB(A)

We note that the above noise levels are maximum noise levels.

2.2.2 BUSSELTON MARGARET RIVER REGIONAL AIRPORT NOISE MANAGEMENT PLAN (NMP)

Guidance has been taken from the 2015 noise management plan as well as reference from the 2016 (Draft) noise management plan.

The NMP has been updated (2016) to state that the AS2021:2015 will be utilised for the basis of its (City of Busselton) noise assessments and amelioration process. Hence the above criteria has been referenced.

Additionally, guidance has been taken from the 2015 NMP whereas section *6.2.2 Noise Amelioration as a Noise Reduction Technique* has an action requirement for the N65/20 noise contour ie for 65 dB(A) for >20 events per day.

ANEC 2038-39 (July 2016) Noise contours have been produced and provided for this assessment by the City of Busselton. These contours have been used for comparative purposes of the above criteria.

2.3 APPROPRIATE CRITERIA

Based on the above, the following criteria are proposed for this development:

Road Traffic Noise

External

Day	Maximum of 55 dB(A) L_{Aeq}
Night	Maximum of 50 dB(A) L_{Aeq}

Internal

Sleeping Areas	35 dB(A) $L_{Aeq(night)}$
Living Areas	40 dB(A) $L_{Aeq(day)}$

Additionally, under the policy, noise received at an outdoor area should, where practical, aim to achieve an L_{Aeq} of 50 dB(A) during the night period.

Aircraft Noise

Less than ANEF 20 is acceptable, and reference to Less than the N65/20 noise contour.

3. MONITORING

As the development has been assessed under a previous LSP, there is a history of noise monitoring and assessment for the site. For information, the previous monitoring conducted in 2008 has been referenced for informational purposes, as this was the basis for other assessments.

Additional noise monitoring and measurement has also been undertaken, with continuous monitoring occurring on the same roadway (Capel) in September 2020, and short term confirmation measurements conducted in August 2022 directly adjacent the development site.

Noise logging was conducted on the site over a continuous fourteen-day period commencing Tuesday 22nd April 2008 (part of the previous study) to determine the existing traffic noise levels on the site. The test location was approximately 10m from the nearest running edge of Bussell Highway.

Noise monitoring was also undertaken on the corner of Bussell Highway and Capel Drive in a 110km zone, north of the Embark development between the 8th and 15th September 2020. The test location is approximately 20m from the nearest running edge of Bussell Highway.

Additional to the above continuous monitoring, short term, observed noise measurement were conducted on the 5th August 2022 approximately 10m from the edge of the Bussell Highway. These measurements were directly between the Embark development and Bussell Highway.

The test results are summarised in Table 3.1.

TABLE 3.1: SUMMARY OF MEASURED NOISE LEVELS

Location	Year of Measurement	Distance from Bussell Hwy	Traffic Flow at Time of Measurement	Measured Level dB(A)*	
				$L_{Aeq,\ day\ (6am\ to\ 10pm)}$	$L_{Aeq,\ night\ (10pm\ to\ 6am)}$
Embark Development	2008	10	9,800	60.8	47.0
Embark Development	2022	10	13,346	72.0*	-
Capel Development	2020	20	15,780	70.0	60.2

* Short term, peak noise level

We note that with the difference between the $L_{Aeq,8hr}$ and the $L_{Aeq,16hr}$ being greater than 5 dB(A), achieving compliance with the day period criteria will also achieve compliance with the night period criteria. Therefore, noise modelling was only undertaken for the day period.

For this project, monitoring of the existing road network for the Busselton Outer Bypass is not possible as this section of the bypass has not been constructed. Therefore, as referenced in State Planning Policy 5.4, Appendix 2 Noise Assessment Methodology, under the section *Acceptable Methodologies*, the DEFRA publication has been used to establish the difference between the $L_{A10,18h}$ and the $L_{Aeq,8hr}$ and the $L_{Aeq,16hr}$. This is calculated as 9.9 and 2.2 dB(A) respectively with the formula provided in Table 3.2. It was assumed that these differences would apply in the year 2042.

It is noted that the DEFRA publication is the Method for converting the UK Road Traffic Noise Index $L_{A10,18hr}$ to the EU Noise Indices for Road Noise Mapping, hence is not used to calibrate the modelled noise levels, but rather provide the most critical time period of day or night for the assessment.

TABLE 3.2 – NON MOTORWAY ROADS – CONVERTING L_{A18hr} TO L_{Aeq} VALUES

Indices		Value dB	Difference $L_{A1018hr}$ to L_{Aeq}
L_{A10}	*Based on Soundplan calculated value at façade of development for future traffic volumes*	*62.8*	
$L_{12hr,day}$ (0700 to 1900)	$=0.95*L_{A10,18hr}+1.44$	*61.1*	
$L_{4hr,evening}$ (1900 to 2300)	$=0.97*_{LA10,18hr}-2.87$	*58.0*	
$L_{8hr,night}$ (2300 to 0700)	$=0.9*L_{A10,18hr}-3.77$	*52.8*	*-10.1*
$L_{Aeq,16hr}$ (0700 to 2300)	$=10*log(1/16)*((12*(10^(L_{Day}/10)))+(4*(10^(L_{evening}/10)))$	*60.5*	*-2.3*

Notes:

1. As noise monitoring of existing road traffic noise emanating from Outer Bypass is not possible at this time, as outlined in the Implementation Guidelines, the standard correction of -1.7 dB has been applied to the noise model.

2. We also note that with the difference between the $L_{Aeq,8hr}$ and the $L_{Aeq,16hr}$ being greater than 5 dB(A), achieving compliance with the day period criteria will also achieve compliance with the night period criteria. Therefore, noise modelling was only undertaken for the day period and the results are shown graphically in Appendix B.

4. MODELLING

To determine the requirements of any noise amelioration, acoustic modelling was carried out using the computer program 'SoundPlan'. Acoustic modelling was carried out for road traffic flows 20 years in the future.

TABLE 4.1 - NOISE MODELLING INPUT DATA

Parameter	Bussell Highway	Proposed Future Busselton Outer Bypass
Existing Traffic (2022)	13,346 vpd	N/A
Forecast Volumes (2031) (growth rate of 1.3%pa used to represent worst case scenario)	17,504 vpd	14,500 vpd
Percentage traffic 0600 – 2400 hours (Assumed)	94%	94%
Heavy Vehicles (%) (Assumed)	13.1%	5%
Speed (km/hr)	90 / 110	90
Façade Correction	+ 2.5 dB(A)	+ 2.5 dB(A)
Road Surface	14mm Chip Seal	14mm Chip Seal

*Based on traffic counts north of development.

The future road traffic volumes were based on information provided by the MRWA ROM department (shown in Appendix E) and the traffic maps.

It is noted that it is likely the outer bypass will contain the bulk of the traffic flows for the future, once open. This would reduce the volume of traffic on the Bussell Highway. However, for the purpose of the modelling, it has been assumed both road systems would contain the above traffic flows to provide a conservative assessment.

Other input data for the model included:

- Traffic data from MRWA (https://mrapps.mainroads.wa.gov.au/TrafficMap/)
- Traffic as provided by the MRWA ROM Department, as attached in Appendix E.
- Noise source heights for the three road source strings (Passenger Vehicles, Heavy Vehicles Engine and Heavy Vehicle Exhausts) are +0.5, +1.5 and +3.6m, with a noise correction of -0.8 and -8.0 applied to the heavy vehicles engine and exhaust noise sources.
- Topographical data, with the ground level within the development based on natural ground levels as per surveys conducted.
- A +2.5 dB adjustment to allow for façade reflection.
- Development receiver heights at 1.4m above ground level.
- Future buildings located on the boundary Lots of the development (assumed to be present for future road traffic volumes).
- Calculations based on CoRTN algorithms.
- Other parameter listed in SPP 5.4 as to guidance for modelling road traffic noise / assessment.

To determine the noise that would be received within the development from the future Bussell Highway and outer bypass, acoustic modelling was carried out using the computer program 'SoundPlan'.

The following scenarios were modelled:

1. Current traffic flows for Bussell highway, for calibration purposes.
2. Future traffic volumes for both roadways.

Additional to the above parameters, a 3.0 metre bund has been included for a section of the Outer Bypass. This has been previously identified as being required. Also, rear fencing at a height of 1.8m (standard height) has been included at the façade Lots, backing onto the proposed Outer Bypass.

5. PREDICTED FUTURE NOISE LEVELS

5.1 ROAD TRAFFIC NOISE

As this assessment is based on an LSP, individual Lots have not been included. Therefore, the noise that would be received at the first row of residences located within the proposed development (Locations shown in Figure 5.1) from vehicles travelling along the Bussell Highway and the proposed future Outer Bypass Road has been predicted, with Table 5.1 summarising the results and Appendix B showing the noise contour plot.

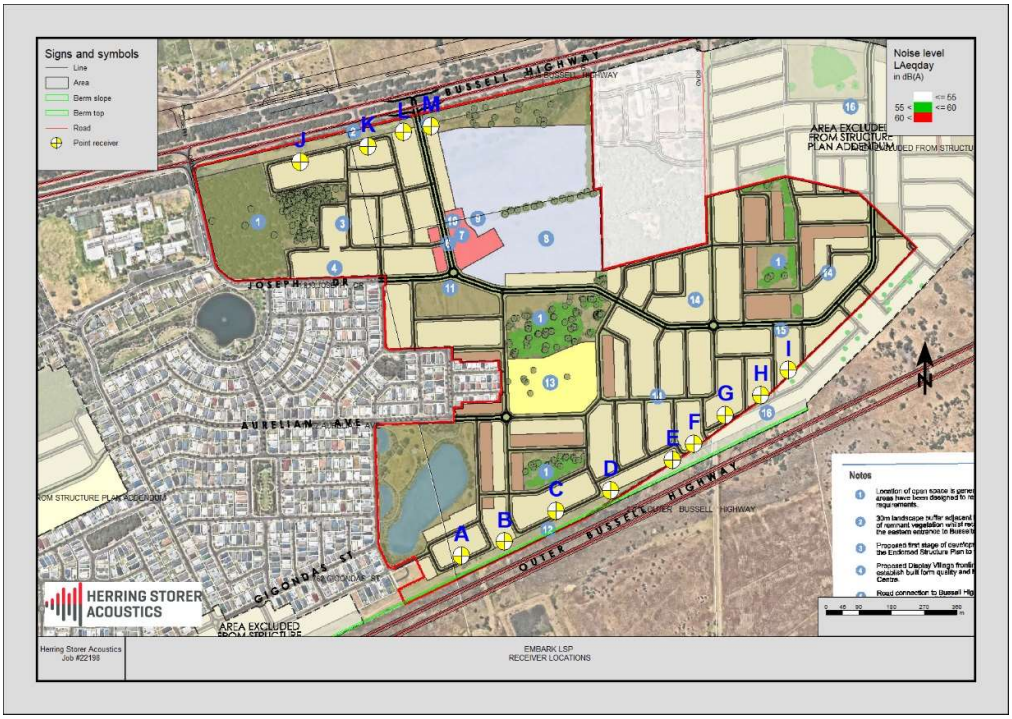


FIGURE 5.1 – LOT RECEIVER LOCATIONS

TABLE 5.1: FUTURE NOISE LEVELS EMBARK LSP

Receiver Reference	Dominant Roadway	Calculated Level dB(A) $L_{Aeq,\ day\ (6am\ to\ 10pm)}$
A	Outer Bypass	54
B	Outer Bypass	54
C	Outer Bypass	54
D	Outer Bypass	54
E	Outer Bypass	54
F	Outer Bypass	54
G	Outer Bypass	54
H	Outer Bypass	54
I	Outer Bypass	54
J	Bussell Highway	60
K	Bussell Highway	60
L	Bussell Highway	62
M	Bussell Highway	62

5.2 AIRCRAFT NOISE

The latest ANEC 2038-39 (July 2016) noise contour plots have been provided by the City of Busselton. These noise contour plots are based on the future noise levels for the upgraded airport operations.

Figure 2 details both the ANEFC and N65 noise contours in relation to the proposed Embark residential estate. For the purpose of this study only the ANEF 20 and N65/20 contours has been referenced.

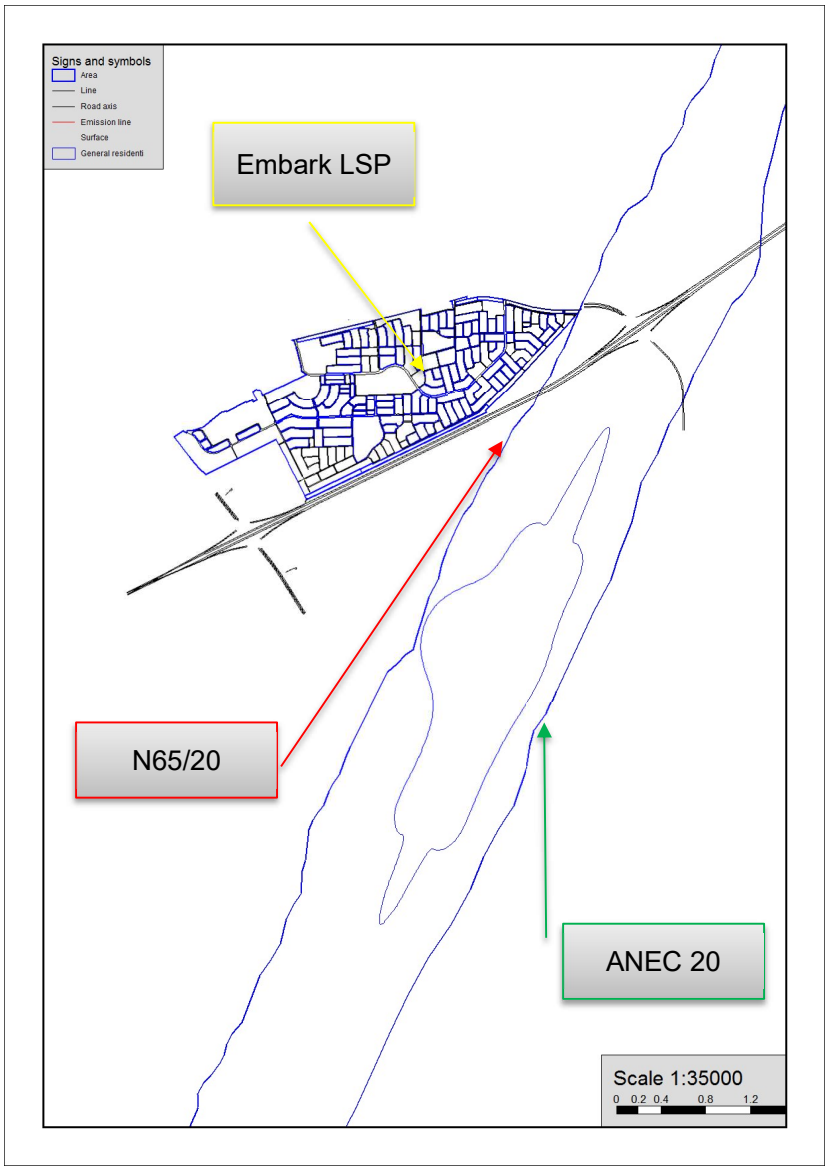


FIGURE 5.2 – FUTURE BUSSELTON MARGARET RIVER REGIONAL AIRPORT – NOISE CONTOURS

6. DISCUSSION

6.1 FUTURE OUTER BYPASS

For future residential Lots effected by noise from the proposed outer bypass, noise levels will be an L_{Aeqday} of 54 dB(A) or less. This is with the inclusion of a barrier in the form of an earthen bund between residence and the proposed bypass.

As the assessable noise level meets the "Target" noise criteria contained in SPP 5.4, there are no further noise mitigation requirements for proposed residence in this area of the LSP.

6.2 FUTURE BUSSELL HIGHWAY

Under the WAPC State Planning Policy 5.4, for this development, the Noise Targets as listed in Table 2 are the appropriate noise levels to be achieved. Based on the noise monitoring, the difference between the $L_{Aeq(16hr)}$ and the $L_{Aeq(8hr)}$ would be greater than 5 dB(A). Therefore, the day period would be the critical period for compliance and if compliance with the day period noise limit is achieved, then compliance with the night period noise limits would also be achieved. The policy states that the outdoor criteria applies to the ground floor level only, however, it also states that noise mitigation measures should be implemented with a view to achieving the target levels in least one outdoor living area.

For residential premises, the Policy states that residence should be designed to meet the following acceptable internal noise levels:

Living and Work Areas	$L_{Aeq(Day)}$ of 40 dB(A)
Bedrooms	$L_{Aeq(Night)}$ of 35 dB(A)

Noise levels are such that there is to be a requirement for quiet house design in the form of Package B, noting that if a barrier was introduced it could be reduced to Package A.

Noise levels would still be above the 55 dB(A) limit, hence notification on title would be required.

Figure 5.1 details the noise level at each proposed Lots and the "Quiet House" design package required to achieve compliance.

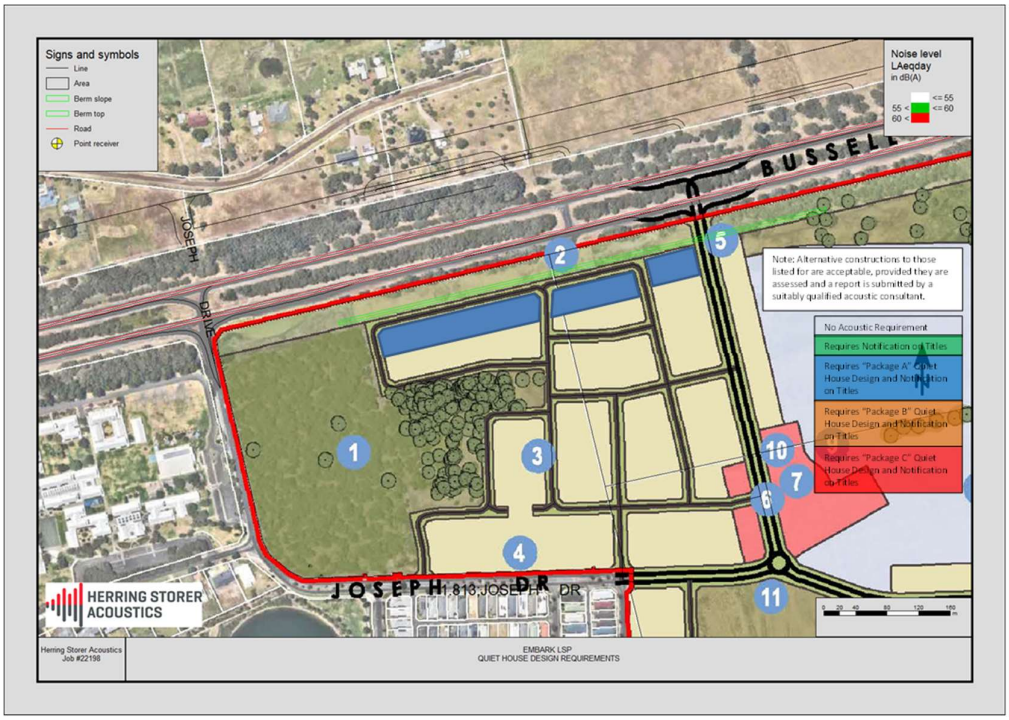


FIGURE 6.1 – QHD REQUIREMENTS

6.3 FUTURE AIRPORT OPERATIONS

In accordance with AS2021:2015, acceptable residential development can be carried out in land less than the ANEF 20 noise contour.

Additionally, the City of Busselton's Noise Management Plan states that no noise amelioration is required for land use less than the N65/20.

As all parts of the Embark residential LSP are not within the stipulate criteria, there are no acoustic requirements for future residential development.

7. CONCLUSION

In accordance with the WAPC Planning Policy 5.4 an assessment of the noise that would be received within the Embark LSP, from vehicles travelling on the future Bussell Highway and the proposed Outer Bypass Road has been undertaken.

In accordance with the Policy, the following would be the acoustic criteria applicable to this project:

External

Day	Maximum of 60 dB(A) L_{Aeq}
Night	Maximum of 55 dB(A) L_{Aeq}

Internal

Sleeping Areas	35 dB(A) $L_{Aeq(night)}$
Living Areas	40 dB(A) $L_{Aeq(day)}$

Additionally, under the policy, noise received at an outdoor area should, where practical, aim to achieve an L_{Aeq} of 50 dB(A) during the night period.

To ensure compliance with SPP 5.4, the following noise attenuation measures have been provided:

- 3.0m bund at the boundary of the development, facing the Bussell Highway and the Outer Bypass.
- Noise bund, Quiet House Design Package A and Notification on Titles for façade Lots facing / backing on to Bussell Highway.

Any future lots exceeding the 55 dB(A) day target criteria would require Notification on Titles.

Information on the deemed to satisfy constructions for the various “Quiet House Design” packages are contained in Appendix D.

With regards to aircraft noise, as all parts of the Embark residential LSP are not within the stipulate criteria, there are no acoustic requirements for future residential development.

Notes:

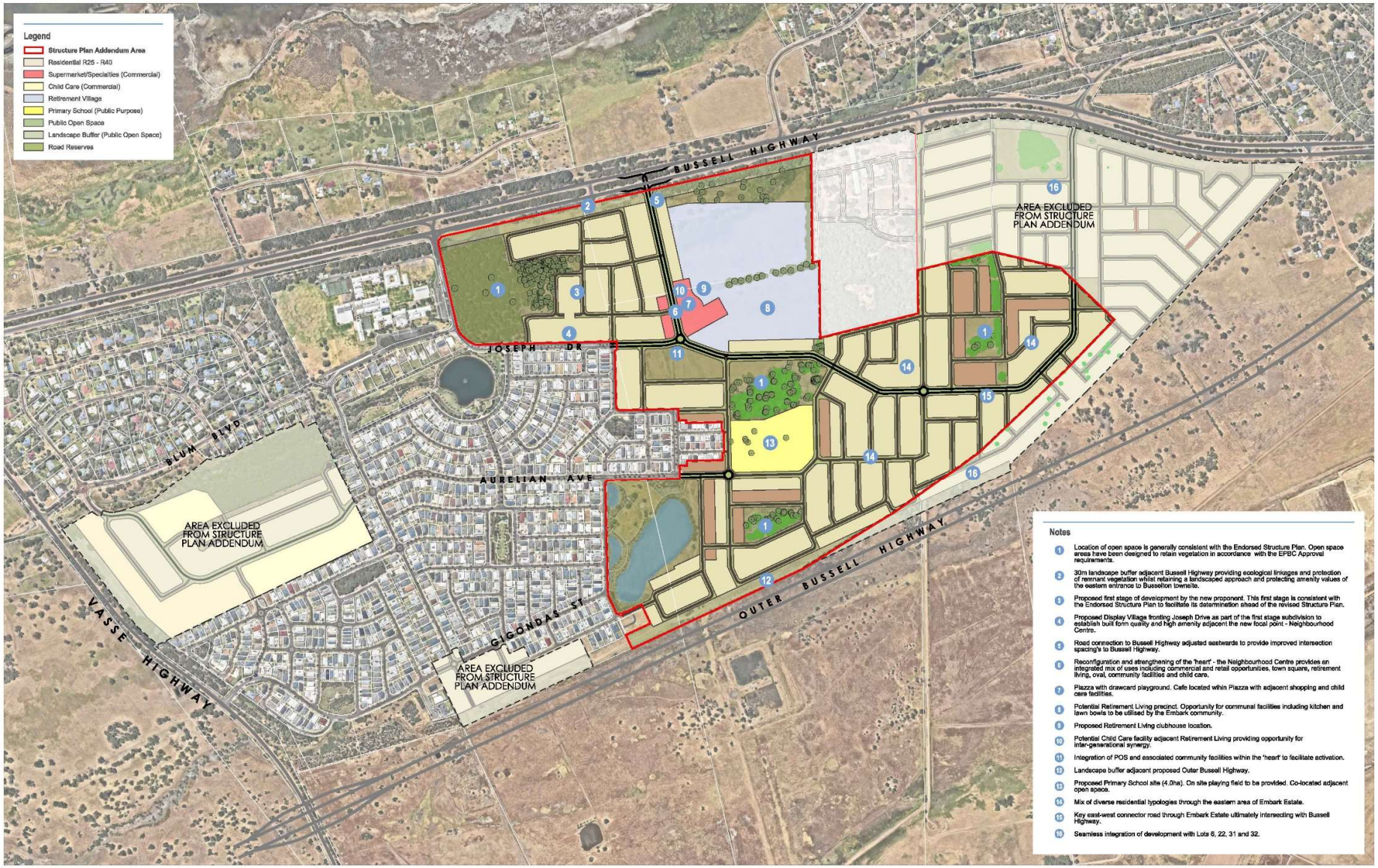
1 The summary of the Quiet House Design Packages attached in Appendix C and D, are “Deemed to Satisfy” constructions. Alternative constructions would be acceptable, provided they are supported by an acoustic report prepared by a suitably qualified acoustic consultant.

2 Quiet House Design requirements are likely to lessen for residential premises set back from the highway, as the façade residences will barrier those behind.

3 Additionally, these residences also require Notifications on Titles when subdivided.

APPENDIX A

PROPOSED LSP



Development Concept Plan - Structure Plan Addendum Area

EMBARK ESTATE, YALYALUP

A Yolk Property Group Project

scale: 1:10,000@A3 | 1:5,000@A1

0 100 200m

plan: 22/010/022A

date: 17/11/2022

aerial: Jan 2022

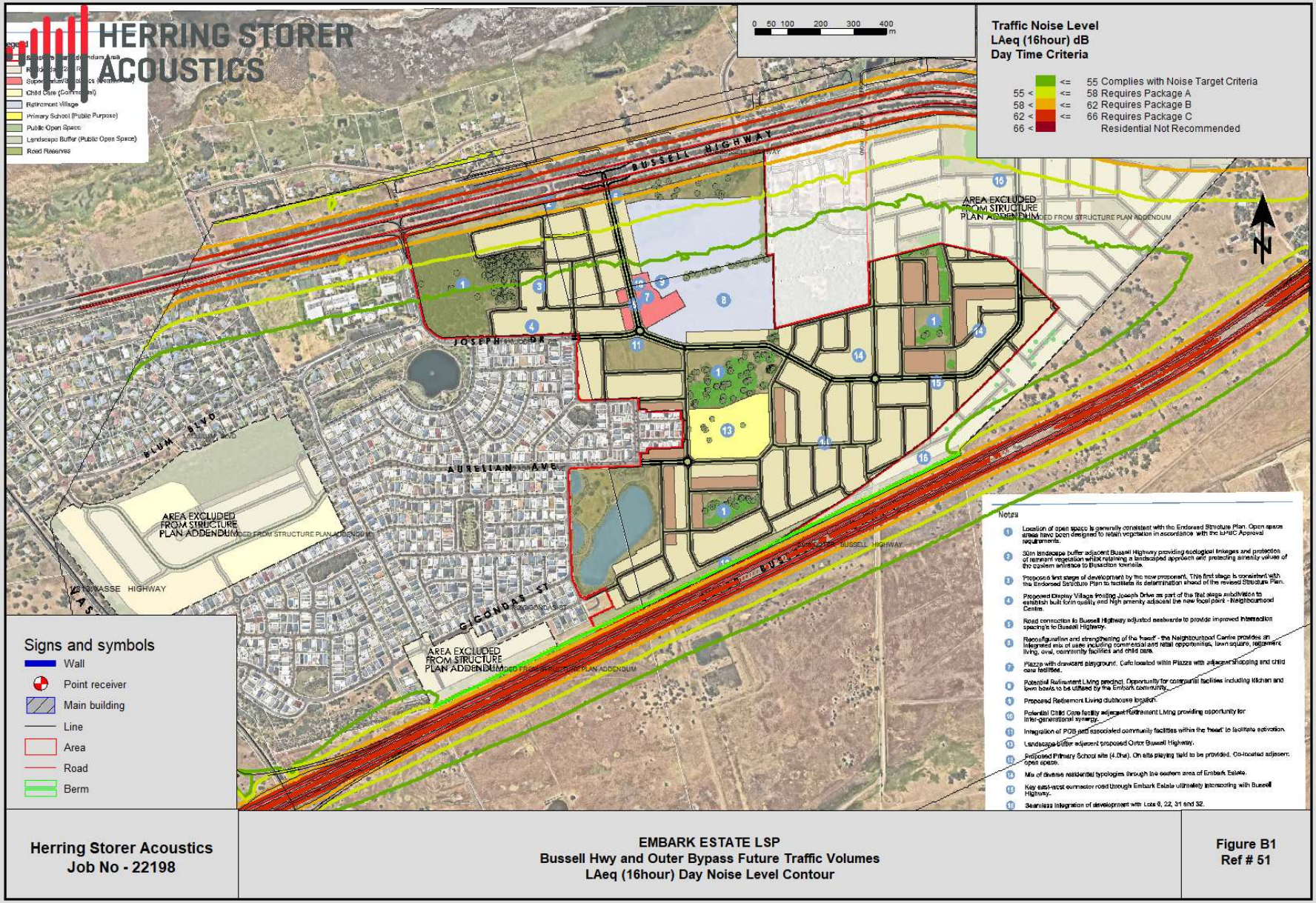
Taylor Burrell Barnett Town Planning & Design
Level 7, 160 St Georges Terrace, Perth WA 6000
e: admin@tbbplanning.com.au
p: (08) 9226 4276

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Taylor Burrell Barnett

APPENDIX B

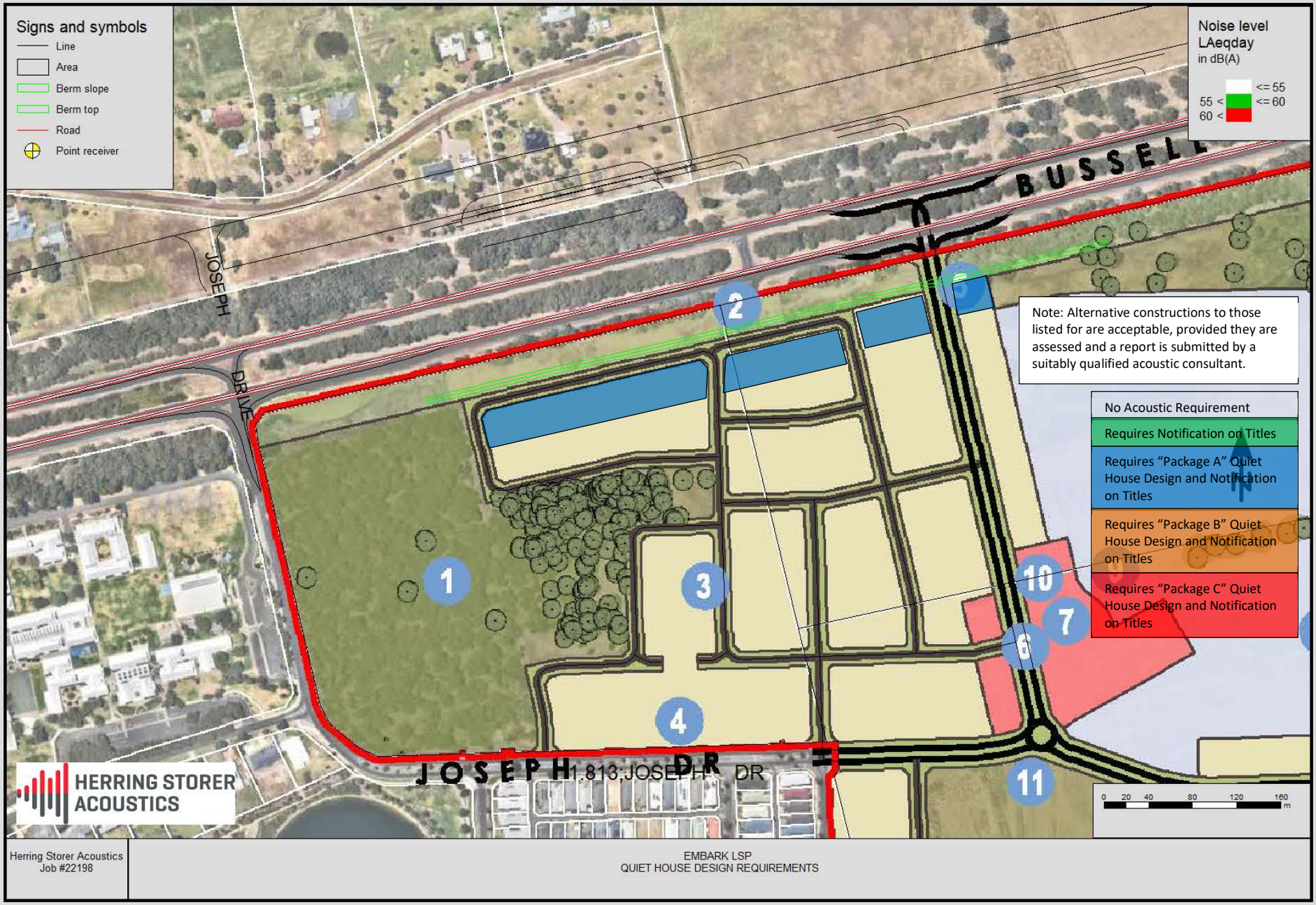
NOISE CONTOUR PLOTS



Herring Storer Acoustics **Job No - 22198**	**EMBARK ESTATE LSP** **Bussell Hwy and Outer Bypass Future Traffic Volumes** **LAeq (16hour) Day Noise Level Contour**	**Figure B1** **Ref # 51**

APPENDIX C

"QUIET HOUSE" DESIGN REQUIREMENTS



Herring Storer Acoustics
Job #22198

EMBARK LSP
QUIET HOUSE DESIGN REQUIREMENTS

APPENDIX D

"QUIET HOUSE" DESIGN PACKAGES

Road Traffic and Passenger Rail
Quiet House Requirements
(*Based on Table 3 of State Planning Policy 5.4 2019*)

Exposure Category	Orientation to corridor	Acoustic rating and example constructions					Mechanical ventilation/air conditioning considerations
		Walls	**External doors**	**Windows**	**Roofs and ceilings of highest floors**	**Outdoor Living areas**	
A **Quiet House A**	**Facing**	**Bedroom and Indoor Living and work areas to Rw + Ctr 45dB** **Stud Frame Walls** ➢ One row of 92mm studs at 60mm centres with: ➢ Resilient steel channels fixed to the outside of the studs; and ➢ 9.5mm hardboard or 9mm fibre cement weatherboards or one layer of 19mm board cladding fixed to the outside of the channels; and ➢ 75mm glass wool (11kg/m3) or 75mm polyester (14kg/m3) insulation, positioned between the studs; and ➢ -Two layers of 16mm fire-protective grade plasterboard fixed to the inside face of the studs. **Brick Walls** ➢ Single leaf of 150mm brick masonry with 13mm cement render on each face: **OR** ➢ Double brick: two leaves of 90 mm clay brick masonry with a 20mm cavity between leaves.	**Bedrooms**: ➢ Fully glazed hinged door with certified **R_w+C_{tr} 28dB** rated door and frame including seals and 6mm glass **Indoor Living and work areas:** ➢ 35mm solid core timber hinged door and frame system certified to **Rw 28dB** including seals**: OR** ➢ Glazed sliding door with 10 mm glass and weather seals	**Bedrooms**: ➢ Total external door and window system area up to 40% of room floor area: Sliding or double hung with minimum 10 mm single or 6mm-12mm-10mm double insulted glazing (**R_w+C_{tr} 28 dB**). Sealed awning or casement windows may use 6 mm glazing instead**: OR** ➢ Up to 60% floor area: as per above but must be sealed awning or casement type windows (**R_w+C_{tr} 31dB**). **Indoor Living and work areas** ➢ Up to 40% floor area: Sliding, awning, casement or double hung with minimum 6mm single pane or 6mm-12mm-6mm double insulted glazing (**R_w+C_{tr} 25dB): OR** ➢ Up to 60% floor area: As per Bedrooms at up to 40% area (**Rw+Ctr28 dB : OR** ➢ Up to 80% floor area: As per Bedrooms at up to 60% area (**R_w+C_{tr} 31 dB**).	**To R_w+C_{tr} 35dB** ➢ Concrete or terracotta tile or metal sheet roof with sarking and at least 10mm plasterboard ceiling	➢ At least one outdoor living area located on the opposite side of the building from the transport corridor and/or at least one ground level outdoor living area screened using a solid continuous fence or other structure of minimum **2 metres** height above ground level	➢ Acoustically rated openings and ductwork to provide a minimum sound reduction performance of **Rw 40dB** into sensitive spaces ➢ Evaporative systems require attenuated ceiling air vents to allow closed windows ➢ Refrigerant-based systems need to be designed to achieve National Construction Code fresh air ventilation requirements ➢ Openings such as eaves, vents and air inlets must be acoustically treated, closed or relocated to building sides facing away from the corridor where practicable
	Side On		As per "Facing" above, except R_w+C_{tr} values may be 3dB less, e.g. glazed sliding door with 10 mm glass and weather seals for bedrooms	As above, except R_w+C_{tr} values may be 3dB less, or max % area increased by 20%			
	Opposite		No specific requirements	No specific requirements			

APPENDIX E

TRAFFIC DATA

mainroads WESTERN AUSTRALIA

SITE 1104

Hourly Volume

Bussell Hwy (H043)

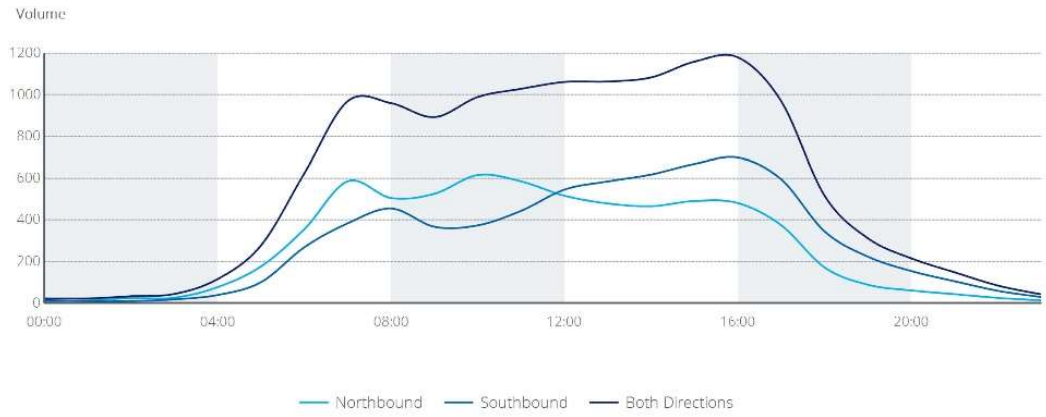
North of Vasse Hwy (SLK 38.11)

2021/22
Monday to Friday

	All Vehicles			Heavy Vehicles			
	NB	SB	Both	NB	SB	Both	%
00:00	8	14	22	3	3	6	27.3
01:00	13	9	22	5	4	9	40.9
02:00	24	9	33	9	4	13	39.4
03:00	26	18	44	8	11	19	43.2
04:00	77	39	116	24	17	41	35.3
05:00	177	101	278	40	20	60	21.6
06:00	356	269	625	60	60	120	19.2
07:00	586	384	970	65	82	147	15.2
08:00	505	455	960	60	82	142	14.8
09:00	526	367	893	63	75	138	15.5
10:00	616	374	990	67	72	139	14.0
11:00	585	444	1029	73	64	137	13.3
12:00	516	546	1062	68	64	132	12.4
13:00	479	585	1064	78	64	142	13.3
14:00	466	618	1084	78	60	138	12.7
15:00	491	669	1160	64	63	127	10.9
16:00	481	699	1180	49	59	108	9.2
17:00	374	594	968	31	42	73	7.5
18:00	171	344	515	18	23	41	8.0
19:00	88	223	311	12	17	29	9.3
20:00	61	154	215	7	9	16	7.4
21:00	43	105	148	7	8	15	10.1
22:00	25	59	84	5	8	13	15.5
23:00	13	29	42	3	3	6	14.3
TOTAL	6707	7108	13815	897	914	1811	13.1

Peak Statistics

AM	TIME	12:00	11:45	11:45	11:00	07:30	07:15
	VOL	616	528	1062	73	88	150
PM	TIME	12:00	15:45	15:30	14:00	15:30	13:00
	VOL	516	712	1210	78	68	142



Paul Daly (Herring Storer Acoustics)

From: Gage Daly
Sent: Wednesday, 14 December 2022 11:20 AM
To: Paul Daly (Herring Storer Acoustics)
Subject: FW: #42474 - Noise assessment for Bussell Hwy and Busselton Bypass, Yalyalup (Chapman Hill Rd to Sues Rd)
Attachments: Surface Detail.H043.43.15.50.02.B.2022-12-12.13-37.444948589.PDF

Kind Regards,

Gage Daly

HERRING STORER ACOUSTICS
Suite 34, 11 Preston St, COMO WA 6152
Tel 9367 6200
Mob 0400 916 512
www.hsacoustics.com.au

From: Thomas Ng <Thomas.Ng@mainroads.wa.gov.au>
Sent: Tuesday, 13 December 2022 11:36 AM
To: Gage Daly <gage@hsacoustics.com.au>
Cc: Wesley Soet <wesley.soet@mainroads.wa.gov.au>; Clare Yu <clare.yu@mainroads.wa.gov.au>
Subject: #42474 - Noise assessment for Bussell Hwy and Busselton Bypass, Yalyalup (Chapman Hill Rd to Sues Rd)

Hi Gage,

Our State Wide Model suggests that the projected compound growth rate is in the order of **1.3%** per annum. Please applied the observed counts from https://trafficmap.mainroads.wa.gov.au/map

Please note that due to the strategic level of network coding, the detail localised development may not be considered in the State Wide model as part of the business-as-usual land use trend case.

Current road surface information is attached for your reference. Let me know if you have any other questions.

Thank you.

Kind regards,
Thomas Ng
Transport Modelling Analyst
Planning and Technical Services
p: +61 8 93236366
w: www.mainroads.wa.gov.au

mainroads WESTERN AUSTRALIA
We're working for Western Australia.



PHASE 0. **LANDSCAPE STRATEGY**

LD TOTAL

FOR YOLK PROPERTY GROUP

DECEMBER 2024

Project	EMBARK
Report Title	EMBARK Phase 0 - Landscape Strategy
Author(s)	LD Total - Landscape Architectural Department
Review By	Sheldon Day - Strategic Planning & Development Manager
For Client	Yolk Property Group Level 2 Atwell Arcade, 3 Cantonment St, Fremantle WA 6160
Issue Date	13.10.2024
File Location	U:\0PROJECTS\Embark (All Projects)\10.7096 Provence Estate - Phase 0\ 4 Tech work area\4.6 Embark_Phase0

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Document to be printed at A3 landscape double sided with binding to short side.

REVISION	ISSUE FOR	DATE
REV A	DRAFT - For Review	2.12.2022
REV B	DRAFT - For Review	16.12.2022
REV C	For Submission	18.01.2023
REV D	Amendments to POS 10	19.04.2023
REV E	Revised Lot layout and updated drainage volumes	14.10.2024

STRATEGY 0. INTRODUCTION
Framework + Objectives

STRATEGY 1. BACKGROUND
Local Context
Existing Site Character

STRATEGY 2. LANDSCAPE VISION + MASTER PLAN
Vision: Landscape Objectives + Place Drivers
Master Plan
Site Diagrams: Analysis + Strategies
CoB POS Hierarchy + Assets
Stormwater + Drainage

STRATEGY 3. IRRIGATION SCHEDULE
Bore and Mainline Strategy
Overall Irrigation Schedule



The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.

Marcel Proust







Embark is an established estate located approx. 4km from Busselton, and 175km south from Perth Metropolitan Area.

The 178 hectare site, is one of the region's strategic urban infill sites with impressive lake views, and adjacent forests, coastal wetlands and the Busselton coast line. The development is an extension of existing Provence Estate, established and expanding new amenities for growing communities.

This Landscape Strategy sets a framework for Embark journey ahead, represents a relaunch of the estate under new management.

Unique site with existing trees results in the evolution of strong timeless guidelines.

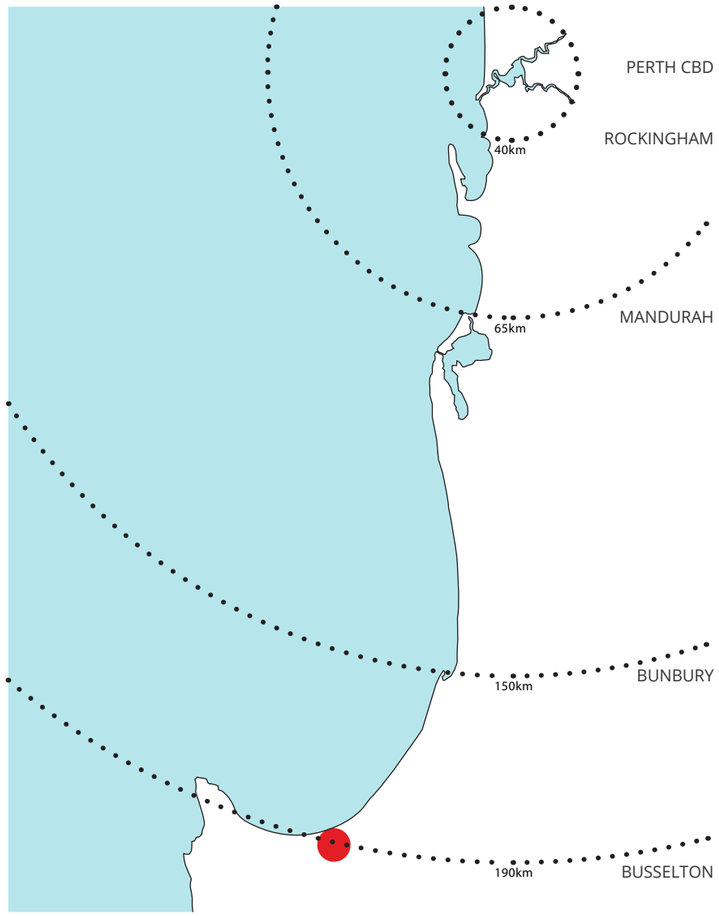
OBJECTIVES

Embark Landscape Strategy is intended to be an overall guide to create a unique sense of place, focusing on engagement with natural wealth of the "Down South" Region, while retaining connections with existing form and function of the site.

FRAMEWORK + OBJECTIVES

STRATEGY 0. INTRODUCTION

© LD TOTAL 2022



SOUTH WEST CONTEXT



LOCAL CONTEXT

LOCAL CONTEXT

STRATEGY 1. BACKGROUND

LD TOTAL

© LD TOTAL 2022

Embark will be a new strategic development within the City of Busselton. It is composed of significant public open spaces that will create a range of new social and community infrastructure to the region.

FLORA



FAUNA









EXISTING SITE CHARACTER

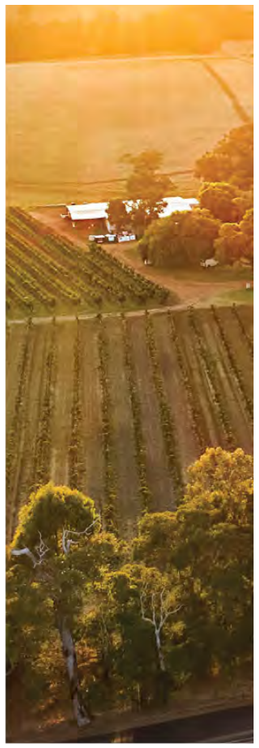
STRATEGY 1. BACKGROUND

LD TOTAL

© LD TOTAL 2022

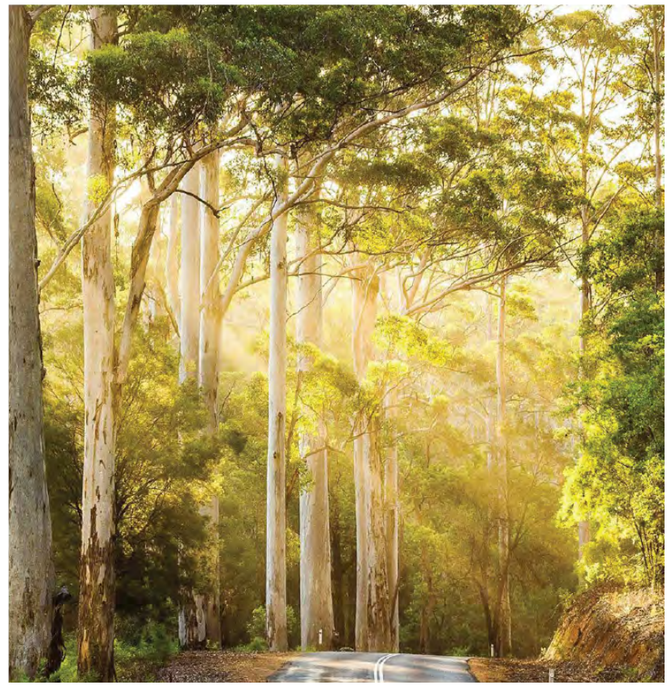












VISION: LANDSCAPE OBJECTIVES + PLACE DRIVERS

© LD TOTAL 2022

Landscape Master Plan

Embark, Busselton



embark
BUSSELTON

Legend

1. Existing Public Open Space
2. Future Public Open Space
3. Southern buffer - Revegetated noise bund and access trail
3. Northern Corridor - 45m Revegetated vegetation buffer
4. Conservation Public Open Space
5. Open Water Body (Existing)
6. Sewer Pump Station
7. Creek and Seasonal Drainage Flow Corridor (opportunity for pedestrian network and crossings in Wetland and Conservation POS)

Land Use

- Proposed Future Residential Lots
- (A) Supermarket/Specialties (Commercial)
- (B) Townsquare (Commercial)
- (C) Retirement Village
- (D) Primary School (Public Purpose)
- (D) Future Pump house

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton.
Road reserve boundary and existing trees to be confirmed with additional feature survey.

YOLK PROPERTY GROUP

LD TOTAL

CLIENT **YOLK PROPERTY GROUP** PROJECT NO **10.7096** REVISION **F** DATE **17.10.2024** SCALE **1:5000 @ A1**

0 50 100 250m

NORTH

CONSERVATION AREAS AND POSSUM HABITAT

Embark
Busselton



DIAGRAM 4. WESTERN RINGTAIL POSSUM CORRIDORS

- Western Ringtail Possum Habitat Corridor/POS
- Key Connected Street Tree Corridor
- Public Open Space
- POS areas with Enclosed habitat

KEY POSSUM HABITAT AND CORRIDOR ACTIVITIES
The key activities to creating and maintaining the Possum habitat are to be carried out as per the WRPMP prepared by RPS group. The key activities within the landscape establishment are below:

- Areas have been Identified where existing western ringtail possum habitat occurs and additional habitat areas are proposed to be incorporated into or adjacent these areas to preserve and increase connectivity of the western ringtail possum habitat.
- These habitat areas and corridors will be maintained by the developer for 2 years after installation and then by council ongoing
- Clearing or modification of natural vegetation and/or trees will not be permitted unless approved by the City of Busselton, or other governmental statutory authority
- Street and POS tree plantings will be predominantly of Peppermint and Eucalyptus trees
- The following habitat corridors to allow the movement of western ringtail possums:
  - East–west habitat corridor linking western POS area and western ringtail possum habitat located to the west of the structure plan.
  - 30m vegetated buffer (plus a vegetated 15 m road reserve) along the northern boundary of the site adjacent Bussell Highway.
  - 30 m vegetated buffer along the southern boundary of the site.
  - North–south corridors will be provided throughout the site through a combination of street plantings, road and verge treatments, lot design and landscaping on future lots, using predominantly native peppermint tree (Agonis flexuosa).
- Implement appropriate weed control within habitat and POS areas.
- Dead trees and fallen logs will not be removed from the POS areas.
- Provide enclosure via appropriate fencing for habitat areas

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REVEGETATION AND CONSERVATION AREAS

Embark
Busselton

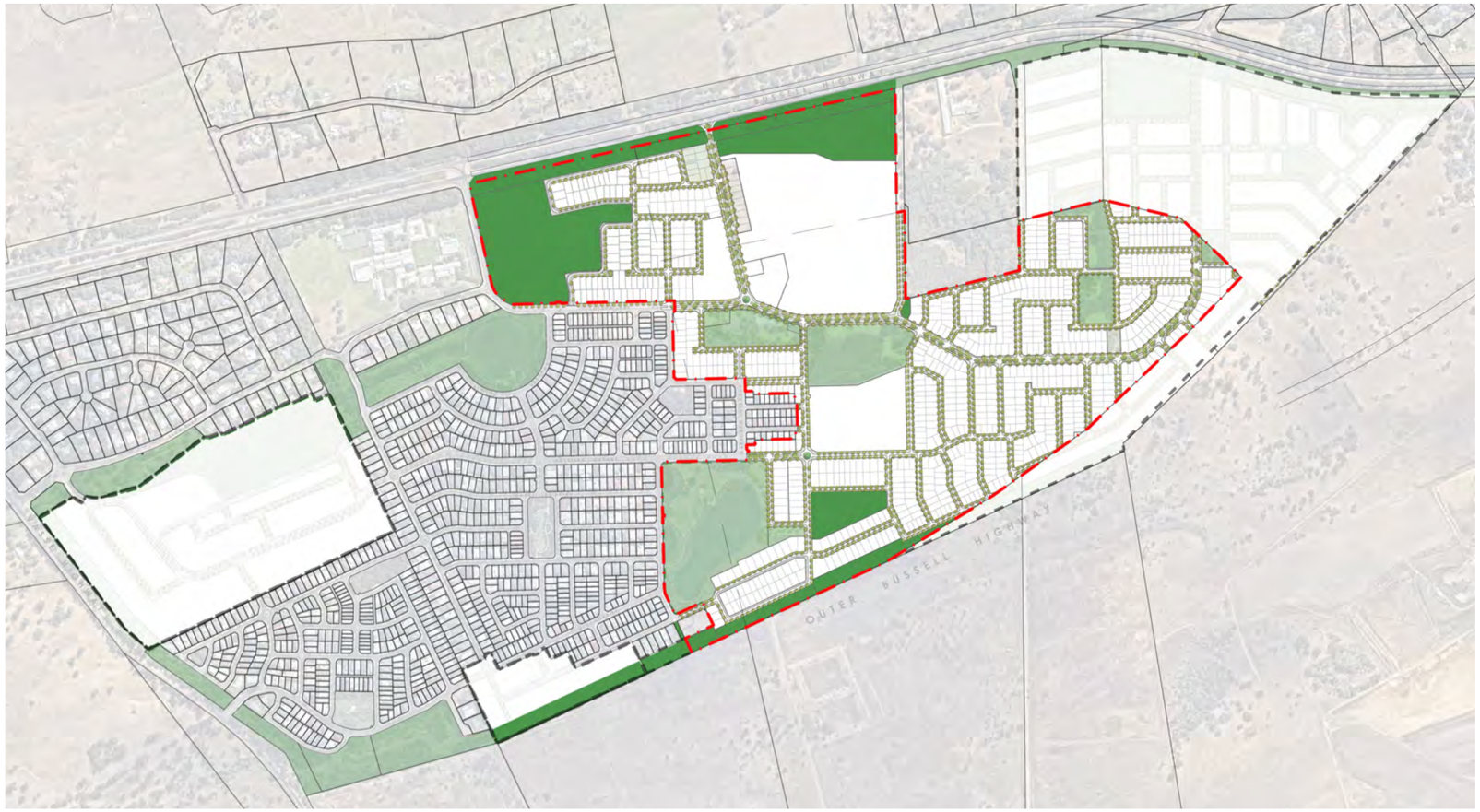


DIAGRAM 5. WESTERN RINGTAIL POSSUM CORRIDORS

Revegetation areas - works commenced as of 2024 to be carried out staged as per development areas

Key Connected Street Tree Corridor- works commenced as of 2024 to be carried out staged as per development areas

The key activities and principles for revegetation activities are below:
These activities have the overarching emphasis on providing successful habitat to the Western Ringtail population and provide residents connection to a natural environment. Detailed documentation to the City of Busseltons standards and requirements will be supplied for review and approval for each area as the staged roll out is carried out.

- The planting species selection across is proposed - these species are locally endemic and to be sourced from local provenance.
- Planting stock are to be planted at the earliest time in Autumn/winter to make the most of the rain season. Supplementary watering is proposed during warmer months for establishment to ensure viability.
- Temporary/permanent Kangaroo fencing and rabbit guards are to be employed to ensure stock survival
- Conservation fencing to be employed in the conservation habitat areas to discourage regular access and prevent vehicles and domestic pets accessing the area.
- Maintenance and seasonal top up planting will occur to the city's satisfaction to ensure adequate survival and coverage rates are met.

Proposed planting list for revegetation areas
The below species are to be installed at the following rates:
Tubestock - 1/m2
Reeds and wetland species - 2/m2
Trees - 1/10m2

BOTANICAL NAME	COMMON NAME	MATURE HT (m)
TREES		
Acacia saligna		
Agonis flexuosa		
Corymbia calophylla		
Eucalyptus cornuta		
Eucalyptus decipiens		
Eucalyptus gomphocephala		
Eucalyptus marginata		
Eucalyptus rudis		
Melaleuca cuticilaris		
Melaleuca hueglii		
Melaleuca preissiana		
Xylomelum occidentale		
SHRUBS & GROUND COVERS		
Acacia applanata		
Acacia cochlearis		
Acacia cyclops		
Acacia extensa		
Acacia incurva		
Acacia lasiocarpa		
Acacia littorea		
Acacia pulchella		
Acacia stenoptera		
Adenanthos obovatus		
Allocasuarina humilis		
Atriplex cinerea		
Banksia attenuata		
Banksia nivea		
Baumea arthrophylla		
Beaufortia sparsa		
Billardiera variifolia		
Calothamnus lateralis		
Calothamnus sanguineus		
Dampiera linearis		
Daviesia physodes		
Diplolaena dampieri		
Dryandra nivea		
Eremophila glabra		
Euchilopsis linearis		
Eutaxia virgata		
Gompholobium capitatum		
Gompholobium confertum		
Gompholobium tomentosum		
Grevillea obtusifolia		
Grevillea vestita		
Hakea ceratophylla		
Hakea lissocarpha		
Hakea ruscifolia		
Hakea sulcata		
Hakea varia		
Hardenbergia comptoniana		
Hemiandra pungens		
Hibbertia amplexicaulis		
Hovea trisperma		
Hovea trisperma var. trisperma		
Hypocalymma angustifolium		
Hypocalymma robustum		
Kennedia carinata		
Kennedia coccinea		
Kennedia prostrata		
Kunzea micrantha		
Melaleuca incana		
Melaleuca pauciflora		
Melaleuca thymoides		
Melaleuca uncinata		
Melaleuca viminea		
Myoporum parvifolium		
Nemcia capitata		
Olearia axillaris		
Pericalymma ellipticum		
Philotheca spicata		
Phyllanthus calycinus		
Pimelea ferruginea		
Pimelea rosea		
Pultenaea reticulata		
Regelia ciliata		
Scaevola crassifolia		
Scaevola nitida		
Solya heterophylla		
Sphaerolobium medium		
Taxandria parviceps		
Viminaria juncea		
REEDS / SEDGES		
Austrostipa semibarbata		
Baumea juncea		
Baumea riparia		
Baumea vaginalis		
Burchardia multiflora		
Carpobrotus virescens		
Conostylis aculeata		
Conostylis candicans		
Dianella revoluta var. divaricata		
Dichopogon preissii		
Ficinia nodosa		
Gahnia trifida		
Haemodorum sparsifolium		
Isolepis cernua		
Juncus kraussii		
Juncus pallidus		
Juncus pauciflorus		
Juncus subsecundas		
Lepidosperma gladiatum		
Lepidosperma squamatum		
Lobelia alata		
Myriophyllum echinatum		
Patersonia occidentalis		
Patersonia umbrosa var. xanthin		
Spinifex longifolius		
Stylidium schoenoides		
Tetrarrhena laevis		
Thysanotus multiflorus		

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SITE DIAGRAMS: ANALYSIS + STRATEGIES

Embark
Busselton



DIAGRAM 1. STREET HIERARCHY + CONNECTIVITY

- Existing high traffic roads
- Existing bus stop
- Neighborhood connector roads
- Local access streets
- Existing neighborhood connector roads
- Key green boulevard/link for pedestrian and cycling access

WAYFINDING AND ENTRIES

- Entry statement - main gateway
- Entry statement - artwork/landmark
- Entry statement - wall + signage

LAND-USE

- Commercial/Town centre
- Aged care
- Primary School co-located with DOS
- Public open space

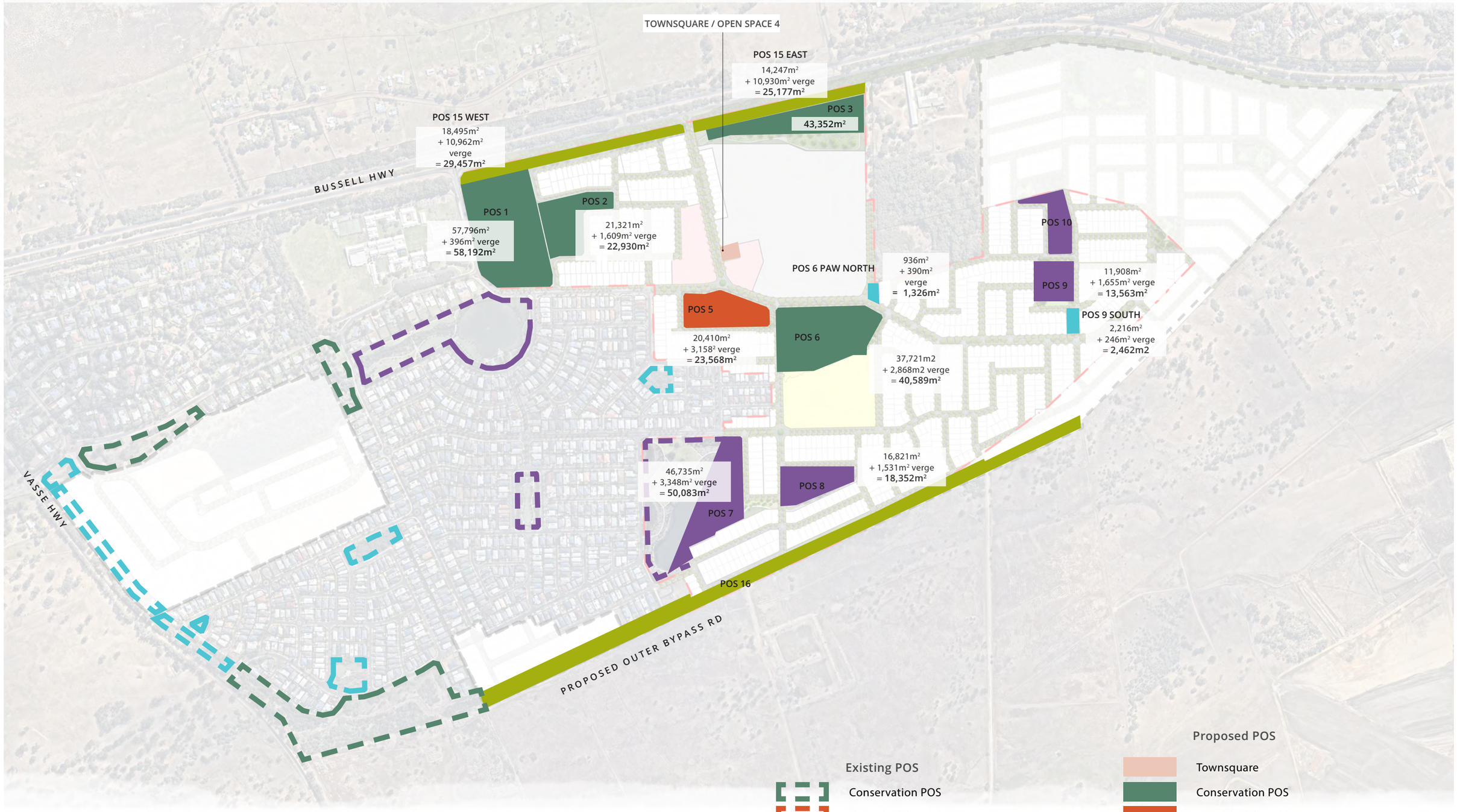
STRATEGY 2. LANDSCAPE VISION + MASTER PLAN

LD TOTAL

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POS LANDSCAPE TYPOLOGY

Embark
Busselton



NOTE:
Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

Existing POS
- Conservation POS
- District POS
- Neighborhood POS
- Local POS
- Landscape Buffer

Proposed POS
- Townsquare
- Conservation POS
- District POS
- Neighborhood POS
- Local POS
- Landscape Buffer

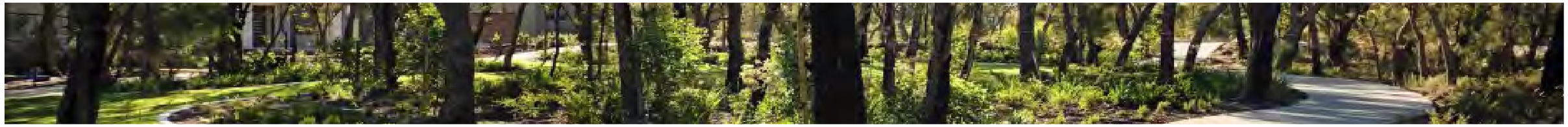
STRATEGY 2. LANDSCAPE VISION + MASTER PLAN

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POS HIERARCHY AND ASSETS

Embark
Busselton



CONSERVATION PUBLIC OPEN SPACES

KEY POINTS

- Usually 1ha to approx 7ha in size
- Predominantly revegetation and restoration areas
- Areas to provide a setting for connection to the natural environment and habitat for local fauna and ecology
- Seating nodes and shelters used strategically adjacent shared pathways and informal trails invite the user to enjoy the natural settings
- Conservation habitat areas to be enclosed

MINIMUM REQUIREMENTS

- Minimal earthworks, retention of existing trees and establishment of habitat areas
- 3m wide vehicle access gates for maintenance, service and emergency vehicles (includes fire access)
- Cement stabilised limestone track/trail surfacing.
- Benches/Seating (to be off access track and on concrete pad).
- Pedestrian access control gates (where appropriate).
- Conservation fencing.

POS 1

- External pedestrian paths
- Retention of existing trees and addition tree plantings
- Endemic native planting and understorey habitat planting
- No earthworks
- Maintenance access gates and informal trails
- Conservation fencing

POS 2

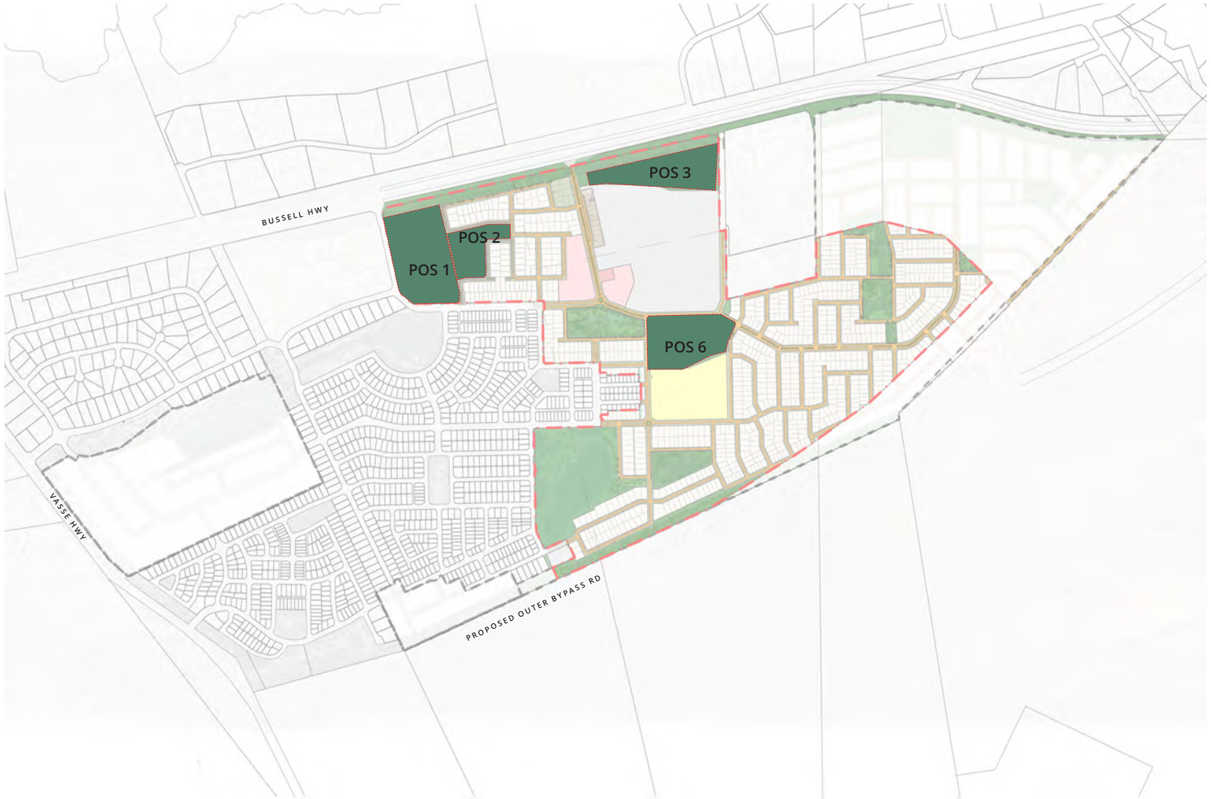
- Pedestrian footpaths and informal trails
- Endemic native planting and understorey habitat planting
- Retained vegetation & existing topography where possible
- Bench seats, lawn areas and shade structure
- Drainage infiltration basin
- Conservation fencing

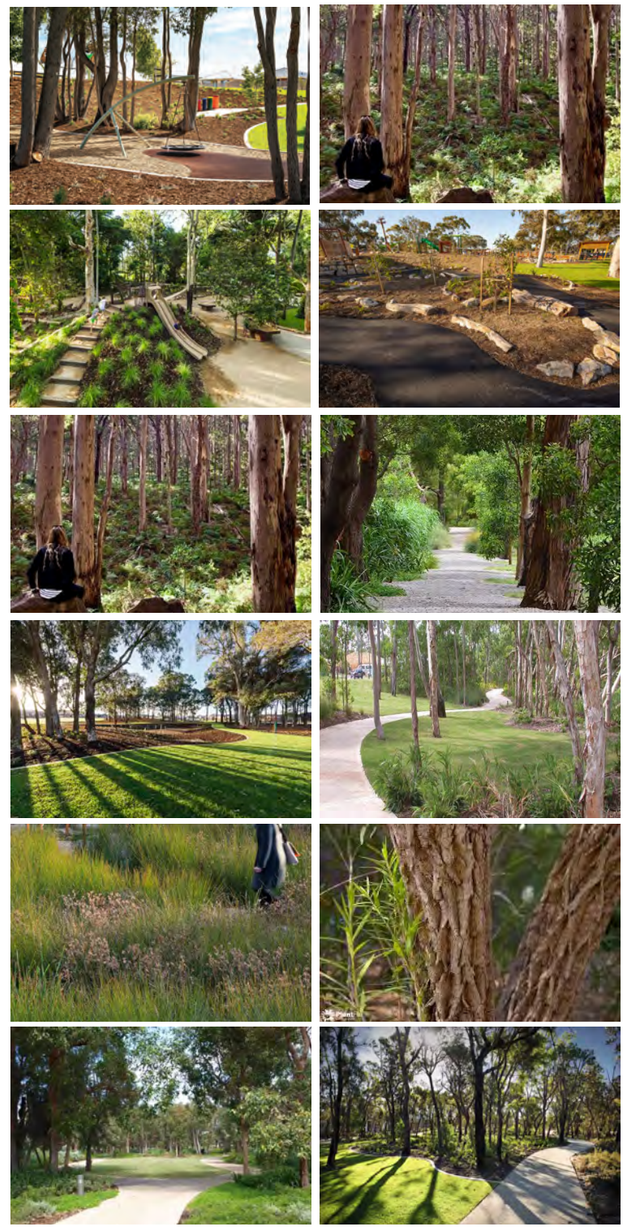
POS 3

- Bench seats and small boardwalk crossing
- Pedestrian paths and informal trails
- Endemic native planting and understorey habitat planting
- Drainage basins and swales

POS 6

- Pedestrian paths and informal paths
- Small nature play area
- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Bench seats, picnic setting and shelter
- No earthworks
- Maintenance access gates and informal trails
- Conservation fencing





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POS HIERARCHY AND ASSETS

Embark
Busselton





TOWNSQUARE

KEY POINTS

- Urban Piazza/plaza town square
- A meeting space to support the immediate commercial area and surrounding community
- Potential event space
- Day/Night activities

MINIMUM REQUIREMENTS

- Clear site lines and CPTED design principles
- Places to rest and pause
- Shaded urban areas
- easy access to buildings with landscape amenity to support functional operations
- Community activated area
- Blend of Hardscape surfaces and soft landscaping, trees and lawn
- Adequate seating and shaded spaces
- Bike parking, bins, drink fountains etc to support
- Feature lighting
- Vehicle accessible for maintenance and events activation

TOWNSQUARE

- Piazza paved community areas
- Native and exotic planting, lawn
- Shade structure and seating nodes
- Drinking fountain, bike racks and bins
- Public art
- Access required for maintenance, service,and emergency vehicles
- Lighting



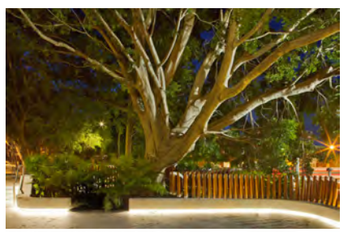
DISTRICT PUBLIC OPEN SPACES

KEY POINTS

- Active POS with sports fields
- Regional adventure playground skate park
- The park provides a large active recreational space to both Embark residents and neighboring school.
- Provides play area for all ages, BBQ facility, shade shelter and, exercise nodes
- Key views are to be emphasised and CPTED principles used to ensure sitelines
- Many native trees provided for shade for park users
- Pathways are positioned to the perimeter of the park for walkers, prams, and running, cycling and catering for all mobility levels
- Toilet facilities if required.
- Community Artwork/sculpture located at key 'entry statement' and visually creates a way finding/ signage point.

POS 5

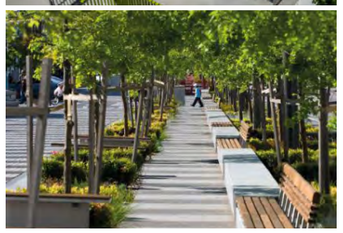
- Feature landmark artwork
- Formal park entry with signage, feature seating, bike parking
- Large kick-about lawns with sports goals
- Buffer verge planting and street trees, widened footpaths to accommodate running, bikes and pedestrians
- Shaded community meeting place with interpretive paving and artwork elements
- Enclosed basketball/multi-sports court with low tired seating areas
- Shade structure, BBQ areas, seating and picnic settings
- Adventure playground with landmark themed play tower, flying fox, pendulum swing, enclosed junior play area, bouldering and climbing features
- Nature-play area located amongst woodland area - winding discovery trails, fallen log, rope and loose parts play, interpretive and educational signage
- Teenage hangout space
- Skate, scoot and bmx park with large shade structure areas
  - Revegetated woodland areas with winding trails, seating and picnic areas



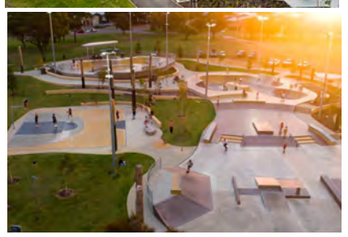










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POS HIERARCHY AND ASSETS

Embark
Busselton



NEIGHBOURHOOD PUBLIC OPEN SPACES

KEY POINTS

- Usually 1ha to 3ha in size
- Comprised of native vegetation beds, lawn and tree zones
- Includes amenities such as shelters, play spaces, small kick-about area, paths and barbeque's
- A mix of active and passive recreation spaces
- Incorporation of basin areas within POS

POS 7

- Neighborhood POS partly constructed
- Existing waterbody - Aurelian Lake
- Shade play area, shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks (existing amenities)
- Continuation of pedestrian paths
- Additional planting to waters edge and native gardens

POS 8

- Shelter, picnic settings, bench seats, BBQ, drinking fountain, bike racks
- Shaded Play area, swings & slides
- Pedestrian paths and trails
- Turf areas
- Retained native vegetation, revegetation ares and enclosed habitat areas with conservation fencing

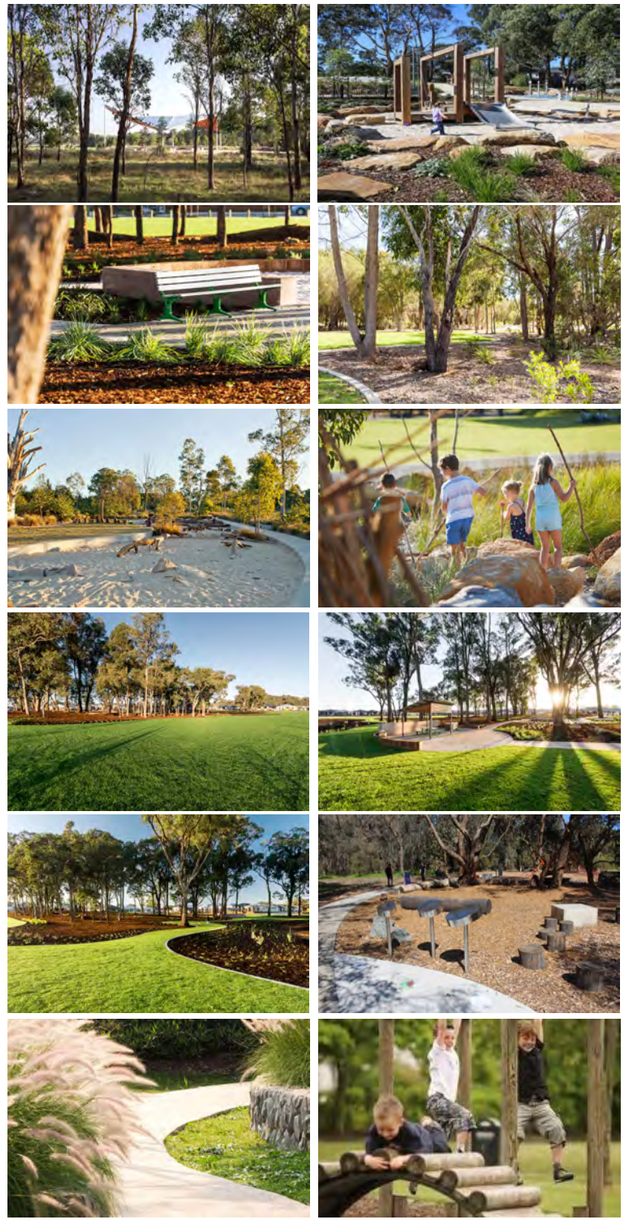
POS 9

- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Shaded play area
- Bench seats, shelters
- Turf area
- Pedestrian paths and informal trails

POS 10

- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Shaded play area
- Bench seats, shelters
- Turf area
- Pedestrian paths and informal trails







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POS HIERARCHY AND ASSETS

Embark
Busselton



LOCAL PUBLIC OPEN SPACES

KEY POINTS

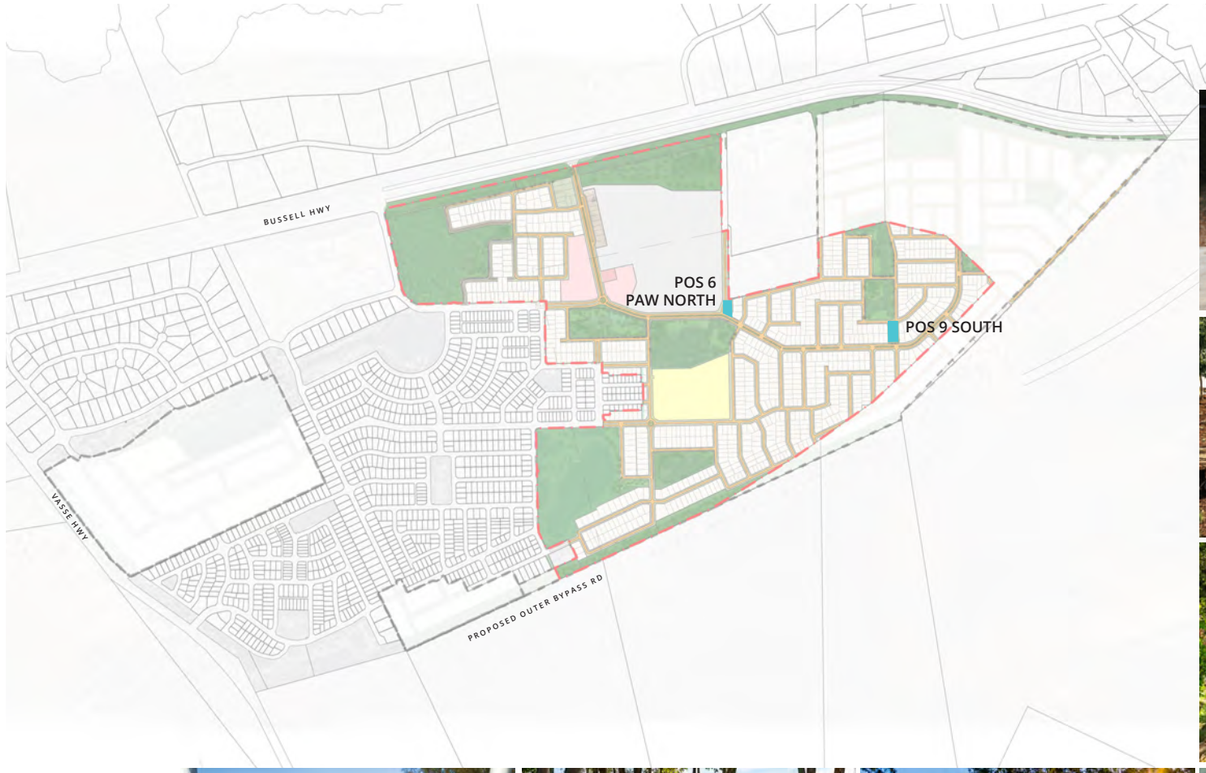
- from 1,500m2 to 1,5ha - Medium sized open space
- Smaller scale local area destination to provide passive recreation or small scale play options
- Retained vegetation & existing topography where possible
- Drainage areas to be incorporated

POS 6 - PAW North

- Native planting
- Pedestrian path to Commercial/Retirement Village
- Bench seating
- Retained trees and minimal earthworks

POS 9 SOUTH

- Native planting and revegetation area
- Retained vegetation & existing topography where possible
- Small nature play and a bench seat
- Turf areas
- Pedestrian path



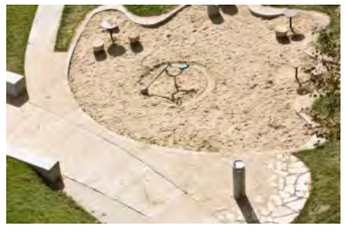




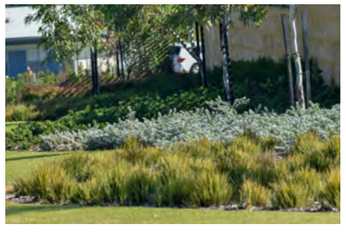






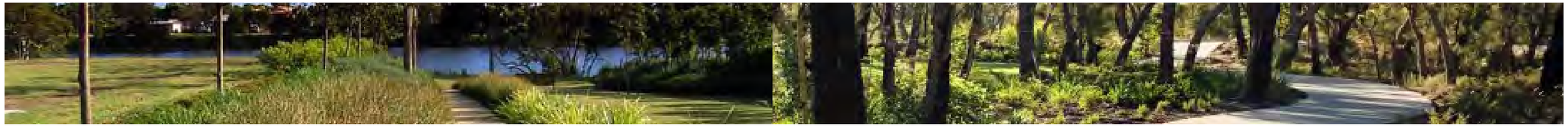


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POS HIERARCHY AND ASSETS

Embark
Busselton



LANDSCAPE BUFFER / BUND PUBLIC OPEN SPACES

KEY POINTS

- Linked green corridors for habitat, sound attenuation and revegetation areas
- Retain existing trees and provide additional habitat

MINIMUM REQUIREMENTS

- Revegetation to be undertaken in accordance with the WRPMP (western ringtail possum management plan)
- Provide maintenance access

POS 15

- Landscape Buffer
- Tree and shrubs to be retained retention
- Endemic revegetation to create habitat corridor
- Pedestrian and cycle links
- Bench seats
- Maintenance access

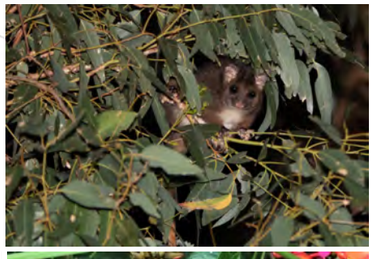
POS 16

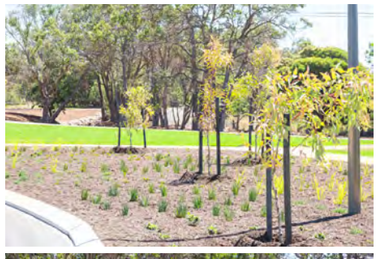
- Landscape Buffer
- Tree and shrubs to be retained retention
- Endemic revegetation to create habitat corridor
- Pedestrian and cycle links
- Bench seats
- Maintenance access
- Linear 3m tall sound attenuation bund to be revegetated



















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STORMWATER AND DRAINAGE PLAN - 01

Embark
Busselton



NOTE: Diagram and base is indicative only. Refer to UWMP for detailed hydro modeling results. POS civil and landscape detail design will determine final layout of proposed stormwater storage basins and road swales.

Subdivision layout is indicative only. POS Design is subject to detailed design, budget allocation and approval with City of CoB. Road reserve boundary and existing trees to be confirmed with additional feature survey. POS design subject to water allocation.

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SOFTSCAPE

Embark
Busselton

POS AREAS

Agonis flexuosa
WA Peppermint

Eucalyptus marginata
Jarrah





Corymbia calophyla
Marri

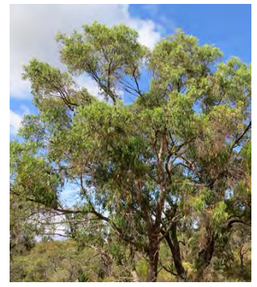
Banksia attenuata
Slender Banksia





Eucalyptus gomphocephala
Tuart

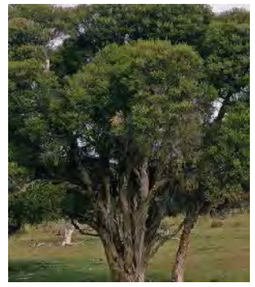
Melaleuca hueglii
Chenille Honey-myrtle





Melaleuca preissiana
Stout Paperbark

Eucalyptus rudis
Flooded Gum





TREE AND PLANTING SELECTION

Vegetation, rehab planting, swale, buffer and POS planting will be provided in a staged manner as the development stages are executed. The detail design and softscape selections, densities and sizes will be issued to City of Busselton for Review for each area prior to installation and in a timely fashion to allow securing of suitable and adequate stock and avoid significant substitutions.

Wherever possible a significantly bio-diverse planting palette of endemic species will be selected to suit the particular microclimate conditions and specific soils in each locale.

Planting selections will prioritise habitat, seasonality, robustness and suitability to the area

SHRUBS

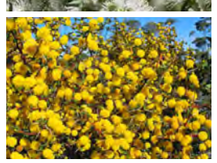
Acacia cochlearis
Coast Wattle

Melaleuca incana
Grey Honey Myrtle

Acacia pulchella
Prickly Moses



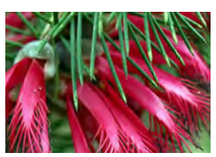




Calothamnus sanguineus
Silky leaved blood flower

Pericalymma ellipticum
Swamp teatree

Xanthorrhoea preissii
Grasstree





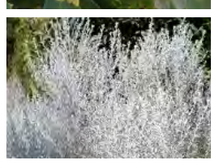


Hakea varia
Variable leaved hakea

Olearia axillaris
Coast Daisy Bush

Scaevola crassifolia
Cushion Fanflower







Patersonia occidentalis
Purple flag

Calothamnus sanguineus
Silky leaved blood flower

Gompholobium tomentosum
Hairy yellow pea







Grevillea crithmifolia
Fine-Lweaved Grevillea

Myoporum insulare
Coastal Boobialla

Conostylis candicans
Grey Cottonheads



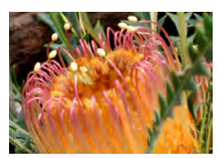




Banksia nivea
Honeypot dryandra

Anigozanthos manglesii
Red & Green Kangaroo Paw

Dampiera linearis
Common Dampiera







GROUND COVERS

Hypocalymma robustum
Swan River Myrtle

Myoporum parvifolium
Creeping boobialla

Melaleuca huegelii
Chenille Honey-Myrtle







BIOFILTERS / DRAINAGE

TREES

Eucalyptus gomphocephala
Tuart

Agonis flexuosa
WA Peppermint

Eucalyptus rudis
Flooded Gum







Melaleuca lanceolata
Rottnest Tea Tree

Melaleuca preissiana
Moonah

Melaleuca rhaphiophylla
Freshwater paperbark







SEDGES

Ficinia nodosa
Knotted Club Rush

Juncus pallidus
Pale Rush

Lepidosperma gladiatum
Coastal Sword Sedge

Patersonia occidentalis
Purple Flag









WATER TOLERANT SHRUBS

Eremophila glabra
Tar Bush

Hakea prostrata
Harsh Hakea



Hypocalymma angustifolium
White Myrtle

Kunzea micrantha
Kunzea

STRATEGY 3. SOFTSCAPE PALETTE

LD TOTAL

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STREET TREE MASTER PLAN

Embark
Busselton

TREE SELECTION

Street trees have been selected for their form, height and relationship to existing trees focusing on WA native species and deciduous trees away from waterbodies.

Tree spacing relates to the scale and use of the street and the desire to create a shaded micro-climate that encourages walking and reduces heat island effects. Generally, wider road reserves are planted with larger tree species. The design of the streetscapes has been primarily driven by the proposed boulevard 'green' spine of Embark with median swale, Western Ringtail Possum habitat and wildlife linkage, and public open space relationships.

NOTE: Design is subject to detailed design, budget, water allocation and approval with City of Busselton. Road reserve boundary and existing trees to be confirmed with additional feature survey.



Agonis flexuosa
WA Peppermint



Corymbia calophyla
Marri



Eucalyptus marginata
Jarrah



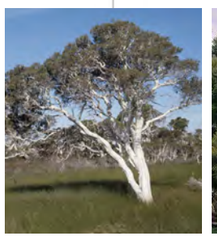
Eucalyptus gomphocephala
Tuart



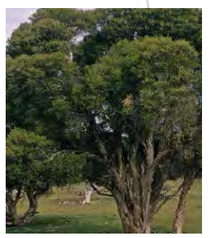
Nuytsia floribunda
WA Christmas Tree



Melaleuca cuticularis
Salt Water Paperbark



Melaleuca preissiana
Stout Paperbark



Eucalyptus rudis
Flooded Gum



Eucalyptus victrix ' Little
Dwarf Ghost Gum



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BORE AND MAINLINE STRATEGY

Embark
Busselton



STRATEGY 5. IRRIGATION STRATEGY

LD TOTAL

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OVERALL IRRIGATION SCHEDULE

Embark
Busselton

EMBARK
IRRIGATION SCHEDULE

1 October 2024

Water Licenses
GWL160990 Leederville bore (34,300 kL)
GWL157168 Yarragadee bore (168,300kL)

PUBLIC OPEN SPACE	Total area m2	POS Type	Irrigation rate (kL/ha/yr)	Irrigated Area (m²)	% Irrigated Long-term	Turf m2	Long-term (Turf) volume (kL/yr)	% Irrigated (Planting) Establishment	Planting m2	Establishment (Planting) volume (kL/yr)	Responsibility
POS 1 (only verges are irrigated)	58,129	Conservation Park		2,093	0.60%	349	235	3%	1,744	1,177	Developer
POS 2 (only verges are irrigated)	22,930	Conservation Park		4,815	15%	3,440	2,322	6%	1,376	929	Developer
POS 3	43,352	Conservation Park		15,173	5%	2,168	1,463	30%	13,006	8,779	Developer
Townsquare (Open Space 4)	2,500	Townsquare		2,625	40%	1,000	675	65%	1,625	1,097	Developer
POS 5	23,568	District POS		17,676	50%	11,784	7,954	25%	5,892	3,977	Developer
POS 6	40,589	Conservation Park		20,295	20%	8,118	5,480	30%	12,177	8,219	Developer
POS 6 PAW North	1,326	Local Park		1,193	10%	133	90	80%	1,061	716	Developer
POS 7	50,083	Neighbourhood Park		27,546	30%	15,025	10,142	25%	12,521	8,452	Developer
POS 8	18,352	Neighbourhood Park		11,011	30%	5,506	3,716	30%	5,506	3,716	Developer
POS 9	13,563	Neighbourhood Park		8,138	30%	4,069	2,747	30%	4,069	2,747	Developer
POS 9 South	2,462	Local Park	6,750.0	1,354	10%	246	166	45%	1,108	748	Developer
POS 10	19,527	Neighbourhood Park		9,764	20%	3,905	2,636	30%	5,858	3,954	Developer
POS 11	31,819	Neighbourhood Park		15,910	20%	6,364	4,296	30%	9,546	6,443	Developer
POS 12	6,256	Local Park		3,754	20%	1,251	845	40%	2,502	1,689	Developer
POS 13	8,560	Local Park		5,136	20%	1,712	1,156	40%	3,424	2,311	Developer
POS 14 West	7,176	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 14 Central	30,365	Landscape Buffer		0	0%	0	0	0%		0	Developer
POS 14 East	26,351	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 15 East	25,177	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 15 West	29,457	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 16	65,181	Landscape Buffer		0	0%	0	0	0%	0	0	Developer
POS 17 (only verges are irrigated)	74,454	Conservation Park		745	0%	0	0	1%	745	503	Developer
TOTAL POS m2	601,177			147,225.93			43,921.08			55,456.42	

MAIN DISTRUBTORS / COLLECTORS	Total length (linear meter)	Street Type (refer LSP)	Irrigated area (m²)		% Irrigated (Planting) Establishment		Establishment (Planting) volume (kL/yr)	Responsibility
Streetscapes - Main Boulevard (median / roundabouts)	2,700	District Distributor B	13,500		100%		9,113	Developer
TOTAL	2,700.00		13,500.00				9,112.50	

TOTAL POS + Streetscapes Irrigation for turf and planting establishment **108,490** (kL/Yr)

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LD TOTAL

Head Office Perth

172 Burswood Road, Burswood, WA 6100
(08) 6436 1111

Bunbury

7 Mason Street, Bunbury, WA 6230
(08) 9725 6555

Melbourne

10 Thomas Street, Yarraville, VIC 3013
(03) 9548 3283

Gold Coast

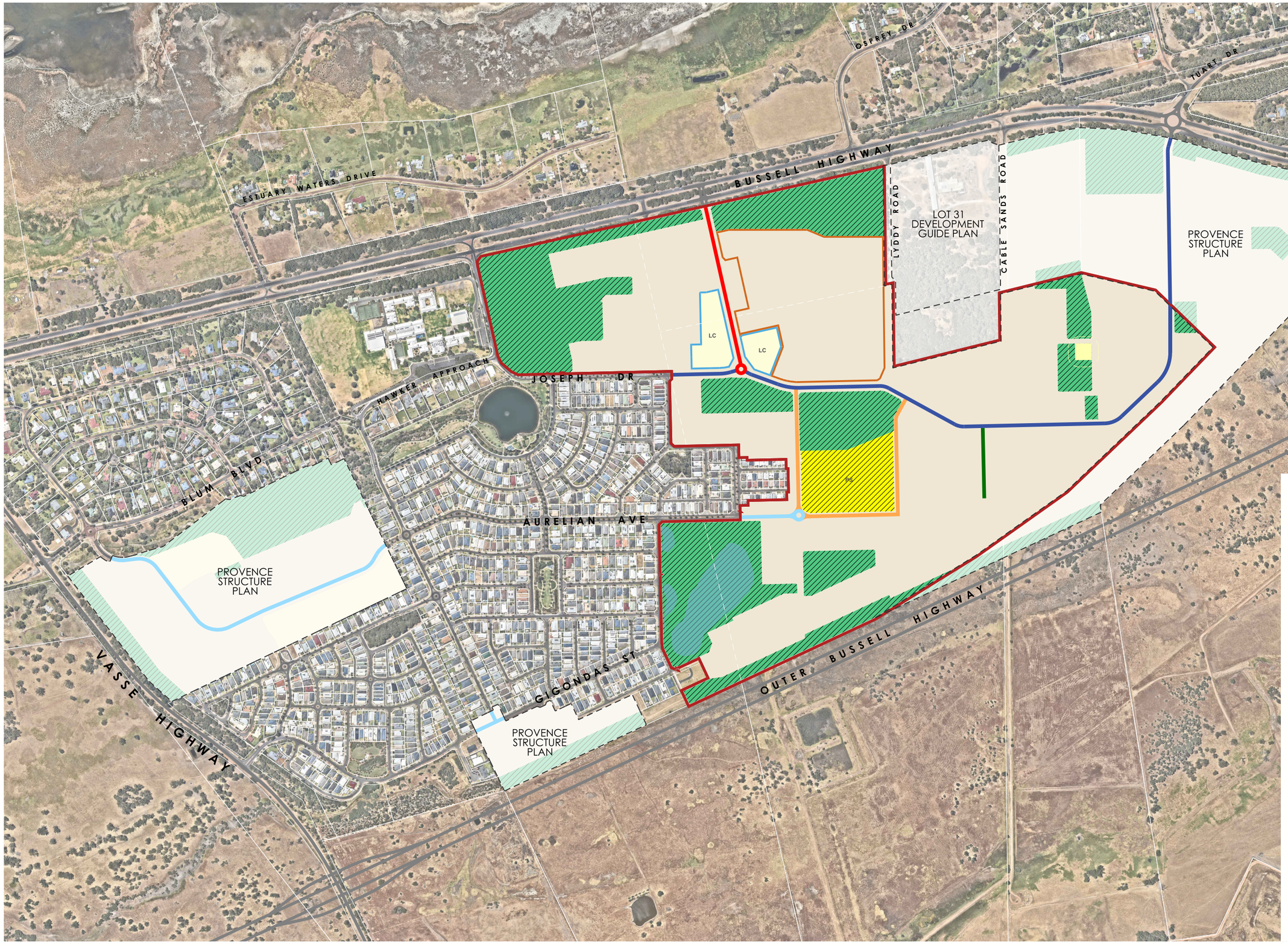
Unit 1/5 Traders Way, Currumbin, QLD 4551
(07) 5607 0508

Sunshine Coast

Unit 1/159 Mark Road, Caloundra West, QLD 4551
(07) 5325 1508

Appendix K

Local Structure Plan Locations



Legend

Busselton Airport North Structure Plan and Provence Structure Plan Amendment

ZONES

- Residential (R25-R40)
- Residential (R25-R40) (Lifestyle Retirement Village)
- LC — Local Centre

RESERVES

- PS — Public Purposes : Primary School
- Public Open Space

MOVEMENT

- Integrator B
- Neighbourhood Connector A
- Neighbourhood Connector B
- Access Street B
- Liveable Street

OTHER

- Waterbody
- Public Purpose (Water Corporation - Indicative location)

Notes

1. Boundaries shown on Plan 1 should not be used for final engineering design.
2. Refer to Appendix G - Transport Assessment for further detail on road hierarchy and intersection considerations.
3. Detailed environmental assessment of Lot 32 Lyddy Road will be required through the preparation of a structure plan amendment for Lots 31 and 32 Lyddy Road, to be consolidated in this structure plan.

Busselton Airport North Structure Plan and Provence Structure Plan Amendment

LOTS 2, 9032 AND Pt LOT 9034 EMBARK ESTATE, YALYALUP

A Yolk Property Group Project

scale: 1:10,000@A3 | 1:5,000@A1

0 100 200m

plan: 22/010/013K

date: 26/02/2025

aerial: Jan 2022

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